

**Socialization Experiences and Research Productivity of Asians and Pacific Islanders:  
“Model Minority” Stereotype and Domestic vs. International Comparison**

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## **ABSTRACT**

Studies of inequality in higher education on both undergraduate and graduate levels have rarely examined experiences of Asians and Pacific Islanders (APIs). In this study, we focus on the experiences and outcomes of API students in doctoral education. More specifically, we examine socialization experiences and research productivity of three groups of students: domestic API, international API, and domestic white students. The results, based on a national cohort of Ph.D. students in biology, reveal notable differences in experiences and outcomes of domestic and international API students. Although variation in socialization experiences explains differences in research productivity in the first year, that is not the case in the second year of doctoral study. In the second year, international API students have publication productivity comparable to their white peers, despite less favorable socialization experiences. Domestic API students, however, have lower research productivity than their white peers, even though they have comparable socialization experiences. Given the presumption of APIs' success, especially in the STEM fields, findings for domestic API students are surprising and not aligned with the model minority stereotype. Contributions to research on API students, doctoral education, and socialization theory are discussed.

## **Socialization Experiences and Research Productivity of Asians and Pacific Islanders: “Model Minority” Stereotype and Domestic vs. International Comparison**

Asians and Pacific Islanders (APIs) have the highest rates of entry into higher education and the highest proportion of adults 25 years and older with a college degree of any racial/ethnic group in the United States (Aud, Fox, & KewalRamani, 2010). Statistics such as these have contributed to the popular depiction of APIs as the “model minority.” Museus and Kiang (2009) define the model minority stereotype as the idea that API students will “achieve universal and unparalleled academic and occupational success” (p. 6). While the operationalization of the model minority stereotype varies across disciplines and studies, we interpret it as implying that API students will have strong academic performance that exceeds that of other groups, including white students. That assumption is likely to be particularly salient in the science, technology, math and engineering (STEM) fields, where the enrollment of API students is high at both undergraduate (Chen, 2009) and graduate (NSF, 2014) levels.

One consequence of the model minority stereotype is a lack of research on API students. Museus (2009) noted that only approximately one percent of articles in the top five higher education journals have focused on API students. A few recent studies have begun to describe experiences of API students in doctoral education (e.g., Le & Gardner, 2010; Sato, 2016; Sato & Hodge, 2009; Zhang, 2016; Zhou, 2014). However, these studies tend to focus on small-sample interviews of specific groups. As such, they provide a thick description of a specific group’s experiences, but they rarely compare those experiences with other groups (including white students) or link them to outcomes such as publication or persistence. While describing doctoral experiences of specific groups is valuable, comparisons are necessary for gaining analytical

leverage and understanding whether those experiences are unique or representative of broader trends in doctoral education. Moreover, the model minority stereotype is fundamentally relational – it implies that API students perform better than other groups, necessitating a comparison.

In addition, the model minority stereotype has produced a misconception that all API students are the same (Museus & Kiang, 2009). Studies at the K-12 and college levels have illuminated variation among API students related to the country of origin (e.g., Hune, 2002; Kao, 1995; Kim, Yang, Atkinson, Wolfe, & Hong, 2001; Palmer & Maramba, 2015). However, attention to variation among API students on the graduate level remains limited. One of the crucial distinctions in graduate education is that between domestic and international students. Prior studies on API doctoral students overwhelmingly focus on international API students. International students face unique challenges in higher education (e.g., Erichsen & Bolliger, 2011; Knox et al., 2013; Lee & Rice, 2007; Suspitsyna, 2013; Zhou, 2015), but their outcomes are distinctly positive. International students, for example, have higher degree completion rates than domestic students (Sowell, Bell, & Mahler, 2008) despite less positive socialization experiences, illuminating the importance of distinguishing between domestic and international students.

The present study contributes to the prior literature by focusing attention on experiences and outcomes of API doctoral students, who have received scant attention in prior research. Moreover, it addresses important limitations of prior research on doctoral education by: a) considering both experiences and outcomes of doctoral students, and b) comparing three groups: domestic API, international API, and domestic white students.<sup>1</sup> The results, based on a national

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<sup>1</sup> While prior research often distinguishes between American and foreign/international students, we use the terms “domestic” and “international” because we did not ask for citizenship. Some of our domestic students could be

cohort of Ph.D. students in biology, reveal notable differences in experiences and outcomes of domestic and international API students. Although variation in socialization experiences explains differences in research productivity in the first year, that is not the case in the second year of doctoral study. In the second year, international API students have publication productivity comparable to their white peers, despite less favorable socialization experiences. Domestic API students, however, have lower research productivity than their white peers, even though they have comparable socialization experiences. These findings offer notable contributions to the literature on graduate education and socialization theory. Moreover, the findings for domestic API students counter the model minority stereotype, which would predict that they would have a higher (or at the very least an equal) level of research productivity as their white peers. The results for international students align with the predictions of the model minority stereotype, yet, finding variation within the API student population in itself counters the stereotype.

These findings are particularly notable because they are observed in a STEM field where API students are well represented. They also illuminate the importance of broadening the definition of success – while API students may enroll in high numbers in STEM fields, that does not automatically mean that they have particularly positive experiences or outcomes. Indeed, despite high enrollments, API students have the lowest Ph.D. completion rate in life sciences among all racial/ethnic groups (Sowell, Bell, & Mahler, 2008).<sup>2</sup> Developing effective ways to support API students will require a nuanced approach that not only discards stereotypes but also considers a range of different outcomes and attends to within-group variation.

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permanent residents. The key distinction examined in this study is not that of citizenship but that of international student status.

<sup>2</sup> Cumulative 10-year degree completion rate in life sciences is 60 percent for whites and African Americans, 54 percent for Hispanics, and 47 percent for Asian Americans.

