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Stereotype Threat:

Undermining the Persistence of Racial Minority Freshmen in the Sciences

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ABSTRACT:

This longitudinal survey study examined whether possessing the combined attributes of having experienced high frequency of negative racial interactions and having a high degree of identification with one's domain or field of study puts underrepresented racial minority (URM) students at greater risk of changing their major by the end of the first year of college. According to the theory of stereotype threat, possessing both attributes increases URM students' vulnerability to *stereotype threat*, which in turn may negatively affect their academic performance. Of particular interest was the extent to which the combination of those two attributes affected first-year URM students in biomedical and behavioral science (BBS) majors. The results show that URM freshmen who reported high levels of both negative racial experiences and science domain identification were significantly less likely to persist in their intended major during the first year of college. The educational implications of the findings are discussed.

Stereotype Threat:

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In 2006, the U.S. Congress held numerous hearings about why a smaller proportion of undergraduates than in the past are undertaking studies in physical and life sciences. Those concerns are driven in part by interests in preserving the nation's economic competitiveness and position in technological leadership. Some legislators have called the U.S. science pipeline "leakier than warped rubber tubing" (Epstein, 2006, p. 1). Indeed, roughly half of undergraduates who show an initial interest in majoring in the sciences decide to major in other fields within their first two years of study, and very few non-science majors switch to science majors (Center for Institutional Data Exchange and Analysis, 2000). The rates of science major completion for underrepresented racial minority students (African American, Latina/o, and American Indian) are even more dismal. Looking at degree attainment, only 24% of underrepresented students complete a bachelor's degree in science within six years of college entry, as compared to 40% of White students (Center for Institutional Data Exchange and Analysis, 2000).

Moreover, the Sullivan Commission (2004) reported that the gap in participation rates between underrepresented racial minority (URM) students and their White and Asian American peers widens at the graduate and professional school levels. In Nelson's (2004) listings of earned doctorates, for example, she reported that between the years 1993 and 2002, African Americans accounted for only 2.6% of earned doctorates in biological sciences, whereas Latinos accounted for 3.6%. For 2002, the report indicated only 122 African Americans and 178 Latinos received doctorates in biological sciences compared to 3,114 Whites and 580 Asian Americans. When considering future generations of scientists and healthcare professionals, the Sullivan Commission declared underrepresented minorities to be "missing persons" in those fields.

Retention of science majors at the earliest stages of undergraduate education, particularly those who are URM students, is a crucial step to purposefully reverse these trends. The purpose of this study is to go beyond explanations of preparation to examine the social and contextual factors, including racial experiences, that result in persistence or departure from pursuing science during the first year of college for URM students. Our goal is to address several explanations regarding why URMs depart science at higher rates and the concerns raised about our nation's capacity to fulfill our science-related interests, especially as they relate to the growth of racial/ethnic minority populations in U.S. society.

Background

Why are URM undergraduates departing from their studies in the sciences at significantly higher rates than their White and Asian American counterparts? According to the American Association for the Advancement of Science (2001), three of the most important factors contributing to undergraduate degree completion in the sciences are the intensity and quality of high school curriculum, test scores, and class rank or grade point average in high school. However, undergraduate science, math, and engineering (SME) majors are usually better prepared academically than students in other majors (Seymour, 1992). Nonetheless, SME students have a higher rate of changing intended majors than other students, and the fact that URM students are even less likely to complete a degree in those majors magnifies this problem. Additionally, students who switch majors are more likely to do so during the first year of college (Tinto, 1993; Upcraft & Gardner, 1989).

A voluminous body of research has examined undergraduate student persistence (e.g., Astin, 1993; Braxton, 2000; Chang, Cerna, Han, & Sáenz, 2008; Hurtado et al., 2007; Nora, Barlow, & Crisp, 2005; Tinto, 1993), and a few important points relevant to retaining URM

students can be drawn from this literature. First, an individual student's own educational success is more than the sum of his or her personal will, aspiration, and traditional academic indicators such as test scores and high school grades. Other social factors, such as one's gender, racial, and socioeconomic background, for example, not only help shape one's access to opportunity for college success but also continue to show independent effects on retention outcomes. Second, institutional structures and normative contexts (e.g. peer environments, the culture of science, structured programs) are differentiated and can be potent socializing forces that affect where the student ultimately lands and how the student progresses in his or her educational journey. Third, educational experiences within institutions are not uniform but are directly affected by a student's racial background and the structure of opportunity encountered in predominantly White institutions (PWIs) and minority-serving institutions (MSIs), which include Historically Black Colleges and Universities (HBCUs) and Hispanic-serving institutions (HSIs). We considered those broad findings regarding the interplay of individual background characteristics and educational environments in choosing an appropriate analytic approach and framework that can potentially explain how race factors into the chances of academic success for URM students intending to major in the biomedical and behavioral sciences (BBS). For the purposes of our discussion, we will refer to intended BBS majors as "science majors." Of that large body of literature regarding college persistence, we are also particularly interested in the effects that minority students' science identity development and negative racial experiences may have on their chances of persisting in college.

Science Persistence and Identity

For URM students intending to pursue studies in the sciences, a combination of external and internal factors facilitates their persistence. Russell and Atwater (2005) noted that a

demonstrated competence in science and mathematics at the pre-college level is vital to African American students' successful progress through the science pipeline from high school to college. In addition, receiving family support and teacher encouragement, developing intrinsic motivation, and maintaining perseverance are other critical factors they identified that significantly affect students' science persistence and academic achievement. Likewise, the presence of family support and guidance from faculty mentors also have been found to be associated with the development of greater academic self-efficacy and success in the sciences for Latino students (Anaya & Cole, 2001; Cole & Espinoza, 2008; Torres & Solberg, 2001).

It also appears that campuses can intentionally improve undergraduate success in the sciences. At the programmatic level, offering undergraduates research opportunities makes a difference not only in attracting and retaining science majors but also in facilitating students' science learning in the classroom by introducing them to what science research careers might entail (Kinkead, 2003; Lopatto, 2003). URM students who participate in well-structured undergraduate research programs can benefit in many ways, including enhancing their knowledge and comprehension of science (Sabatini, 1997); clarifying graduate school or career plans in the sciences (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009; Kardash, 2000; Sabatini, 1997); and obtaining other professional opportunities that further develop students' scientific self-efficacy (Gándara & Maxwell-Jolly, 1999; Hurtado et al., 2009; Mabrouk & Peters, 2000). By increasing students' tendencies to feel, think, behave, and be recognized by meaningful others (e.g., faculty role models) as a "science person," Carlone and Johnson (2007) argue that URM students stand a much greater chance of believing in their abilities to succeed in the sciences. As such, those students are more likely to identify with science and view it as an

important aspect of their self-identity, which should in the long run enhance their chances of persisting.

