The Contradictory Roles of Institutional Status in Retaining Underrepresented Students in

Biomedical and Behavioral Science Majors

Mitchell J. Chang, Oscar Cerna, June Han, and Victor Saenz

University of California, Los Angeles

Abstract

This study drew from a national longitudinal dataset to statistically model students' background, first-year college experience, and institutional characteristics that contribute to the chances of persisting in a biomedical or behavioral science major through the first-year of college. Of particular interest was the extent to which *institutional status* affects those chances for underrepresented minority students (URMs). The two competing conceptual frameworks, *anticipatory socialization theory* and *the mismatch hypothesis*, used to understand the potential impact of status were helpful but not fully adequate for explaining the findings. Since the effects of the institutional status variables used in the study were mixed, this suggests that the controversy regarding status has less to do with mismatching underrepresented students in highly competitive institutions and more to do with the institutional culture and practices of competitive educational environments. Other contributing factors to science persistence and their implications are also discussed.

The Contradictory Roles of Institutional Status in Retaining Underrepresented Minority

Students in Biomedical and Behavioral Science Majors

In 2006, the US Congress held numerous hearings about why a smaller proportion

of undergraduates than in the past are undertaking studies in the hard 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 American science pipeline "leakier than warped rubber tubing" (Epstein, 2006).

Indeed, roughly half of those undergraduates who show an initial interest in majoring in

the sciences switch out of these 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 minority

students (African American, Latino, and Native American) are even more dismal.

Looking at degree attainment, only 24 percent of underrepresented students complete a

bachelor's degree in science within six years of college entry, as compared to 40 percent

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 minority students (URMs) and their White and Asian

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 1993-2002, African

Americans accounted for only 2.6 percent of earned doctorates in biological sciences,

whereas Latinos accounted for 3.6 percent. For 2002, the report indicated only 122

African Americans and 178 Latinos received doctorates in biological sciences compared

to 3,114 Whites and 580 Asians. When considering future generations of scientists and

health care professionals, the Sullivan Commission declared underrepresented minorities

to be "missing persons" in those fields. Retention through undergraduate science major

preparation is a crucial juncture to purposefully reverse these trends.

The overarching purpose of this study is to examine factors that contribute to the

chances of retaining underrepresented minority students in an undergraduate biomedical

or behavioral science major. Of particular interest is the extent to which institutional

status affects those chances of retention, given that this issue is relevant to current policy

debates regarding access to quality higher education. Policies such as race conscious

admissions practices, for example, attempt to increase the proportion of URM students

attending the most elite colleges and universities. Differing theoretical viewpoints debate

the benefits and concerns related to such policies, and their impact on a college student's

success. According to Anticipatory Socialization Theory (Kamens, 1981), attending

"higher status" institutions should improve one's chances of persisting. Conversely, the

"mismatch hypothesis" (Sowell, 1993; Thernstrom, 1995) claims that URM students

lower their odds of achieving their initial educational goals when they attend highly

selective institutions where the White and Asian students are academically better

prepared. By extension, applying race conscious admissions in higher education

mismatches URM students and dampens their academic or career aspirations.

This study will empirically examine this running debate within the context of

concerns raised about our nation's capacity to fulfill our science-related interests,

especially as they relate to the growing presence of the racial/ethnic minority populations

in U.S. society. A major issue raised is the public health disparities between these

populations in comparison with Whites. As these disparities continue to gain increasing

prominence on the national health policy agenda, the education of aspiring URM science majors takes on even greater significance.

Background

According to the American Association for the Advancement of Science (2001), three of the most important variables 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 than students in other majors (Seymour, 1992). Nonetheless, SME majors are also more likely to switch majors, as noted earlier. Students are particularly vulnerable to changing their initial educational course during the first year of college (Tinto, 1993; Upcraft & Gardner, 1989).