## LITERATURE REVIEW

### Theoretical Framework: Socialization

Socialization has become the dominant theoretical framework for research on doctoral education (e.g., Gardner, 2010; Holley, 2009; Weidman, 2010). While socialization has roots in many disciplines, the definition underpinning most doctoral education research draws on Merton's work (Merton, 1957; Merton, Reader, & Kendall, 1957). Merton, Reader, and Kendall defined socialization as: "The process through which [an individual] develops [a] professional self, with its characteristic values, attitudes, knowledge and skills ... which govern [his or her] behavior in a wide variety of professional (and extraprofessional) situations" (p. 287).

As applied to doctoral training, socialization is more specifically defined as "a process of internalizing the expectations, standards, and norms of a given society, which includes learning the relevant skills, knowledge, habits, attitudes, and values of the group that one is joining" (Austin & McDaniels, 2006, p. 400). The socialization process evolves over time as novice disciplinary researchers become well versed in the values, attitudes, knowledge, and skills of their chosen discipline (Braxton & Baird, 2000; Gardner, 2009a; Weidman, Twale, & Stein, 2001). The intended outcome of the socialization process of doctoral training is the creation of autonomous disciplinary researchers who are able to extend their discipline's knowledge base (Lovitts, 2005; Weidman, 2010).

The department is considered "the locus of control for doctoral education" (Golde, 2005, p. 671) and the stage upon which doctoral student socialization unfolds. In disciplines like biology, in which laboratory-based research teams are common (Cumming, 2009; Parry, 2007), the socialization process is further reinforced within interactions among research team members. Team members often include the lead faculty supervisor and possibly other associated faculty,

postdoctoral fellows, doctoral students, master's-level students, and sometimes undergraduate researchers. While all team members participate in the socialization process (Knorr-Cetina, 1999), faculty are considered the primary socialization agents in doctoral students' development as disciplinary researchers (Nettles & Millett, 2006; Parry, 2007; Wisker, 2005). In the lab environment, faculty supervisors or mentors play a crucial role in students' academic and social integration into the discipline (e.g., Gardner, 2009b; Lee, 2012; Weidman, Twale, & Stein, 2001; Wisker, 2005). This often extends to opportunities for coauthorship. Kamler (2008) suggested that without faculty to initiate the process, many students would fail to publish at all, and a number of other studies have described the importance of collaboration between faculty and graduate students in producing scientific publications (Maher, Feldon, Timmerman, & Chao, 2014; Maher, Timmerman, Feldon, & Strickland, 2013; Paglis, Green, & Bauer 2006).

Although the socialization process is deemed central to doctoral education, traditionally underrepresented groups of doctoral students report receiving less academic and emotional support from faculty mentors than their white peers (e.g., Felder, Stevenson, & Gasman, 2014; Gardner, 2008; Herzig, 2006; Ramirez, 2016). Prior studies also reveal racial and ethnic disparities in opportunities to publish or present at conferences (e.g., Millett & Nettles, 2006). Comparing experiences of majority and minority women doctoral students across disciplines, Turner and Thompson (1993) noted that minority women were much less likely to coauthor with a faculty member and that they attributed this disparity to a lack of mentorship by faculty. In addition, underrepresented groups of students do not always feel supported by their white peers (Gildersleeve, Croom, & Vasquez, 2011; Sato & Hodge, 2009). For example, Gildersleeve and colleagues found that minority students reported experiencing racially charged moments of discomfort among peers, such as being asked to represent one's racial group to classmates. Not

surprisingly, students from underrepresented groups in the study described a sense of academic and social isolation within their doctoral programs.

While prior studies have considered the socialization process and outcomes of traditionally underrepresented groups of students, experiences and outcomes of API students remain poorly understood. This is captured in the opening line of a chapter on Asian American doctoral students written by Poon and Hune (2009): “One might ask, ‘What is a chapter on Asian American doctoral students doing in a volume on underrepresented minority graduate students?’” (p. 82). These authors contend that while Asian American students have become visible on campus, the model minority stereotype contributes to their invisibility within dialogues on race in education studies. Students in the study described experiences of racial isolation, being mistaken as a foreigner, and being dismissed as, “not a ‘legitimate’ population of color and instead viewed as a ‘model minority’” (p. 100).

### **Experiences of Asian American Students**

Most research on the experiences and outcomes of Asian American students in higher education to date has focused on undergraduates and documents myriad challenges experienced by these students, including identity confusion, discrimination, hostility, and prejudice (Iwamoto & Liu, 2010; Museus & Park, 2015; Museus, Sariñana, & Ryan, 2015; Wong, Tsai, Liu, Zhu, & Wei, 2014). Museus and Park (2015), for instance, noted that Asian American undergraduates regularly experience different types of social and racial discrimination and harassment on their campuses, such as experiencing feelings of isolation and exclusion from peers in and outside of class, feeling pressure to segregate into a certain racial group, and witnessing racist incidents.

Only a few studies have examined the socialization experiences of Asian American graduate students (e.g., Kim, 2009; Nadal, Pituc, Johnston, & Esparrago, 2010). In these studies,

Asian American students reported feeling marginalized in their graduate programs and experiencing a lack of interaction and support from their peers and faculty. These students also perceived that their institutions provided them with inadequate academic and financial resources, which the authors attributed to the model minority stereotype. In addition, Wasburn-Moses (2007) quantitatively compared doctoral students' socialization processes across racial/ethnic groups (Caucasian, Asian, Latino, and African American) and found that Asian American doctoral students reported the lowest satisfaction with both research activities and financial aid.