Negative Racial Experiences and Minority Student Persistence

Conversely, a large body of research suggests that prejudice or negative racial experiences are negatively related to the quality of minority students' academic and social experiences in college and their commitment to degree completion (Arbona & Novy, 1990; Fleming, 1984; Hendricks, Smith, Caplow, & Donaldson, 1996; Hurtado & Carter, 1997; Hurtado et al., 2007; Hurtado, Milem, Clayton-Pederson, & Allen, 1999; Nora & Cabrera, 1996; Tracey & Sedlacek, 1984, 1985, 1987). According to Fleming's (1984) student development model, exposure to prejudice and discrimination on campus can seriously disrupt African American students' cognitive development (i.e., academic performance, critical thinking) as well as their affective development. Similarly, Tracey and Sedlacek (1984; 1985; 1987) claim that non-cognitive factors such as self-concept, an understanding of racism, and one's ability to deal with racism, are more influential than cognitive ones such as academic competence when it comes to minority students' academic performance and their capacity to persist in college.

Feelings of prejudice or alienation have also been shown to be negatively correlated with minority student persistence (Loo & Rolison, 1986; Muñoz, 1987; Suen, 1983). For example, Loo and Rolison (1986) and Suen (1983) found that minority students attending predominantly White institutions were significantly more likely than their non-minority peers to report feelings of isolation or not belonging on the campus. Moreover, minority students who reported feeling isolated were more apt to consider withdrawing from college (Loo & Rolison, 1986). Similarly, Smedley, Myers, and Harrell (1993) reported that racism and discrimination on campus increased the levels of psychological and sociocultural stressors that minority students

experience, which in turn negatively affected their adjustment at their institution. As with other stressors, experiencing higher levels of racism or alienation is associated with poorer academic performance and heightened psychological distress. But unlike other stressors, according to Smedley, Myers, and Harrell, experiencing negative racial interactions can be unique because such experiences potentially amplify feelings of not belonging at the institution and compound the negative effects of other existing stressors. For example, while all students who report negative racial experiences also tend to report a lower sense of belonging in college, URM science students who experienced such climates are more likely to report less success in managing the academic environment at the end of the freshmen year than White or Asian American science peers (Hurtado et al., 2007). However, having had high frequencies of negative racial experiences is not always debilitating and does not necessarily derail students' academic goals.

Some studies show that other factors supersede the detrimental effects associated with having negative racial experiences (Hendricks et al., 1996; Nora & Cabrera, 1996; Tracey & Sedlacek, 1984, 1985, 1987). For example, Nora and Cabrera (1996) found that academic performance, parental support, intellectual development, and social integration have a much stronger effect on minority student persistence than students' perceptions about prejudice. Their findings suggest that perhaps researchers have overestimated the extent to which racial experiences matter in determining academic performance. Likewise, Arbona and Novy (1990) found that URM students who indicated experiencing higher levels of prejudice at their respective institutions did not necessarily demonstrate a higher probability of departure from college. Such findings regarding the weaker than expected effects of negative racial experiences would be explained by Hendricks and colleagues (1996) as being partially due to minority

students having learned how to "depersonalize" negative racial experiences and subsequently becoming better positioned to do well in college and ultimately persist. Further, the level of peer support received by African Americans tends to increase their sense of belonging to an institution and intention to persist over time (Hausmann, Schofield, & Woods, 2007). More recently, a qualitative study of URM science majors indicated a high degree of involvement in structured research programs but also highlighted student reports of experiencing racial stigma on campus and in other science contexts (Hurtado et al., 2009). In short, the research on the capacity of URM students to persist in college suggests that the effects associated with experiences that are regarded as having strong racial undertones may not be just a matter of degree or frequency of negative experiences but also appear to be conditional based in part on students' unique attributes in specific institutional environments. One of those attributes may be associated with a student's commitment to a science identity.

Stereotype Threat

A theory based on "stereotype threat" has much to say about student attributes that moderate the damaging effects of negative racial experiences on academic performance. Claude Steele (1992; 1997) claims that under certain conditions, negative racial stereotypes concerning the intellectual ability of disadvantaged groups (e.g., racial minorities, women in male-dominated fields) can undermine the academic performance of members of those groups. According to Steele's stereotype-vulnerability or threat theory, the academic underperformance of students from disadvantaged groups can be explained partly by their anxiety associated with the fear that others' judgments or their own actions will confirm negative stereotypes about their group's intellectual capacity. While most students experience some anxiety over being negatively evaluated, Steele argues that students who belong to groups often targeted with

negative intellectual stereotypes not only risk embarrassment and failure but also risk confirming those negative perceptions of the group. This threat of being reduced to negative stereotypes in various situational contexts can lead to increased anxiety, which then depresses performance.

The research of stereotype threat on task performance has increased steadily since Steele and Aronson (1995) conducted their classic study that introduced how implicit stereotypes about the intellectual inferiority of African Americans generated stereotype threat and, in turn, undermined those students' test performance. Other studies examining the influence of stereotype threat on the academic performance of African Americans have yielded similar findings (Aronson, Fried, & Good, 2002; McKay, Doverspike, Bowen-Hilton, & Martin, 2002; Osborne, 2001). Some studies have also shown similar negative effects of stereotype threat on Latinos (Aronson & Salinas, 1997; Gonzales, Blanton, & Williams, 2002; Schmader & Johns, 2003). Indeed, there are now far too many empirical findings to report here that support the contention that stereotype threat can affect the member of nearly any stereotyped social group.

What is also important to note in this growing body of research is that, over time, stereotypes may have a cumulative effect on individuals. Aronson (2004), for example, has shown that a student's repeated exposure to stereotype threat can lead to "disidentification" with a domain of study with which the student was previously identified. Steele (1997) refers to disidentification as a retreat of not caring about the domain as a basis of self-evaluation and identity, thus undermining a student's sustained motivation in the domain. For example, an African American student who faces the challenges of being one of a handful of aspiring minority scientists within her institution's competitive academic environment may ultimately reject any association with her science major as a way to preserve her self-esteem and to alleviate anxiety associated with confirming a stereotype. This can subsequently decrease her motivation

and interest in pursuing a science-related career. Disidentification, however, need not be the typical outcome for adapting to stereotype threat. Steele (1997) contends that situational changes can either enhance or reduce the stereotype threat URM students might otherwise be under.

Because stereotype threat is a situational problem and is not internal to individuals or groups, Rosenthal and Crisp (2006) argue, "All that is really needed to produce stereotype threat is to be placed in a situation where the stereotype is salient" (p. 502). According to Massey and Fischer (2005), the threat may be particularly salient within a higher education context, where deeply embedded societal stereotypes regarding intellectual competence are especially relevant. In considering susceptibility to stereotype threat, the theory maintains that a combination of attributes puts some URM students at significantly greater risk of having their performance negatively affected by stereotype threat compared to other URM students.

One important attribute is what Aronson et al. (1999) call "stigma-consciousness." According to those leading researchers of stereotype threat, "the degree to which a person is exposed to stereotypes about his or her group breeds an awareness of stigma, which has been linked with individual differences in responses to stereotype threat" (p. 31). Thus, Aronson and his colleagues suggest that students who report higher frequency of negative racial experiences would have higher expectations about whether they would be racially stereotyped, and the perceived probability of being stereotyped can have implications for how individuals experience their stereotyped status.