There is a voluminous body of research regarding undergraduate student persistence (see for example Astin, 1993; Braxton, 2000; Hurtado, in press; Nora et al., 2005; Tinto, 1993). 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 factors, such as one's gender, racial, and socio-economic background, for example, also help shape one's opportunity for college success. Second, institutional structures and normative contexts are differentiated and can be potent socializing forces that affect where the student ultimately lands 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).

Our focus is specifically on URM students, their science major choice, and the type of institution they attend. A study by Grandy (1998), which examined the reasons why capable minority students either persisted or abandoned academic tracks in the sciences, found that support from other minorities at their institution had important effects on their commitment to the science field both during and after college. When looking at type of institution attended, Grandy showed that students at the university level were more likely to persist in the sciences than students at other types of institutions. Moreover, university students indicated they received more support from advanced students of their own ethnic minority group and within their major in the form of academic advice and mentorship.

However, URM students enrolled at more selective institutions, including many research universities, are less likely to persist if these environments engender stereotypes that devalue their expectations of succeeding as science majors or if their coursework does not relate back to improving conditions in their communities (Bonous-Hammarth, 2000). In a recent study, Bonous-Hammarth (2006) found that attending a selective institution is negatively associated with URM persistence as science majors, arguing that a lack of institutional diversity and a highly competitive environment work jointly to impede URM persistence, especially when there are fewer minority students present on campus.

While the above points are important for helping us broadly conceptualize persistence, we turn to other frameworks to develop a deeper understanding of the role

that institutional status, specifically, plays in preparing underrepresented students in the sciences. Here, we draw from two frameworks that consider the dynamics between students and the normative context of an institution. They seemingly offer opposing positions on the benefits of attending high status institutions for URM students.

Anticipatory Socialization Theory

Anticipatory socialization theory links the socializing and allocation function of schools. According to Kamens (1981), schools signal to students the social identities that they can occupy and students will engage in "anticipatory socialization" to the roles for which a school is preparing them. Students' expectations of and preparation for future positions vary as a function of their school's status. Kamens argues that "higher status" institutions provide for their students higher levels of anticipation and socialization for higher status opportunities than "lower status" institutions. Thus, students who attend higher status institutions are more likely than their counterparts to develop the identities, attitudes, and skills that are considered appropriate for future status opportunities.

Although much of the work that supports anticipatory socialization theory is based on research in the K-12 system, it can be easily adapted to higher education and the preparation of undergraduates for careers as biomedical or behavioral scientists and health care professionals. It is widely accepted that the U.S. system of higher education serves a socializing function and is highly differentiated with respect to allocating future opportunities and status (Bowen & Bok, 1998; Brint & Karabel, 1989; Trent et al., 2003). For instance, if becoming a research scientist or health care professional is considered a status opportunity, then the same mechanisms of anticipatory socialization should, in theory, be operating for biomedical and behavioral science majors. That is, of those

students who major in the biomedical and behavioral sciences, attending "higher status" institutions should provide higher levels of occupational anticipation and better socialization than "lower status" institutions, leading to a higher likelihood of persisting in their initial major.

In short, anticipatory socialization theory claims that there are unique benefits to attending higher status or more prestigious institutions. For URM students in particular, several studies have documented the benefits of attending such institutions, although they do not explain the benefits as a function of anticipatory socialization. Bowen and Bok (1998), for example, found consistent positive associations between institutional selectivity and several outcomes for Black students, including degree completion, earnings, leadership, and college satisfaction. Alon and Tienda (2005) also found in their examination of three different data sets using several analytical methods, that for Black and Latino (as well as White and Asian) students, the likelihood of graduation increases as the selectivity of the institution attended rises. In his review of the literature, Kane (1998) argues that the net relationship between institutional selectivity and college retention rates is positive for all students, which may be a result of better learning opportunities via better-prepared classmates or better instructors at more selective institutions. Beyond undergraduate retention, some studies have shown that graduating from "high quality" colleges, usually measured by the level of competitiveness for admissions, increases the probability of attending graduate school (Ethington & Smart, 1986; Smart 1986), particularly in doctoral programs and research universities (Eide, Brewer & Ehrenberg, 1998; Lang, 1987; Zhang, 2005).