### **Within-Group Variation: International vs. Domestic**

In graduate education, one of the most salient distinctions is that of international student status. International students are considered “academic sojourners” who are expected to psychologically and socioculturally acculturate to a new environment (Sato, 2016, p. 341; Ward & Kennedy, 1999). Existing research has aimed to gain a deep understanding of the uniqueness of the international students' experiences mostly using qualitative interview data. These studies have examined international students' experiences in relation to academic struggles, including language deficiency, relationships with advisors and peers, cross-cultural transition and adjustment, and financial concerns (e.g., Erichsen & Bolliger, 2011; Knox et al., 2013; Lee & Rice, 2007; Suspitsyna, 2013; Zhou, 2015).

A number of studies in graduate education have focused specifically on the experiences of international API students. This research identifies academic-related difficulties and challenges associated with English language deficiency and social relationships that international API doctoral students typically face in the process of acculturation into doctoral programs in the United States (e.g., Le & Gardner, 2010; Sato, 2016; Sato & Hodge, 2009; Swagler & Ellis, 2003; Zhang, 2016; Zhou, 2014). Limited language abilities often become major obstacles to

comprehension during classes (Sato, 2016) and engagement with different scholarly activities (e.g., presenting in classes or at conferences and writing papers or dissertations) (Sato & Hodge, 2009; Zhang, 2016). Moreover, language barriers lead to unsatisfying and low interaction with peers, which can make the international API doctoral students feel isolated or lonely (Le & Gardner, 2010; Zhang, 2016).

In addition to language-related concerns, international API doctoral students have other academic-related struggles, such as challenges with managing time and prioritizing multiple tasks (e.g., coursework, teaching, research) (Sato & Hodge, 2009) and experiencing academic pressure and anxiety about doing research (Sato, 2016). In terms of social relationships, international API doctoral students often have difficulty establishing satisfying relationships with their faculty advisors. According to these students, their advisors lack understanding about international students' unique difficulties (Sato, 2016), and their research interests or expectations are mismatched with those of their advisors (Zhou, 2014).

Despite the challenges, prior research notes that international students have more positive outcomes, such as higher degree completion rates, than domestic students (Sowell, Bell, & Mahler, 2008). Several studies have considered how motivational factors may contribute to international doctoral students' academic persistence and success (e.g., Takashiro, 2017; Zhou, 2014, 2015). Based on interviews with 19 international doctoral candidates, Zhou (2015) reported that these students were highly intrinsically interested in and passionate about research or teaching. These students also perceived that a doctoral degree earned in the United States would make it easier for them to obtain permanent residency in the United States or to have more favorable job and career opportunities in their home countries. In addition to the perceived high utility values of a degree earned in the United States, international doctoral students were

motivated by high levels of psychological burdens (e.g., responsibility to their families or fear of disappointing their parents) and opportunity costs (e.g., quitting their previous jobs to come to the United States to pursue their doctoral degrees) associated with terminating their doctoral studies.

Focusing specifically on international API doctoral students, Zhou (2014) and Takashiro (2017) discussed distinctive features of academic motivation arising from a Confucian cultural perspective. They reported that students from Confucian countries (e.g., China, Japan, Korea) believe that academic success can be achieved through effort, hard work, and diligence rather than innate ability. In addition, because they tend to perceive the relationship between their lives and the lives of their parents interdependently, they feel a great responsibility to meet their parents' expectations and to bring honor to their families. Zhou (2014) and Takashiro (2017) argue that these Confucian beliefs may be a source of motivation for international API doctoral students to continue their studies despite challenges. However, none of these studies compare domestic and international students making it difficult to deduce the extent to which these values and approaches are unique to international API students.

### **Extending Prior Research**

We extend prior research on API doctoral students in several respects. First, most studies focus on experiences of a particular group of students and lack comparisons that would place those experiences in a broader context of doctoral education. In particular, research focusing on API graduate students has primarily documented the experiences of specific groups of international students. As such, this research has not compared experiences of API students with their white peers or examined variation within API student populations by directly comparing international and domestic students (for a recent exception, see Curtin, Stewart, & Ostrove,

2013). All students experience certain challenges as they transition into the Ph.D. program. To understand the unique ways in which certain groups are affected necessitates a comparison. Comparison is also necessary in light of the model minority stereotype, which assumes that API students will have more positive outcomes than other groups, including white students.

Second, prior studies of API graduate students' experiences do not link students' socialization experiences with outcomes of doctoral education (whether that is publication, degree completion, or post-graduation outcomes). While negative experiences could lead to negative outcomes, research on international students shows that is not always the case. As noted earlier, despite the challenges, international students have more positive outcomes (e.g., rates of degree completion and time to degree) than domestic students (Sowell, Bell, & Mahler, 2008). Specific experiences during graduate studies thus may or may not have a direct correlation with specific outcomes, necessitating an examination of the link between students' experiences and outcomes.

In the present study, we address both of these gaps in the prior literature. First, we compare socialization experiences of three student groups: domestic API, international API and domestic white students. These comparisons offer analytical power that moves beyond the description of a specific group's experiences to exploring how experiences vary across groups. Second, we link students' socialization experiences with a specific outcome of doctoral education – research productivity. In scientific fields, written text preserves and transmits science, becoming “a constitutive part of science ... [which is] inextricably linked to the very nature and fabric of science” (Norris & Phillips, 2003, p. 226). Thus, “it is clearly important for science that its most junior members learn how to be productive in the traditional sense of developing peer-reviewed presentations and publications” (Louis, Holdsworth, Anderson, &

Campbell, 2007, p. 312). A track record of research productivity is important for securing academic employment (Ehrenberg, Zuckerman, Groen, & Brucker, 2009), and Ph.D. students are increasingly expected to have a publication record prior to completing their degrees (Nettles & Millett, 2006), making this an important outcome to examine.