Another important attribute associated with the intensity of stereotype threat is "domain identification." According to Steele (1997), only members of a group who identify with schooling (or its various domains) may be threatened by societal stereotypes that explicitly link to intellectual competence. In other words, a negative stereotype must first involve a domain that

is relevant to an individual's self-identity if that stereotype will become threatening to that individual. If the student does not identify with the domain, Steele claims that stereotype threat will have very little, if any, effect on that individual.

In sum, the theory of stereotype threat would predict that the interaction between URM students' experienced frequency of negative racial interactions and level of domain identification would yield a unique combined negative effect on first-year BBS major persistence, which is independent of the individual effect of each attribute. In other words, URM science students who are most highly identified with their field of study and also report the highest frequency of negative racial experiences will be at greater risk than their peers to change their major by the end of the first year of college. We set out to test this hypothesis.

Method

Data Source and Sample

Participants in this study provided longitudinal data by completing two surveys administered by the Higher Education Research Institute (HERI) at UCLA. In 2004 during fall orientation or in the summer prior to their first fall term, undergraduates completed the Cooperative Institutional Research Program (CIRP) Freshman Survey. At the end of their freshman year in spring 2005, participants completed the Your First College Year (YFCY) survey (for more detail on both surveys, see Keup & Stolzenberg, 2004; Sax et al., 2004).

This study utilized two sampling strategies to target institutions. First, a National Institutes of Health (NIH) grant provided funds to target minority-serving institutions (MSIs) with NIH-funded research programs that had a reputation for graduating large numbers of URM students in the biomedical and behavioral sciences. The second strategy targeted CIRP-participating institutions with NIH-sponsored programs. The two strategies provided an initial

institutional sample of 160 colleges and universities that represented the diversity of higher education institutions in the U.S., as the sample featured varying levels of control (public and private), Carnegie classification, and selectivity.

Within the institutional sample, we identified three subgroups of students: URM students intending to major in the biomedical and behavioral sciences (BBS), White and Asian American students intending to major in BBS, and URM students intending to major in non-BBS fields. For the present study, we chose to focus solely on the sample of URM students intending to major in BBS.[1]

The 2004 Freshman Survey included responses from 8,329 URM intended BBS majors attending the 160 institutions in our original target sample. The 2005 YFCY survey provided an initial longitudinal sample of 1,796 URM students intending to major in BBS. The longitudinal response rate was 21.5% for our targeted URM students, and we calculated appropriate weights to address the low response rate (for complete sampling details and weighting methodology, see Hurtado et al., 2007). Missing data on the outcome variable (first-year persistence in a biomedical or behavioral science major) and constraints of the hierarchical generalized linear modeling (HGLM) statistical techniques utilized in this study further reduced the sample to 1,745 students at 123 institutions.

Outcome Measure

Because switching majors is more likely to occur during the first year of college (Tinto, 1993; Upcraft & Gardner, 1989), the outcome of interest is whether students persisted in their intended BBS major through the end of their first year. This dichotomous variable was measured from a single item on the YFCY survey, which asked students if they had decided to pursue a

[1] In our study, biomedical and behavioral science majors include: general biology, biochemistry/biophysics, microbiology/bacterial biology, zoology, other biological science, chemistry, medicine/dentistry/veterinary medicine, pharmacy, and psychology.

different major during the last year. Since this study included only those students who reported on the Freshman Survey that they planned to pursue a BBS major at the beginning of the academic year, an affirmative response to this question indicated that they departed from their original BBS intentions. Of the 1,745 URM students who had initially planned to pursue a BBS major as entering freshmen, 1,187 of them persisted in that BBS major through the end of their first year. Thus, we identified 558 students as not persisting in their BBS majors.

Main Independent Variables

Per our research interests grounded in the theory of stereotype threat, the key variable for this study is the interaction between students' level of having experienced negative racial interactions and domain identification in the sciences. To assess the frequency of having experienced negative racial interactions, we used principal axis factoring with varimax rotation to create a factor composed of students' responses to five YFCY survey items that queried their racial experiences during their first year of college (see Appendix A). Students were asked to respond to the frequency (5-point scale with 1 = "never" and 5 = "very often") that they (1) felt insulted or threatened because of race/ethnicity; (2) had tense, somewhat hostile race-related interactions; (3) had guarded/cautious race-related interactions; (4) have been singled out because of race/ethnicity, gender, or sexual orientation; and (5) have heard faculty express stereotypes about racial/ethnic groups in class. The responses to those items were calculated into a composite score (range, central tendency), and the overall reliability for this composite, as measured by Cronbach's alpha, was 0.72, suggesting adequate reliability (Pedhauzer & Schmelkin, 1991). We categorized those students who reported having encountered these five circumstances at a higher frequency as having faced a higher level of negative racial experiences.

Again using principal axis factoring with varimax rotation, we constructed a factor to assess students' level of domain identification. This factor was composed of students' responses to five items on the Freshman Survey (see Appendix A). For these items, students indicated the degree of importance (4-point scale ranging from 1 = "not important" to 4 = "essential") each of the following objectives are to them: (1) obtaining recognition from my colleagues for contributions to my field; (2) becoming an authority in my field; (3) making a theoretical contribution to science; (4) improving the health of minority communities; and (5) working to find a cure to a health problem. We calculated a composite score for each student based on their responses. Overall, the Cronbach's alpha for this set of items was 0.68, which falls just below the recommended reliability threshold in the social sciences of 0.70 (Pedhauzer & Schmelkin, 1991). Based on the literature regarding science identity development that we briefly reviewed earlier, we considered students who rated these five objectives as having greater personal importance to be more identified with their respective BBS domain.

We re-scaled the negative racial experience and domain identification factors to improve interpretability in the analyses, as a one-unit or one standard deviation increase in the composite score has little practical meaning. Rather than keeping these factors as continuous, we categorized the scores into "high," "medium," and "low." To create these classifications, we divided the sample into equal thirds based on the respective distribution of each factor. By re-scaling these two factors, we can compare students with relative high scores to their peers with relative medium or low scores on these factors. Given our theoretical framework, we called these two variables "stereotype threat factors."

Because stereotype threat theory maintains that the combination of high stigma consciousness shaped by having negative racial experiences and high domain identification are

supposed to put URM students at greater risk of stereotype threat, we combined the two stereotype threat factors to create an interaction term. For this term, high scores denote students who both strongly identified with their science major at the beginning of their first year in college and experienced high levels of racial prejudice and stereotyping during the course of that year. Thus, students with higher scores on this term are believed to be more vulnerable to stereotype threat. This interaction term is our main independent variable of interest.

Moderating Variables

Given that the effects of stereotype threat can be mitigated (Steele, 1997), we tested three activities/experiences of students in the first year of college (see Appendix A). They included whether students during their first year took part in health science research and/or joined a pre-professional or departmental club as measures of peer and faculty support. We also considered students' level of comfort with their professors because Massey et al. (2003) maintain that URM students who are more self-conscious about what their professors think of them are more vulnerable to stereotype threat. We included these three college activities/experiences in our analyses to assess whether the interaction between students' level of having experienced negative racial interactions and domain identification, which may be a marker for students' level of risk of experiencing stereotype threat, can be mitigated through certain types of interventions.