If attending a more selective or elite institution improves the likelihood of achieving one's educational goals, one major problem with respect to addressing the intractable racial disparities that persist in the sciences is that URMs are much less likely than their White and Asian counterparts to attend what are commonly referred to as "high status" institutions or those that open "status opportunities" for graduates (Trent et al., 2003). URMs who received an undergraduate degree in the sciences are more likely to have graduated from a minority serving institution than from an institution that is commonly viewed as "high status," which is especially the case for African Americans. *Diverse* (2006) listed the top fifteen institutions that graduated in 2004-2005 the largest numbers of African Americans who majored in the biological and biomedical sciences. Taken together, those institutions graduated approximately 778 African American students, but only two (98 total graduates) of those top fifteen institutions were not either a historically Black college or university. Given this, we will operationalize institutional status for this study in more complex ways that extend beyond typical measures such as selectivity.

Mismatch Hypothesis

Still, it would seem, based on anticipatory socialization theory and the documented benefits of attending elite institutions, that one basic solution for addressing racial disparities in the sciences would be to enroll larger numbers of URM science majors in those high status institutions. Some would object to this strategy because URM students who attend highly selective institutions tend on average to have lower graduation rates and grades than their White and Asian peers with comparable academic preparation and socio-economic backgrounds (Cole & Barber, 2003; Klitgaard, 1985). Many factors

contribute to this "underperformance" among URM students. Certainly, racial inequities in educational opportunities, which are particularly pervasive in the areas of mathematics and science at the K-12 levels, contribute to URM students being less prepared academically on average to compete as science majors than their White and Asian peers (Cole & Barber, 2003; Massey et al., 2003). Some studies have also shown that URMs are more likely than their peers to perform poorly due in part to reasons unrelated to academic preparation but hint at issues of campus climate and disengagement (Seymour & Hewitt, 1997; Steele & Aronson, 1998).

Concerns raised about the underperformance of URM students challenge race conscious efforts to increase URM admission to high status institutions. Cole and Barber argue that "mismatching" URM students in terms of institutions and SAT scores, has a harmful effect on the ability of those students to reach their intended goals. In their study of those who expressed a desire to become college professors in their freshmen year, Cole and Barber found that there is a much higher likelihood among Black and Latino students of advancing toward this initial intention when they attend somewhat less selective schools. They argued that among this group of URM students, attending a more selective institution contributed to lower grades received, which in turn discouraged these students from pursuing careers in academia. They claim that if URM students want to improve their chances of persisting with their initial intentions toward careers that recruit from those who receive higher undergraduate grades, then they should avoid institutions where the White and Asian students are academically better prepared.

The mismatch hypothesis also raises doubts that attending high status institutions necessarily improves the chances that URM science students will achieve their intended

science career goals, as suggested by anticipatory socialization theory. Thus, this study examines whether or not institutional status affects the chances of persisting in a science major, especially as it applies to URM science students. The main research question is: "To what extent does institutional status or prestige contribute to end of first college year undergraduate persistence in a biomedical and behavioral science major?" The findings will address both the controversy surrounding the benefits of attending elite institutions and the preparation of future URM scientists and health care providers.

Method

Data Source and Sample

This study draws from data collected by the Higher Education Research Institute (HERI), as part of their 2004 Cooperative Institutional Research Program (CIRP) Freshman Survey and 2005 Your First College Year (YFCY) Survey efforts. For the purposes of this study, we also targeted and surveyed students from a group of institutions that do not regularly participate in HERI surveys. These institutions (n=104) included Minority-serving institutions (MSIs), campuses with National Institutes of Health (NIH)-funded retention programs, and campuses with a reputation for graduating large numbers of baccalaureates in the sciences (see Hurtado et. al., 2006 for more detail). In total, over 26,000 students from 203 four-year institutions participated in both surveys to constitute a longitudinal assessment over the first-year of college. Due to concerns about the overall survey response rate (22.5%), we applied statistical weights that adjust the sample upward to better approximate the original population (Babbie, 2001; Dey, 1997). The weighting procedure used for this study also accounted for the probability of responding to both the 2004 and 2005 surveys and corrected for inaccurate

standard errors due to producing a larger weighted sample size (see Hurtado et al., 2006

for more detail on the weighting procedures).