## **DATA AND METHODS**

This study is based on a national sample of students in biology Ph.D. programs.<sup>3</sup> Participants were recruited in two ways. First, program directors and department chairs of the 100 largest biological sciences doctoral programs in the United States were contacted by email to describe the study and request that they inform incoming Ph.D. students about the research project. Following, to diversify the prospective pool of participants, all public flagship universities (research intensive), historically black colleges and universities (HBCUs), and Hispanic serving institutions (HSIs) offering Ph.D. programs in appropriate biology subfields were contacted. Collectively, emails were sent to administrators at 203 postsecondary institutions. Those who agreed forwarded recruitment information on behalf of the study to students, who then contacted the research team expressing interest in participation. In instances where incoming cohorts were 6 students or more, campus visits were arranged for a member of the research team to present information to eligible students and answer questions during program orientation or an introductory seminar meeting. Second, emails describing the study and eligibility criteria were forwarded to several listserves, including those of the American Society for Cell Biology and the CIRTL (Center for the Integration of Research, Teaching, and Learning) Network for broader dissemination. All students who responded to these emails

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<sup>3</sup> More specifically, the study focused on “bench biology” – doctoral programs in fields including microbiology, cellular and molecular biology, genetics, and developmental biology.

already attended programs contacted in the first phase of recruitment, suggesting that recruitment efforts approached saturation at the institutional level.

The study includes 336 Ph.D. students who began their biology Ph.D. programs in the fall of 2014. The sample is distributed across 53 institutions, reflecting 26.1% of the institutions contacted. A traditional response rate cannot be computed due to uncertainty regarding whether inquiry emails in fact reached appropriate personnel, whether recruitment materials were forwarded to all students eligible to participate in the study, and the lack of available data regarding the total number of students admitted to appropriate doctoral programs within each institution. One institution, for example, indicated that it happened to admit no Ph.D. students in fall of 2014. Circumstances like these could have been the case at other institutions that did not volunteer such information.

Overall, the institutions included in the sample are highly research intensive. Based on Carnegie classification, 42 institutions are R1 (highest research activity), 7 institutions are R2 (higher research activity) and the remaining 4 institutions fall in other Carnegie categories. The sample for this manuscript is restricted to three groups of students: international API, domestic API, and domestic white students (reference).<sup>4</sup> These groups comprised 259 students in the Year 1 sample (77.1% of the total sample), including 41 international API students, 30 domestic API students, and 188 domestic white students. The overall attrition rate from the study between year 1 and year 2 is 10 percent and is similar across the three groups (10 percent for international API students, 7 percent for domestic API students, and 11 percent for domestic white students).

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<sup>4</sup> Students who identified as white international students were excluded from analysis given that the experiences of international students differ from their domestic peers, apart from race/ethnicity. In addition, six students were missing information on race/ethnicity and four were missing a report of whether they were international students and where thus excluded from analysis.

Logistic regression analysis predicting attrition between year 1 and year 2 shows no significant differences across groups in leaving the sample by year 2.

Given a dearth of comparable nationally representative data, it is difficult to establish the representativeness of the sample. Reports from the Survey of Earned Doctorates, a national annual survey of doctoral recipients, include information only on degree completers. Given high and unequal attrition rates, racial/ethnic distributions for enrollment and completion inevitably differ. Moreover, reports based on the Survey of Graduate Students and Postdoctorates in Science and Engineering, which provide information on enrollment, combine all international students and all graduate enrollment (including both Master's and Ph.D. level). Based on those reports, API students represent 12 percent of domestic graduate enrollment in biological sciences, and international students represent 23 percent (NSF, 2014). If we construct comparable comparisons using the same definitions, APIs represent 11 percent of domestic students in our sample, and international students represent 20 percent of the total sample. According to these metrics, our study sample does not notably deviate from national samples of doctoral students in biological sciences.

## **Variables**

Students participating in the study completed annual surveys regarding their Ph.D. program experiences. Given the prominence of socialization experiences in the literature on doctoral education, and the identification of potential challenges in interactions between API students and their peers and faculty, we focused on two indicators of socialization experiences.<sup>5</sup> These indicators were developed by Weidman and Stein (2003) based on the model of graduate

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<sup>5</sup> The survey also includes more specific questions regarding satisfaction with advisors. However, those measures are not related to the outcome – research productivity – and thus are not included in the presented analyses. Moreover, students in most programs go through rotations in the first year and thus do not have a permanent lab or advisor, making that measure problematic for the first year.

student socialization. The first scale reflects respondents' participation in scholarly activities, which asks students to check if they are involved in a range of different scholarly activities in their programs (see Table A1 in the Appendix).<sup>6</sup> The second scale gauges faculty and peers' interactions in specific ways listed in Table A1. Both measures used in the study are averages of the respective items included in each scale.<sup>7</sup>

The key outcome of interest is research productivity. At the end of the spring semester of their first and second year, participants were asked to identify any journal articles, conference papers, or published abstracts for which they had received authorship credit during the academic year. Responses were validated through independent researcher verification of the citation information provided against conference proceedings and journal tables of contents.

Respondents were contacted regarding any observed discrepancies and finalized information was subsequently used for analysis. We used this information to create scholarly productivity as an indicator for whether students had any publications (an article, conference paper or abstract) in the previous year.<sup>8</sup>

All analyses control for a set of factors that are likely related to research productivity and may vary across different demographic groups, including: a dummy variable for female, performance on the Lawson's Test of Scientific Reasoning administered at the start of doctoral

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<sup>6</sup> The original scale included three additional items asking students whether they 1) authored a paper submitted for publication, 2) presented at a conference, and 3) authored a paper accepted for publication. These items present endogeneity concerns given their relationship to the outcome and are omitted from the scale used in this study.

<sup>7</sup> While some research, especially on undergraduate education, points to discrimination as another potential factor, we find no differences in the reports of campus climates or prejudice across the three groups of students examined in the study (see Table 2A in the Appendix). Moreover, neither of these measures is related to research productivity in either bivariate or multivariate specifications. Thus, given our small sample size and limited degrees of freedom, we do not include these measures in presented analyses.