Control Variables

Lastly, our analyses included a number of control variables (see Appendix A) as per previous studies that examined undergraduate aspirations toward science-based degrees and careers (see Chang et al., 2008; Hurtado et al., 2007). They included a set of student demographic characteristics (gender, race, parents' education and income) and level of academic preparation (number of years students studied math and biology in high school, high school

grade point average, SAT composite score). We also included a set of students' pre-college opinions about their academic ability, concerns about financing their college education, and ease of adjusting to their new academic demands in college. Lastly, we included a control for plans to major in psychology because this major is arguably distinct from other BBS majors, in large part, due to its disciplinary roots in both social and life sciences.

In addition to those individual-level variables mentioned previously, we included several institutional variables in the analyses to control for the contextual effects of institutions on students' likelihood to persist in their science majors. These variables included institutional control (public vs. private), size, research expenditures, the percentage of bachelor's degrees that were awarded in BBS fields during the 2004-2005 academic year, and level of institutional selectivity, as measured by the average SAT scores of students entering in the fall of 2004.

Data Analysis

We conducted missing values analysis to address issues of missing data. Cases with missing data for the outcome variable and demographic characteristics (e.g., race and gender) were deleted from the sample. For all other variables in the study, we applied the expectation-maximization (EM) algorithm. The EM algorithm more accurately estimates values for cases with missing data compared to other less robust methods, such as mean replacement (McLachlan & Krishnan, 1997). The EM algorithm uses maximum likelihood (ML) estimates to replace missing values when a small proportion of data for a given variable is missing (McLachlan & Krishnan, 1997). Missing values analysis suggested that missing data occurred at random, and nearly all of the variables included in the analysis had fewer than 5% missing data. Composite SAT score, father's education, and parents' income had 13%, 5.7%, and 7.7% missing data, respectively; therefore, results for these variables should be interpreted with caution.

The central purpose of this study was to examine how the combination of two key attributes associated with stereotype threat affects students' likelihood of persisting in a biomedical or behavioral science major through the end of the first year. The data for this study had a clustered, multi-level structure, as students were nested within institutions. Because of the binary outcome variable and the multi-level nature of the data, use of hierarchical generalized linear modeling (HGLM) techniques was warranted (Raudenbush & Bryk, 2002). Single-level techniques, such as generalized linear modeling, also known as standard logistic regression, do not account for the nesting of students within institutions. Ignoring this clustering effect often results in underestimated standard errors, which may lead analysts to make a Type I statistical error by concluding a parameter is significant when, in fact, it is non-significant (Raudenbush & Bryk, 2002). Additionally, HGLM enables analysts to identify the unique effects of institutional characteristics on student-level outcomes.

To use HGLM, the outcome variable must vary across institutions. For this study, institutions must vary in the average likelihood of first-year student persistence in biomedical and behavioral science majors. Hierarchical linear modeling (HLM) analyses use the intra-class correlation (ICC) to determine the amount of variation in the outcome variable attributed to group-level effects. However, due to the dichotomous nature of our outcome variable representing major persistence, the individual-level variance was heteroscedastic, which made the ICC non-instructive (Raudenbush & Bryk, 2002). Instead, we ran a fully unconditional model to determine the significance of the random variance component at level 2. The significance of the chi-square statistic ($\chi^2 = 477.79$, $p < 0.001$) suggested that the variance of BBS retention across institutions was significantly greater than zero; thus, we proceeded with both within- and between-institutional models in HGLM.

The dichotomous nature of the outcome variable in this study required a Bernoulli sampling model (Raudenbush & Bryk, 2002):

$$\text{Prob}\,(Y_{ij} = | \beta_{ij}) = \Phi_{ij}, \qquad (1)$$

The level-1, or within-institution, model is:

$$\text{Log}\left[\frac{\Phi_{ij}}{1-\Phi_{ij}}\right] = \beta_{0j} + \beta_{1j}\,(\text{BACKGROUND CHARACTERISTICS})_{ij} \qquad (2)$$

$$+ \beta_{2j}\,(\text{COLLEGE EXPERIENCES})_{ij}$$

$$+ \beta_{3j}\,(\text{STEREOTYPE THREAT FACTORS})_{ij}$$

$$+ \beta_{4j}\,(\text{INTERACTION TERM})_{ij}$$

where *i* denotes the student and *j* denotes the institution. B_{1j} -B_{4j} represent the individual coefficients corresponding to each variable in the model. For simplicity's sake, we do not present every variable in our model in Equation 2; instead, background characteristics, college experiences, stereotype threat factors, and the interaction term refer to the blocks of variables previously described. The intercept for Equation (2), β_{0j}, was allowed to vary between institutions, as preliminary analyses suggested that the average likelihood of first-year persistence in the biomedical and behavioral sciences varied significantly across institutions.

The institution-level model is shown in Equation (3). Equation (3) models the intercept term from Equation (2):

$$B_{0j} = \gamma_{00} + \gamma_{01}\,(\text{INSTITUTIONAL CHARACTERISTICS})_j \qquad (3)$$

$$+ \gamma_{02}\,(\text{INSTITUTIONAL SELECTIVITY})_j + \mu_j$$

where *j* denotes the institution. Institutional characteristics and institutional selectivity refer to the blocks of variables previously described and γ_{01} and γ_{01} refer to the coefficients associated with the individual variables within those blocks. Institutional selectivity was re-scaled so that a

one-unit increase actually represents a 100-point increase in average institutional selectivity. Finally, μ_j represents the randomly varying error term in the level-2 model.

Although we present the equations for the level-1 and level-2 models, respectively, it is important to address our strategy in building each of these models. To begin, we estimated a fully unconditional model, or a model without any predictors at level 1 or level 2, to assess the extent to which students' average likelihood of BBS persistence varied across institutions. Next, we added blocks of variables to the level-1 model in the following order: demographic characteristics, college experiences, and factors of domain identification and negative racial experiences. We then added all of our level-2 predictors to the model to take into account a number of institutional characteristics. Finally, we added the interaction between negative racial experiences and domain identification to the model. For simplicity purposes, we only report the results of the final two models – the model immediately prior to the interaction term and the final model, which includes the interaction term.

Results are reported as delta-p statistics to improve interpretability of the findings. We used the method described by Petersen (1985) to calculate delta-p statistics from the log-odds coefficients of the HGLM results. For this analysis, delta-p statistics represent the change in a student's probability of first-year major persistence, relative to not persisting, associated with a one-unit change in an independent variable while holding constant other variables.