<sup>8</sup> While it would be valuable to consider variation among different publication types, our small sample and limited scholarly productivity in the first two years of doctoral education eliminates this possibility. As Table 1 indicates, only 30 and 46 percent of students in the sample have any publications in their first and second year, respectively. In general, the most common publication type is an article, followed by an abstract; very few students reported having a conference paper.

training, Kardash Research Self-Efficacy Scale, months of research experience prior to entering the Ph.D. program, and a dummy variable indicating any scholarship produced before entering the Ph.D.

Lawson's Test of Scientific Reasoning is a 24-item test assessing students' general science reasoning (Lawson, 1978; Lawson, Clark, Cramer-Meldrum, Falconer, Sequist, & Kwon, 2000). Kardash's (2000) Research Self-Efficacy Scale asks respondents to rate their abilities on different research-related tasks, from understanding concepts in the field and identifying a research question, to designing experiments and analyzing and interpreting data. Each item is rated on a Likert scale of 1 to 5 ("not at all", "less capable", capable, "more capable", "a great deal"). In addition, respondents were asked to report the number of months of prior research experience they have had during high school, undergraduate and previous graduate education, as well as in industry. We sum all of their experiences to report the total amount of research experience.<sup>9</sup> Students also reported whether that prior research experience resulted in any scholarly products (including journal articles, conference papers, posters, or patents), which we include as an additional control.

Table 1 includes descriptive statistics for all measures used in analyses. In addition to differences across groups observed in research productivity and socialization experiences, which are discussed in the results section, it is worthwhile to note that the groups differ on control measures. In particular, descriptive results reveal variation in the amount of prior research experience and scholarship produced during that prior research experience: international API students have less prior research experience and less experience publishing before entering their

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<sup>9</sup> The most common type of research experience is undergraduate. Almost 90 percent of students in the sample reported having undergraduate research experience (mean = 19.4 months among those reporting at least some undergraduate research experience).

Ph.D. programs. These differences point to the importance of attending to students' experiences before Ph.D. entry in any analysis of doctoral students' experiences and outcomes.

[Table 1 about here]

## **Analyses**

Socialization experiences are estimated using OLS regression while publication outcomes are estimated using logistic regression (and thus estimate the likelihood that students have a publication in their first and second year, respectively). All analyses are adjusted for clustering of students within institutions using SVY command with a CLUSTER option in SAS.

From the starting sample of 259 students, 235 provided information regarding their scholarly productivity that the research team could verify in year 1. Similarly, 229 respondents have provided the information in year 2. A small number of students were missing information on either socialization experiences or control variables. Given the small amount of missing data on those measures (approximately 5 percent on all independent variables included in analysis), we used listwise deletion. All presented analyses thus reflect students with complete cases on all of the measures included in the study.

## **Limitations**

Given current research on doctoral students, particularly API students, which often involves interviews with a dozen or so students at one or a few institutions, our sample is much larger and broader than what is currently available in the literature. At the same time, the sample is small relative to databases collected by federal agencies and not nationally representative. There is no national dataset that includes detailed information on socialization experiences and publication outcomes for students enrolled in doctoral programs by field. The Survey of Earned Doctorates provides information on degree completers, which is quite different from enrollment

given high and unequal attrition rates from graduate programs. The Survey of Graduate Students and Postdoctorates in Science and Engineering collects primarily basic enrollment information. Our results present a strong case for the importance of collecting large-scale nationally-representative data on doctoral education that include information on both socialization experiences and outcomes such as publications and track students as they progress through their doctoral programs.

Moreover, small sample size of the study hinders our ability to conduct more nuanced analyses on specific subgroups. For example, recent studies have suggested that Asian women are disadvantaged in unique ways (e.g., Dutta, 2015; Green & Kim, 2005; Wong, Tsai, Liu, Zhu, & Wei, 2014), but we are not able to disaggregate analyses by gender (N is too small and analyses will not converge).<sup>10</sup> Similarly, prior research indicates that ethnicity and country of origin are important to consider, as not all API sub-groups have the same experiences or outcomes (e.g., Hune, 2002; Kim, Yang, Atkinson, Wolfe, & Hong, 2001; Palmer & Maramba, 2015). Notwithstanding our inability to disaggregate beyond the comparisons presented, this is the first study in doctoral education to examine inequality in socialization experiences and outcomes of domestic and international API students relative to their white peers. We hope that this endeavor will stimulate future research in the area and generate additional large datasets that can expand on presented findings.

Finally, it is important to note that the sample is restricted to bench biology. Focusing on one area with common methodologies and relevant primary literatures allows us to present more precise analyses. Given the importance of enculturation into academic disciplines, it is likely that

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<sup>10</sup> Descriptive results indicate that the gender distribution varies across groups, although gender is not related to either socialization or publication outcomes. Gender coefficients for socialization outcomes are close to zero across models. There is some indication that women may be disadvantaged in terms of publication in year 1, although the difference is not statistically significant, and there are no gender differences in year 2.

students' experiences vary across them, which would make it difficult to disentangle the unique experiences of API students from the context of their fields of study if multiple disciplines were included. Moreover, the model minority stereotype is likely to be particularly prominent in STEM fields, and thus focusing on biology presents a compelling context within which to draw inferences. Future research is needed to assess the extent to which the patterns observed herein are representative of students' experiences across different academic disciplines.

## **RESULTS**

### **Socialization Experiences**

Descriptive results in Table 1 indicate that international API students have less positive socialization experiences than their White peers during both first and second year of doctoral study. Domestic API students report lower levels of participation in scholarly activities during their first year, but otherwise have socialization experiences similar to those of their white peers. Table 2 presents OLS regression analyses of the two socialization measures, controlling for several confounding factors.

[Table 2 about here]

The results indicate that even net of controls, in the first year of doctoral study, international API students report less opportunity to engage in scholarly activities and less positive interactions with faculty and peers. The magnitude of the coefficients is notable. Given that the standard deviation for interaction with faculty and peers is 0.23 points, the gap of 0.29 points in year 1 implies that international API students report interactions that are, net of controls, more than one standard deviation below those of their white counterparts.

These patterns continue into the second year. During the second year of doctoral study, international API students report less opportunity to engage in scholarly activities and less positive interactions with faculty and peers. The magnitude of the coefficients is similar to that in the first year. Thus, contrary to our expectations that international API students would have more positive experiences over time as they become acclimated to the U.S. doctoral education context, reports of less positive experiences continue into the second year.

Domestic API students show a notably different pattern of experiences. Domestic API students do not differ from white students with respect to interactions with faculty and peers in the first year of doctoral study. They do report less opportunity for participation in scholarly activities in the first year, although the magnitude is notably lower than that for international API students. Moreover, by the second year, domestic API students do not differ on either indicator of socialization experiences from their white peers. Thus, whatever small differences existed in the first year are eliminated by the second year, and domestic API students and their white counterparts report similar opportunities for engaging in scholarly activities and interaction with faculty and peers.

These results reveal the importance of attending to both race and international student status when exploring graduate students' experiences. In addition, these results point to the importance of studying socialization processes as they evolve over time. Socialization is presumed to be a longitudinal process, as students become acclimated and integrated into the academic culture. Yet, socialization processes examined in this study show variation in trajectory across groups – while domestic API students resemble their white peers in socialization experiences by the second year of doctoral study, that is not the case for international API students. The acculturation process thus is unequal across groups.

## Research Productivity

Table 3 presents two sets of logistic regression models – one that examines the gaps in research activity between international and domestic API students relative to white students (reference) and the other that examines the same gaps while also considering differences in socialization experiences. In the first year, both groups of API students are less likely to have a scholarly publication. The coefficient for domestic API students is significant only at  $p < 0.10$ , although it is of similar magnitude as the international API students' coefficient. The results indicate that API students, both international and domestic, are approximately 40 percent less likely than their white counterparts to have a publication in their first year of doctoral study.

[Table 3 about here]

The second model shows that this gap in the first year is primarily a result of differences in socialization experiences. Once socialization experiences are included in the model, there are no statistically significant differences between either group of API students and their white peers. The coefficient for international API students is especially reduced, as would be expected given the large differences in socialization experiences noted in Table 2. These findings indicate that the lower research productivity of API students in the first year of doctoral study, and especially international API students, is largely attributable to the differences in their socialization experiences.

By the second year of doctoral study, international API students appear to be able to overcome their less positive socialization experiences and excel despite those experiences. In the first model, including only controls, we observe no differences in scholarly productivity between international API students and their white peers. Even though they reported substantially less positive socialization experiences in the second year (Table 2), they are managing to produce at a

level comparable to white students. The same pattern holds once we control for socialization experiences, at which point the coefficient for international API students is of reasonable magnitude and positive, although not statistically significant at  $p < 0.05$ .

Domestic API students, on the other hand, follow a very different pattern. In Model 1, domestic API students have a much lower likelihood of having a publication: they are 40 percent less likely to have a publication in the second year than their white peers. Moreover, this gap is not eliminated once socialization experiences are considered. This would be expected given that Table 2 showed no differences in socialization experiences between domestic API and white students. Thus, while international API students have caught up (or even potentially surpassed) white students in scholarly productivity in the second year, domestic API students are lagging substantially behind.

These findings are notable not simply because they show differences between domestic and international API students. They illuminate the limitations of socialization experiences, at least those assessed in this study, to explain differential productivity outcomes during doctoral study. Domestic API students have socialization experiences comparable to their white peers, and yet have a lower productivity level. International API students, on the other hand, face notable difficulties with respect to their socialization experiences, and yet manage to have a high level of productivity. We explore potential explanations for these patterns in the next section.

## **DISCUSSION**

Studies of inequality in higher education on both undergraduate and graduate levels have focused on understanding the experiences of traditionally underrepresented groups, including African Americans and Hispanics. This research has rarely considered the experiences of API

students, who are perceived as having positive outcomes and thus do not warrant attention.

Although API students do well on certain metrics, such as access and completion of higher education, much inequality remains below the surface (see reviews in Museus & Kiang, 2009; Ng, Lee, & Pak, 2007). These more subtle forms of inequality remain largely hidden, as limited research examines experiences and outcomes of API students.

To contribute to the literature on API students, we examine socialization experiences and research productivity of doctoral students in biology. The model minority stereotype implies that API students would have better (or at the very least equitable) outcomes to their white peers. Moreover, since the stereotype is typically used in reference to Asian Americans, the pattern should be particularly prominent for domestic API students. Our findings, however, reveal that domestic API students have lower research productivity than their white peers, even when they report comparable socialization experiences.

In addition to inviting a reconsideration of the model minority stereotype, presented findings offer several key insights for research on doctoral education and socialization theory. First, socialization experiences of international API students are less positive than those of their white peers. Moreover, contrary to expectations from both socialization theory and research on international students, those experiences do not improve over time. Although some studies have reported that international students become more socially and academically confident over time (e.g., Le, LaCost, & Wismer, 2016), that does not seem to translate into more positive socialization experiences. International API students continue to report lower levels of participation in scholarly activities and less positive interactions with faculty and peers in their second year of doctoral study. Domestic API students, on the other hand, report socialization experiences similar to those of their white peers.