Limitations

This study was limited in several ways. First, we were limited by the variables and data included in the 2004 Freshman Survey and 2005 YFCY survey. Because the YFCY survey did not specifically ask students about their current major, we used a proxy measure to determine if students had persisted. This proxy may have inappropriately categorized students as not

persisting in the biomedical and behavioral sciences when, in fact, they had persisted. This instance may have occurred when students indicated they had switched their major during their first year, and that switch was from one BBS major to a different BBS major. Although within-BBS switching is rare (Center for Institutional Data Exchange and Analysis, 2000), we also established more stringent measures of persistence by combining students' answers to the question about whether they are pursing a different major with their freshman year-end responses to interest in either contributing to scientific research or addressing health problems. For example, a persister under a more stringent measure would be defined as someone who answered that he or she is both pursuing the same major and has high interest in contributing to science research. When it came to differentiating students by persistence, however, the results for those more stringent outcome measures were nearly identical to using only students' response to changing majors. So, we opted to use a single item as the dependent measure.

Second, although we relied on weights to correct our sample for non-response bias (Dey, 1997), our sample likely remains unrepresentative of first-year URM BBS majors nationwide, as indicated by a high proportion (80%) of women. Instead of weighting our longitudinal sample up to an unknown population, our response weights adjusted our longitudinal sample to look more like the sub-set of students who responded to the Freshman Survey in the fall of 2004. Therefore, readers should use caution in generalizing these results beyond the analyzed sample.

Third, because HGLM requires variation in the outcome variable within and between groups, we had to delete institutions with fewer than two student respondents. Additionally, we deleted students who had missing data on the outcome variable. These constraints reduced the sample by 37 institutions and 51 students. Fourth, the reliability of the level-1 intercept is admittedly low due to small within-institution samples. This low reliability may limit any

generalizations about the average likelihood of BBS persistence across institutions; however, this parameter is not a primary focus of our research. Finally, most studies that employ the theory of stereotype threat use an experimental design. Because we conducted our analyses using survey data, our study design was non-experimental; therefore, we did not manipulate levels of threat and assess stereotype threat directly, nor were we able to implement similar controls that other experimental studies typically include. Instead, we use this theory to help us understand the relationship between two important attributes constructed from pre-existing student data, which we reason represent stereotype threat conditions in different institutional contexts.

Results

Key Descriptive Statistics

Of the 1,745 URM students in our sample, 68% of them persisted in their BBS majors through the end of their first year in college (see Appendix B for descriptive statistics for all of the variables). Nearly 80% of the sample identified as female, which suggests an overrepresentation of women. More than 50% of the sample identified as African American, 37% of participants identified as Latina/o, and approximately 7% identified as American Indian. On average, students in this sample had a high school GPA ranging from a B+ to an A-. The average student studied high school math for nearly four years and high school biology for just over one year. Participants in this study had a high level of academic confidence, as students on average rated themselves at an "above average" level for their academic ability in relation to their peers. Lastly, approximately 24% of the sample intended to major in psychology.

Among the institutional characteristics, 53% of the institutions were privately controlled. Additionally, during the 2004-2005 academic year, 14% of all bachelor's degrees awarded by the institutions in this study were in the biomedical and behavioral sciences. Average institutional

selectivity in this study was moderate, as the average SAT score of entering students across all 123 institutions was 1106, which is slightly higher than the individual average SAT score of 1075 for this study's URM sample.

Hierarchical Generalized Linear Modeling (HGLM) Analyses

Table 1 presents the results from the HGLM analysis. For simplicity purposes, we report only the results of the final two models – the model immediately before adding the interaction term and the final model with the interaction term. The chi-square statistics reported for the models suggest that the addition of the interaction term neither enhances nor reduces model fit. Unlike logistic regression analyses conducted with more traditional software packages, HLM software provides limited statistics to assess the overall strength of our models. For example, we do not have Hosmer-Lemeshow chi-square statistic or classification tables to assess goodness of fit for our level-1 model. However, the model statistics suggest that the institutional predictors alone account for slightly more than 18% of the variation in science major persistence rates across institutions. The following discussion highlights the significant findings.

As shown in Table 1, two background variables emerged as statistically significant. After controlling for all variables in our study, we found that psychology majors were more than 5% more likely to persist in their major compared to students in other BBS disciplines. The other background characteristic that had a significant effect on BBS persistence was students' ability to adjust to their academic environment. A one-unit increase on this scale corresponded to a 5.38% increase in students' probability of BBS persistence. We found no significant relationship among controls for prior academic preparation, gender, race, income, or parental education with URM freshmen's likelihood to persist in their initial science major after considering all other variables in our final model.

In addition to background characteristics, we controlled for three variables specifically related to students' experiences during the first year of college. Of those three variables, one proved to have a statistically significant effect on students' chances of persisting. The results of Model 2 in Table 1 show that URM students who joined a pre-professional or departmental club during their first year of college increased their probability of persisting by 10.81% compared to their peers who did not participate in such activities. The results suggest no significant effects on science major persistence from either students' attitudes about faculty or participation in health science research. This may be because first year students are somewhat less likely to participate in health science research or have significant contact with faculty at this stage of their studies (Hurtado, Eagan et al., 2008).

Turning to the main effects of the two variables that comprise the interaction term shown in Model 1, we found a significant and positive relationship between students' identification with science and their likelihood to persist in their BBS majors. We focus on the main effect results from Model 1 due to the increased level of multicollinearity among these main effects after the interaction term enters in Model 2, which renders their statistical effects to be incomprehensible. The results show that URM students who reported a high level of domain identification were 3.99% more likely to persist in their major than their counterparts who reported moderate levels of identification. That effect becomes even more evident when comparing the high and low domain-identified students. Though not shown in Table 1, extrapolating this result further, we calculated that those URM students who were strongly domain identified were 7.98% more likely to persist than their peers who reported the weakest level of identification with science. We detected no main effect associated with students' frequency of negative racial experiences on persistence.

The results under Model 2, which adds the interaction term, show that the interaction between negative racial experiences and domain identification exerted a statistically significant and negative effect on students' likelihood of persisting in their initial BBS majors. This interaction term served to identify students who were at greatest risk of experiencing stereotype threat, as a high score represented students who had high levels of both measures in our study. A one-point increase in URM students' susceptibility to stereotype threat was associated with a 5.43% reduction in their probability of persisting.

With respect to institutional characteristics, only institutional selectivity had a significant and negative effect on URM students' likelihood to persist in their major through the end of their first year in college. Specifically, a 100-point increase in the average SAT score of an institution's student body corresponded to a 3.81% reduction in the average probability a student has in persisting as a science major.

Additional Descriptive Analyses

To understand better the above findings, we conducted additional analyses. Figure 1 illustrates the relationship between the interaction term representing students' vulnerability to stereotype threat and URM students' likelihood to persist in their BBS majors. On the x-axis are the three codes corresponding to students' level of domain identification, with weak domain identification coded as 1, moderate as 2, and strong as 3. The y-axis shows the probability of persisting in a student's initial BBS major through the end of the first year. The graph has three lines, each of which corresponds to one of the three distinct frequencies of negative racial experiences. The line with triangular markers corresponds to students with low frequency of negative racial experiences; the line with square markers refers to those students who have a moderate level; and the line with diamond-shaped markers refers to those with the highest level.

As shown in Figure 1, students with a low level of domain identification appear to have approximately the same probability of major persistence regardless of their reported frequency of negative racial experiences. This trend is evidenced by the close proximity of all three lines at the far left end of the graph. As students become more domain identified, the frequency of their negative racial experiences exacts a higher toll on URM students' chances of persisting. The line with triangular markers shows that students indicating a low frequency of negative racial experiences have greater probability to persist, as depicted by the positive slope. In contrast, students reporting a high frequency of negative racial experiences appear to have a slight decrease in their probability of persisting as they become more domain identified, as evidenced by the negative slope of the line with diamond-shaped markers.

To shed more light on the relationship between domain identification and negative racial experiences, we conducted a set of cross-tabulations. The results confirm that the most domain-identified URM students were the most negatively affected by such experiences. Of those students, 79.5% who reported low frequency of negative racial experiences persisted in their BBS majors, which was the highest rate reported in these analyses. Comparatively, 74.6% of those who reported moderate frequency persisted, and only 63.4% of those who reported high frequency did the same. The frequency of negative racial experiences did not display the same effect on those URM students who were moderately domain identified, and interestingly, almost the opposite was the case for those with the lowest level of BBS domain identification. For those URM students with the lowest level of domain identification, 57.7% who reported low frequency of negative racial experiences persisted in their BBS majors, whereas the persistence rate was 65.4% and 64.2% respectively for those who reported moderate and high frequencies. Interestingly, although we found a significant positive main effect for domain identification in

the HGLM analyses, the results of the cross-tabs suggest that URM students who are moderately identified with their domain and report moderate frequency of negative racial experiences are slightly more likely to persist in their BBS majors than the highest domain-identified URM student who also report high frequency of such experiences. It appears, then, that encountering negative interactions with racial overtones exacts its greatest educational toll on the most domain-identified URM students.

Next, we examined how negative racial experiences play out for high domain-identified URM students across different levels of institutional selectivity. We considered this because similar to an earlier study (Chang et al., 2008), we also found in the HGLM analyses that selectivity had a statistically significant negative effect on BBS persistence. Figure 2 shows the differences in BBS major persistence rates among the highest domain-identified students attending institutions with either the lowest or highest levels of selectivity. Comparing the plots on the far left to those on the far right of the figure, we find that among the high domain-identified URM students, institutional selectivity makes more of a difference for those who reported the highest frequency of negative racial experiences, as the proximity between the two lines are farthest apart on the right-hand side. In fact, the figure suggests that negative racial experiences do not seem to exact a negative toll on persistence for those highly domain-identified URM students who attend the least selective institutions. Among them, the persistence rates for those who reported the highest frequency of negative racial experiences (83.3%) are higher than those who reported either moderate (65.8%) or low (74.2%) frequencies. Nearly the opposite is true for highly domain-identified URM students who attend the most selective institutions, with the students who experienced the most negative interactions with racial overtones having the lowest rate of BBS persistence (60.3%) among all groups.

Discussion

The main purpose of this study was to address why URM undergraduates are departing from their studies in the sciences at significantly higher rates than their White and Asian American counterparts. To that end, this study considered two effects regarding URM students: that negative racial experiences might hinder their rate of undergraduate persistence whereas domain identification enhances persistence. We drew from stereotype threat theory (Aronson et al., 1999; Steele, 1997) to understand the combined impact of those two attributes on persistence in a biomedical or behavioral science (BBS) major through the end of the first year of college. The findings confirmed our main prediction based on stereotype threat theory; however, it is also important to note the strength of peer contexts as a key factor in student persistence.

We found that URM freshmen who reported high levels of both domain identification and negative interactions with racial overtones—those who were more susceptible to the negative effects of stereotype threat—were significantly less likely to persist in their initial BBS major. Put another way, those who were low domain identified and report low frequencies of negative racial experiences (lowest risk of stereotype threat) were nearly 50% more likely to persist in their BBS major than those at highest risk. For us, the most troubling findings concern the URM students who began college having the highest level of domain identification and presumably, were the most motivated and cared most about succeeding in their field of study. We regarded students with high domain identification as those who greatly value several key research-oriented achievements, including contributing to and becoming an authority in his or her field, making a theoretical contribution to science, improving the health of minority communities, and working to find a cure to a health problem. Indeed, we found, as suggested by others (see Carlone & Johnson, 2007), that being highly identified with these science-related goals significantly improved the chances of persisting in a BBS major. The positive association

between students' science domain identification and their persistence in the science major was moderated by relatively high frequencies of negative racial experiences. More importantly, students who developed peer networks in the form of pre-professional or department clubs and organizations were more likely to persist in science. Both findings underscore the importance of the development of science identity in the early years of college. The difficulty arises when highly domain-identified students also encounter racial stigma.

According to Aronson et al. (1999), the degree to which a person is exposed to stereotypes about his or her group enhances stigma-consciousness, and those who are more conscious of their group's negative stigma are also more vulnerable to stereotype threat. We reasoned that students who reported higher frequencies of negative racial experiences (i.e., felt insulted or threatened because of race/ethnicity, had tense or somewhat hostile cross-racial interactions, been singled out because of race/ethnicity, and heard faculty express stereotypes about racial/ethnic groups) would be more stigma-conscious. The frequency of negative racial experiences alone had a negative but statistically insignificant independent effect on BBS major persistence, which tends to support some of the previous findings (e.g., Nora & Cabrera, 1996), but it did have an effect on more domain-identified URM freshmen...

Highly domain-identified students who also reported having higher frequencies of negative racial experiences were considerably less likely to remain in their initial BBS majors compared to their counterparts who reported having fewer of the same experiences. For example, among URM students who were the most domain identified, 79.5% who reported the lowest frequency of negative racial experiences persisted in their BBS majors, whereas only 63.4% who reported the highest frequency persisted. Making matters worse, the potentially harmful effect associated with having negative racial experiences for the most domain-identified URM

freshmen appears to be strongest among those attending the most selective institutions, which presumably enroll the most academically prepared and ambitious students.

Although our findings show that those students who were more susceptible to stereotype threat were more likely to drop out of their initial BBS major, we do not know if their negative first-year racial experiences might also be associated with a broader disidentification with academics in general. Since our domain identification variable measured interest in making broader scholarly contributions rather than specific ones to a given scientific field, those interests may remain intact even after changing majors. That is, by finding a new academic domain where students' prospects are better, according to Steele (1997), interest in making scientific contributions may not alter significantly if students are able to preserve their self-esteem as a result of this academic shift. If so, then we should expect those URM students under stronger stereotype threat and who remain in their initial BBS majors to experience a steeper decline in their domain identification after one year of college. Although not addressed in our study, these issues would be worthwhile for future research, as they point to the potential cost of remaining in a major under heightened stereotype vulnerability.

Theoretically, our overall findings appear to support the mounting evidence that stereotype threat can undermine URM students' educational prospects. Unlike the majority of the studies regarding stereotype threat, which occur in laboratory settings, we assessed the real world relevance of this theory by tapping into natural variations in populations. In order to do this, however, we had to begin with some basic assumptions. One is that stereotype threat is particularly salient within a higher education context and can occur for URM students on college campuses without experimental manipulation. If so, the broad academic BBS domain should present sufficient natural conditions to observe the potential cumulative and long-term effects of

stereotype threat. Because stereotype threat is regarded as a situational problem and is not internal to individuals or groups, we also reasoned that certain URM students undertaking BBS majors – those who reported higher levels of both *domain identification* and *negative racial experiences* – are more susceptible to having their academic performance undermined by stereotype threat.