The second notable finding pertains to the limits of the influence of socialization experiences. Although socialization experiences (and in particular opportunities to participate in scholarly activities) are related to research productivity, they do not explain variation across groups in research productivity in the second year of doctoral study. In the second year, international API students have research productivity comparable to their white peers, despite their less positive socialization experiences. Domestic API students, on the other hand, have lower levels of research productivity, notwithstanding their positive reports of socialization experiences, which are statistically indistinguishable from those of white students.

Taken together, these findings point to a greater need to examine group differences within a socialization framework. Although prior research has conceptualized differential access to opportunities within doctoral training as a function of socialization and faculty perceptions of student ability (e.g., Gopaul, 2011; Green & Bauer, 1995; Paglis, Green, & Bauer, 2006), the prospect that socialization mechanisms may have differential explanatory power across groups has not yet been explored. The differential role of socialization may occur as a consequence of interactions amongst students' nonacademic cultural models and networks (e.g., Sweitzer, 2009), pervasive stereotypes that play out in academic contexts (e.g., Felder, Stevenson, & Gasman, 2014), and disciplinary practices related to the distribution of scholarly work within laboratories and working groups (e.g., Campbell, 2003; Roulston, Preissle, & Freeman, 2013; Shore, Randel, Chung, Dean, Ehrhart, & Singh, 2011). To examine such interactions effectively, studies would benefit from larger and more intentionally diverse samples, as well as the application of mixed methods to capture both scalable outcome data and rich insights into the experiential nature of socialization processes within doctoral education. For example, Feldon, Maher, Roksa, and Peugh (2016) identified divergent themes in how STEM graduate students interpreted the value

and effectiveness of their training experiences as a function of their quantified upward or downward trajectories in research skill development. Such nuances can provide important insights into the mechanisms of socialization in graduate programs that can be directly applied to changes in training practice.

Our findings also point to several specific directions for future research. First, future studies are needed to understand why international API students are able to demonstrate high research productivity despite less than optimal socialization experiences. Such insight could be useful in fostering the success of students from a variety of groups who often struggle with successful socialization in existing academic systems. Prior research in K-12 education has often linked strong academic achievement of API students to parenting practices, educational investments and/or cultural differences (e.g., Byun & Park 2012; Gibbs, Shah, Downey, & Jarvis, 2016; Hsin & Xie, 2014; Kao, 1995; Liu & Xie, 2016; Sun, 1998). Similarly, research on college students has at times invoked cultural values in understanding performance of specific API sub-groups (e.g., Kim, Yang, Atkinson, Wolfe, & Hong, 2001; Maramba & Palmer, 2014; Museus & Maramba, 2011). However, most of that research is based on American students, which would imply that domestic API students should have similarly positive outcomes, especially since they report socialization experiences comparable to those of white students. It is not clear from past research why we should observe such a strong difference between domestic and international API students. One possible explanation includes variation in the country of origin. Prior studies on K-12 and college levels (e.g., Hune, 2002; Kao, 1995; Kim, Yang, Atkinson, Wolfe, & Hong, 2001; Palmer & Maramba, 2015) show that API students' academic outcomes vary depending on the country of origin. Thus, if domestic and international API

students in our sample differ in their countries of origin, that may contribute to the differences observed.

Moreover, Zhou (2014) proposed that factors such as high motivation and utility value of a U.S.-trained Ph.D. contribute to the persistence of international API students despite academic and social difficulties. That study, however, is based on a sample of Chinese international students, precluding an understanding of whether motivational factors for this group are indeed more prominent than for other groups. In addition, Curtin, Stewart, and Ostrove (2013) suggested that selection may explain why international students outperform their domestic peers. If international students are more talented, committed, or ambitious, they may be more likely to succeed. However, the descriptive statistics presented in Table 1 are not aligned with that explanation. International API students do not have higher scientific reasoning, stronger research background or higher research self-efficacy than domestic students. Although, differences in other variables not observed in this study, such as ambition, family expectations, or perceptions about the importance of high productivity to secure employment after the Ph.D. might exist. Future research would benefit from examining potential variations in these factors between domestic and international students as well as API and white students.

Another potential area of future research pertains to implicit biases and stereotypes. Previous studies have suggested that a person's self-stereotype activated unconsciously or implicitly could affect that person's behavior or performance (Cheryan & Bodenhausen, 2000; Devine, 1989; Shih, Pittinsky, & Ambady, 1999). For instance, Shih, Pittinsky, and Ambady reported that female Asian-American undergraduate students whose Asian identity was manipulated to be unconsciously salient earned higher scores on a mathematic test than a control group (i.e., no identity salience), while students with gender identity salience earned lower scores

on the test than the control group. However, other studies have suggested that even a positive bias or stereotypes can undermine performance due to high pressure toward achievement (e.g., Cheryan & Bodenhausen, 2000). These studies imply that future research could extend our current findings by examining whether the performance of API and international doctoral students is influenced by implicit biases associated with their racial identity or international status.

More research is also needed to explore why domestic API students have lower research productivity than their white peers. Prior literature would imply that those differences arise either from different socialization experiences or negative racial climates and incidences of prejudice and discrimination. Our results do not support either of those explanations, as no difference exists between domestic API students and their white peers on those indicators (see Appendix A). One place to look for alternative explanations may be the scientific workforce. The U.S. EEOC's Asian American and Pacific Islander (AAPI) Work Group (2009) recently issued a report examining challenges faced by AAPIs in progressing toward leadership positions, which has been termed "the bamboo ceiling" (Hyun, 2005). Akin to the ways in which AAPI employees encounter challenges in being recognized and supported in advancing in their careers, domestic API doctoral students may face difficulties in gaining inclusion in scientific publications. As the Work Group noted, much more research in this area is needed, since AAPIs represent the "forgotten minority," with very little research available examining their experiences and outcomes. Only through more research will we gain the knowledge necessary to dispel the model minority stereotype as well as point to productive ways of facilitating success for all students.