If the above reasoning is sound, then our findings support Steele's (1997) claims that "stereotype threat affects only a subportion of the stereotyped group, and in the area of schooling, probably affects confident students more than unconfident ones" (p. 617). Subsequently, we too share Steele's deep concern that stereotype threat inflicts the largest educational toll on those in the "vanguard" with the "skills and self-confidence to have identified with the domain" (p. 614), which for this study is an academic domain that has a crisis of under-representation of African American, Latina/o, and American Indian students. Because we also controlled for a variety of background characteristics in our analyses, including academic preparation and parent's educational level, our findings suggest that susceptibility to stereotype threat, as Steele claims, is less a function of personal assessments about academic ability and more likely driven by higher levels of "identification with the domain and the resulting concern [students] have about being stereotyped in it" (p. 614). In short, the theory of stereotype threat can be applied, as we did here, to explain why URM students who stand to achieve academic success, in part because they care about performing well in their field of study, do not persist in that academic domain after their first year of college. We do acknowledge, however, that because our research design did not permit us to artificially manipulate levels of stereotype threat either by describing a test as a measure of intellectual ability or by having respondents indicate their racial group identity before completing a cognitively oriented task, we cannot conclusively

attribute the observed negative effects directly to internalized anxiety cued by negative stereotypes.

Still, our findings point to the damaging effects associated with chronic and cumulative negative racial experiences in the real world. Evidently, these racial experiences are shaped by social forces similar to those that produce the negative effects associated with stereotype threat. In this way, findings established outside of a laboratory uniquely support Steele's contention that stereotype threat may well be "a threat in the air." That is, the threat is neither isolated nor remote but more endemic and broadly experienced through racialized circumstances shaped by social structures that affect educational prospects. Most troubling is that negative racial circumstances associated with stereotype threat have the most damaging effect on those URM students who most value making future contributions to science and who attend our nation's most selective institutions.

One way to address concerns about our nation's capacity to fulfill our science-related interests and the absence of underrepresented racial minorities in those fields is for colleges and universities to pay serious attention to what Aronson (2004) calls the fragility of "human intellectual performance" and how "it can rise and fall depending on the social context" (p. 16). Although minimizing racial and other vulnerabilities in the social climate is certainly complex and involved, our study points to several key areas that can make a difference in retaining the most domain-identified URM students in BBS majors. They include significantly reducing the probability that students will (1) experience racial insults, threats, or hostile interactions, (2) be singled out because of race/ethnicity, and (3) have instructors who express stereotypes about racial/ethnic groups. Having higher frequencies of those experiences, we argue, heightens stigma consciousness and in turn, depresses achievement for students who would otherwise excel in

their academic pursuits. This approach calls for addressing institutional climate issues, particularly where URMs in science are few in number, building supportive peer networks, and addressing faculty pedagogy to consider diversity in the classroom. Many structured programs of undergraduate research provide both supportive faculty mentors and peer networks (Hurtado et al., 2009). Given the potential of stereotype threat to exert a harmful impact on URM students' educational prospects, the urgent challenge is to implement strategies that erase debilitating stigmas from educational settings.

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Appendix A

Description of Variables and Measures

Variables	Scale Range
Dependent Variable	
Persistence in a biomedical or behavioral science major through the first year of college	0=no, 1=yes
Independent Variables	
Student Background Characteristics	
Gender: female	0=no, 1=yes
Ethnic background: Latina/o, African American, American Indian (African American/Black reference group)	0=no, 1=yes
Mother's education	1=grammar or less, 8=graduate degree
Father's education	1=grammar or less, 8=graduate degree
High school grade point average	1=D, 8=A or A+
Years of mathematics in high school	1=none, 7=five or more
Years of science in high school	1=none, 7=five or more
Parental income	1=less than $10,000, 14=$250,000 or more
SAT composite	Continuous, 640-1530
Concern about financing college education	1=none, 3=major
Psychology major	0=no, 1=yes
Self-rated academic ability	1=lowest 10% to 5=highest 10%
Academic adjustment	A scale of five variables: understanding what professors expect academically, developing effective study skills, adjusting to the academic demands of college, and managing time effectively, measured separately on a three-point scale: 1=unsuccessful to 3=completely successful; and current college GPA, 1=C- or less, 6=A. Cronbach's alpha = 0.77. We recoded the academic adjustment scale, which was constructed from five variables on the YFCY survey (see Appendix A), into "low," "moderate," and "high" adjustment. We based these recodes on the frequency distribution of the scale, as each new code reflected the scores of one third of our sample.
College Experiences	
Joined pre-professional/departmental club	0=no, 1=yes
Participated in a health science research program	0=no, 1=yes
Relationships with faculty (felt intimidated, reverse coded)	1=not at all, 4=frequently, reverse coded
Measures of Stereotype Threat	
Domain identification	A scale of five variables relating to goals: 1) obtaining recognition from colleagues for contributions to my field, 2) becoming an authority in my field, 3) making a theoretical contribution to science, 4) improving the health of minority communities, and 5) working to find a cure to a health problem, measured separately on a four-point scale: 1=not important, 4=essential. Cronbach's alpha = 0.68
Negative racial experiences	A scale of five variables: 1) felt insulted or threatened because of race/ethnicity, 2) had tense/hostile interactions related to race, 3) had guarded/cautious interactions

	related to race, measured separately on a five-point scale: 1=never, 5=very often; 4) singled out because of race/ethnicity, gender, or sexual orientation, and 5) heard faculty express stereotypes about racial/ethnic groups in class, measured separately on a four-point scale: 1=strongly disagree, 4=strongly agree. Cronbach's alpha = 0.72.
Interaction Term	Continuous (domain identification X negative racial experiences)
Interaction between domain identification and negative racial experiences	
Institutional Characteristics	
Institutional control	0=public, 1=private
Institutional selectivity	Range: 4 to 16
Total full-time equivalent undergraduate enrollment (log transform)	Range: 6.06 to 10.44
Total research expenditures (log transform)	Range: 0.00 to 20.55
Percentage of bachelor's degrees earned in the biomedical and behavioral sciences during 2004-2005	Range: 4.65 to 62.53

Appendix B

Descriptive Statistics for Variables in the Study

Variable Name	N	Mean	S.D.	Min.	Max.
Outcome Variable					
Persistence in BBS majors	1745	0.68	0.47	0.00	1.00
Background Characteristics					
Female	1745	0.79	0.41	0.00	1.00
African American/Black	1745	0.55	0.50	0.00	1.00
American Indian	1745	0.07	0.26	0.00	1.00
Latina/o	1745	0.37	0.48	0.00	1.00
Years of high school mathematics	1745	5.90	0.58	1.00	7.00
Years of high school biology	1745	3.73	1.08	1.00	7.00
High school GPA	1745	6.51	1.37	1.00	8.00
SAT composite	1745	1075.50	149.63	640.00	1530.00
Father's education	1745	4.73	2.12	1.00	8.00
Mother's education	1745	5.01	2.02	1.00	8.00
Parental income	1745	7.22	3.26	1.00	14.00
Concern about financing college education	1745	2.04	0.66	1.00	3.00
Psychology major	1745	0.24	0.43	0.00	1.00
Academic adjustment	1745	2.02	0.83	1.00	3.00
Self-rated academic ability	1745	4.00	0.68	2.00	5.00
College Experiences					
Relationship with professors	1745	1.96	0.86	1.00	4.00
Joined pre-professional/departmental club	1745	0.25	0.43	0.00	1.00
Participated in health science research	1745	0.11	0.32	0.00	1.00
Measures of Stereotype Threat					
Domain identification	1745	2.01	0.74	1.00	3.00
Negative racial experiences	1745	2.04	0.76	1.00	3.00
Interaction Term					
Domain identification x negative racial experiences	1745	4.07	2.35	1.00	9.00
Institutional Characteristics					
Private	123	0.53	0.50	0.00	1.00
Research expenditures (log)	123	13.22	6.78	0.00	20.55
Percentage of bachelor's degrees awarded in BBS majors	123	14.09	7.54	4.65	62.53
Undergraduate FTE (log)	123	8.49	1.01	6.06	10.44
Institutional selectivity	123	11.06	1.42	7.80	14.25

Source: Data are from the 2004 Freshman Survey, 2005 Your First College Year survey, and 2004-2005 Integrated Postsecondary Education Data System.

Table 1
Hierarchical Generalized Linear Modeling (HGLM) Results

	Model 1				Model 2			
	Log Odds	S.E.	Delta-P		Log Odds	S.E.	Delta-P	
Background Characteristics								
Female (male reference group)	-0.17	0.16			-0.17	0.16		
American Indian/Alaska Native	-0.38	0.23			-0.4	0.24		
Latino/a	0.02	0.16			0.03	0.16		
(African American/Black reference group)								
Yrs. study high school mathematics	0.18	0.12			0.18	0.12		
Yrs. study high school biological science	-0.03	0.06			-0.04	0.06		
High school GPA	-0.01	0.05			-0.01	0.05		
SAT composite	0.01	0.01			0.01	0.01		
Father's education	0.07	0.04			0.07	0.04		
Mother's education	-0.02	0.03			-0.03	0.03		
Parental income	-0.01	0.02			-0.01	0.02		
Concern about financing college education	0.13	0.09			0.13	0.09		
Psychology major	0.28	0.13	5.76%	*	0.28	0.13	5.76%	*
Academic adjustment	0.27	0.08	5.57%	***	0.26	0.08	5.38%	***
Academic ability self-rating	0.06	0.1			0.07	0.1		
College Experiences / Interventions								
Joined pre-professional/dept. club	0.57	0.16	10.98%	***	0.56	0.16	10.81%	***
Participated in health science research	0.17	0.2			0.16	0.19		
Felt intimidated by professors	0.15	0.07			0.15	0.07	3.17%	*
Main Effects								
Domain identification	0.19	0.08	3.99%	*	0.69	0.25	12.90%	***
Negative racial experiences	-0.03	0.08			0.44	0.22	8.74%	*

Interaction Term							
Stereotype threat: DOMID X NEGRACEXP				-0.24	0.11	-5.43%	*
Institutional Characteristics							
Institutional control: private	0.05	0.16		0.04	0.16		
Research expenditures	-0.01	0.01		-0.01	0.01		
Percent BBS	0.62	0.41		0.65	0.41		
Undergraduate FTE	0.02	0.04		0.02	0.04		
Level of institutional selectivity (4-16)	-0.17	0.07	-3.81% *	-0.17	0.07	-3.81%	*
Model Statistics							
Chi-square	129.98			130.46			
Intercept reliability	0.12			0.11			
Explained variance at level 2	15.70%			18.38%			
Baseline probability of persistence	68.00%			68.00%			

*** $p < .001$, ** $p < .01$, * $p < .05$

Source: Weighted data of 1,745 student-level cases and 123 institution-level cases from the Cooperative Institutional Research Program Freshman Survey, Your First College Year survey, and Integrated Postsecondary Education Data System.

Figure 1
Interaction Effect of Domain Identification and Negative Racial Experiences on Students' Likelihood of Science Major Persistence

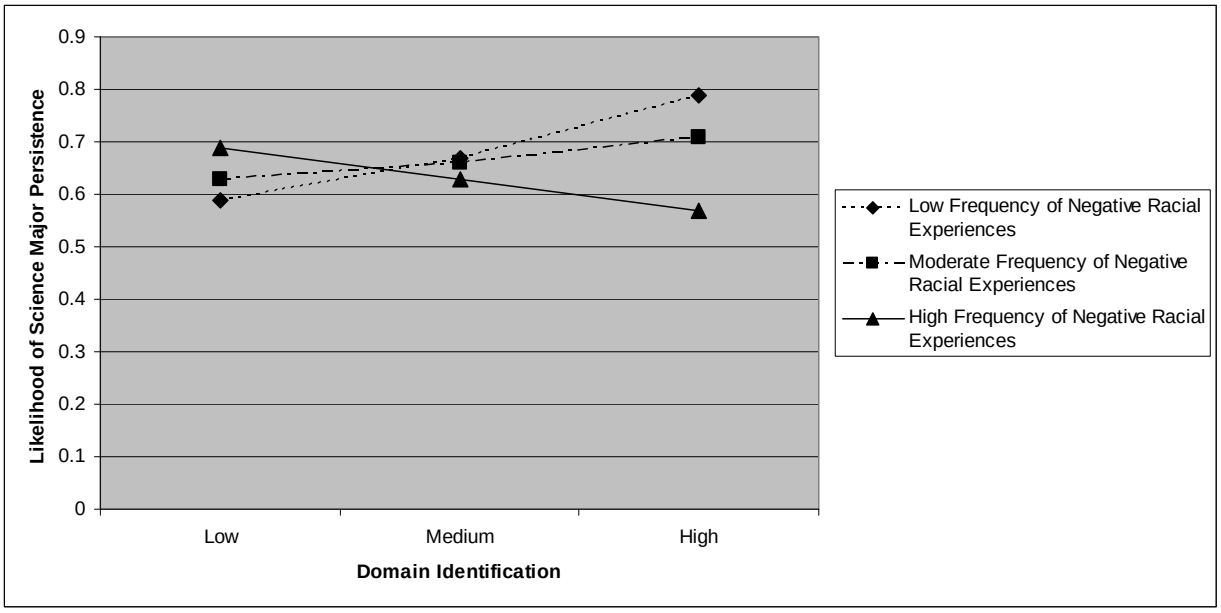

Figure 2
Science Major Persistence Rates for Highly Domain-Identified Students by Institutional Selectivity and Frequency of Negative Racial Experiences