## APPENDIX A

Table 1A. Items included in socialization scales (Weidman & Stein, 2003)

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### **Scholarly activities**

Check any of the following activities in which you are/were involved...

- Been asked by a fellow student to critique his/her work
- Held membership in a professional organization
- Asked a fellow student to critique your work
- Attended a convention of a professional organization
- Performed research of your own which was not required by your program or studies
- Called or written to a scholar at another institution to exchange views on scholarly work
- Written, alone or with others, a grant proposal
- Authored, alone or with others, an unpublished manuscript (not part of a course)

### **Interactions with faculty and peers**

Is there a professor in your department with whom you...

- Sometimes engage in social conversation
- Often discuss topics in his/her field
- Often discuss other topics of intellectual interest
- Ever talk about personal matters

Is there any student in your department with whom you...

- Sometimes engage in social conversation
  - Often discuss topics in his/her field
  - Often discuss other topics of intellectual interest
  - Ever talk about personal matters
-

Table 2A. Campus climate and prejudice measures (Nora & Cabrera, 1996)

	<b>Campus climate</b>		<b>Faculty/staff prejudice</b>	
	Year 1	Year 2	Year 1	Year 2
	Means		Means	
International API	1.16	1.24	1.24	1.19
Domestic API	1.12	1.27	1.03	1.19
Domestic White	1.17	1.26	1.10	1.13
	Correlations		Correlations	
Publications year 1	0.07		0.00	
Publications year 2		0.11		0.07

Note: None of the mean differences or correlations are significant at  $p < 0.05$

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Table 1. Descriptive statistics (means and standard deviations for continuous measures), by group

	Full sample	International API	Domestic API	Domestic White
<b>Socialization</b>				
<i>Year 1</i>				
Scholarly activities	0.39 (0.24)	0.26 (0.19)	0.33 (0.17)	0.42 (0.24)
Interaction with faculty and peers	0.76 (0.23)	0.55 (0.22)	0.78 (0.21)	0.81 (0.20)
<i>Year 2</i>				
Scholarly activities	0.53 (0.24)	0.36 (0.21)	0.52 (0.19)	0.56 (0.22)
Interaction with faculty and peers	0.78 (0.22)	0.55 (0.22)	0.82 (0.21)	0.83 (0.18)
<b>Publication</b>				
<i>Year 1</i>	0.31	0.19	0.21	0.33
<i>Year 2</i>	0.47	0.49	0.29	0.49
<b>Controls</b>				
Female	0.60	0.73	0.63	0.59
Scientific reasoning	19.73 (3.87)	18.56 (4.66)	20.40 (3.29)	20.43 (2.98)
Self-efficacy	3.41 (0.60)	3.37 (0.66)	3.31 (0.52)	3.40 (0.56)
Prior research experience (months)	28.98 (20.55)	25.29 (18.46)	31.40 (20.50)	29.52 (22.12)
Prior publication	0.75	0.55	0.83	0.78

Table 2. OLS regression models predicting socialization experiences

	<b>Year 1</b>		<b>Year 2</b>	
	Scholarly activity	Interaction	Scholarly activity	Interaction
<b>Race/international status</b>				
<i>[reference: domestic white]</i>				
International API	-0.17** (0.04)	-0.29** (0.04)	-0.20** (0.04)	-0.30** (0.03)
Domestic API	-0.08* (0.04)	-0.02 (0.05)	-0.03 (0.03)	-0.01 (0.05)
<b>Controls</b>				
Female	-0.02 (0.03)	-0.02 (0.03)	0.01 (0.03)	0.03 (0.03)
Scientific reasoning	-0.00 (0.01)	-0.01* (0.00)	0.00 (0.01)	-0.00 (0.00)
Self-efficacy	0.10** (0.03)	0.06** (0.02)	0.11** (0.03)	0.04^ (0.02)
Prior research experience (months)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Prior publication	0.05 (0.04)	0.00 (0.03)	0.00 (0.03)	0.00 (0.03)
Intercept	0.13 (0.14)	0.79** (0.11)	0.13 (0.14)	0.71** (0.11)
N	244	244	224	224

Note: ^p<0.10, \*p<0.05, \*\*p<0.01 (analyses adjusted for clustering of students within institutions)

Table 3. Logistic regression analyses predicting research productivity (publications)

	Year 1		Year 2	
	Model 1	Model 2	Model 1	Model 2
<b>Race/international status</b>				
<i>[reference: domestic white]</i>				
International API	-0.88*	-0.17	0.06	0.70^
	(0.44)	(0.50)	(0.41)	(0.40)
Domestic API	-0.83^	-0.70	-0.94*	-0.88*
	(0.48)	(0.51)	(0.43)	(0.41)
<b>Socialization</b>				
Scholarly activities		1.06		2.13**
		(0.81)		(0.63)
Interaction with faculty and peers		2.09*		0.85
		(0.95)		(0.75)
<b>Controls</b>				
Female	-0.54	-0.53	0.02	-0.01
	(0.35)	(0.36)	(0.23)	(0.24)
Scientific reasoning	-0.14**	-0.13*	-0.05	-0.06
	(0.05)	(0.05)	(0.04)	(0.05)
Self-efficacy	0.14	-0.06	0.01	-0.25
	(0.26)	(0.29)	(0.22)	(0.24)
Prior research experience (months)	0.02*	0.02*	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)
Prior publication	0.56	0.49	0.51	0.51
	(0.34)	(0.34)	(0.32)	(0.34)
Intercept	1.05	-0.49	0.45	-0.36
	(1.65)	(1.76)	(1.27)	(1.33)
N	226	226	217	217

Note: ^p<0.10, \*p<0.05, \*\*p<0.01 (analyses adjusted for clustering of students within institutions)