After adjusting for response bias, we selected two subgroups of students from the

full sample for this study. One group included URM students, which served as our

baseline sample, who in the 2004 Freshman Survey indicated on the Freshmen Survey

that they plan to pursue one of the following four majors: biology, chemistry, health

science or psychology. The other group was a comparative sample matched by institution

of White and Asian biomedical or behavioral science major aspirants who were randomly

selected to correspond with the number in the baseline group. The final weighted sample

for this study consisted of 2,964 students (1,692 URM science majors and 1,272 White or

Asian science majors) enrolled in 159 institutions.

Dependent Variable

The dependent dichotomous variable in this study measures whether or not those

students in our sample who initially indicated that they would select a biomedical or

behavioral science major remained in the major after their first college year. Specifically,

those students who were identified as having persisted in their major, indicated on the

YFCY that: (1) they did not change their major during their first college year and/or, (2)

they intended to pursue a biological or behavioral science major. All other students were

identified as having departed from their initial science major interest after their first

college year.

Independent Variables

The key independent measures related to our research question involve

institutional status. To operationalize the concept of institutional status and acknowledge

its complexities, we included a variety of measures, and specifically some which might

be particularly relevant to URM science students (see Appendix A for description of this

factor). The first set of variables consisted of students' perceptions of the institutions they

attended, including whether the institution was considered his/her first choice as well as

the level of importance that the institution's reputation played in a student's decision to

attend that particular institution. These perceptions are undoubtedly influenced by

external assessments of an institution's quality, but they may contribute to those

valuations as well. Moreover, their effects on persistence can function independently

from externally applied "status" measures.

Next, a set of more descriptive variables that characterize aspects of an institution

were considered, including institutional control and production of science bachelors (as

determined by IPEDS 2001 data on the aggregate percent of degrees awarded in the four

science fields of interest). The latter speaks to the potential science oriented socializing

function of a college or university. Arguably, a school that produces a larger proportion

of science majors imparts resources, a peer environment, or perhaps an institutional

emphasis that supports the pursuit of science. The last group of status variables consisted

of institutional race and selectivity. These items are central to our examination of how

traditional notions of institutional status affect persistence given the success of Minority-

serving institutions, often considered "lower-status" schools, at training URM scientists.

Separate variables for enrollment at a Historically Black College or University (HBCU)

versus an Hispanic-serving institution (HSI) were employed, as our analysis showed that

these institutional types have differing influence on retention in a science major. Finally,

institutional selectivity was also included by calculating the average SAT composite

score (math + verbal) of the entering freshman class in 2004 (divided by 10) for each of the institutions in the sample.

Other variables in our analyses included students' background characteristics, pre-college experiences, and first-year college experiences, perceptions and behaviors (see Appendix A). Student background characteristics consisted of a student's race/ethnicity, gender, and socioeconomic status (i.e. a combination of parental education and income), whereas precollege experience variables consist of a variety of high school behavior and self-perceptions regarding students' personal competencies, goals, and college expectations. Recent studies (Hurtado et al., 2006) have demonstrated that these background characteristics and precollege experiences are important points of reference to consider when examining how college students aspire towards science-based degrees and careers. Lastly, items from the YFCY were included, such as major type, participation in various academic and social activities on campus, college GPA, and views about different aspects of campus life.

It is important to note that some of the variables described above include a combination of survey items. To combine items that measure a common construct, we conducted a series of factor analyses, using principal components factoring with varimax rotation. After verifying the reliability of these factors, new scales were developed for each factor, using a regression approach (see Appendix A & B for more details about these variables). In addition to the final list of variables listed, other related variables were also considered and tested during preliminary analyses, but were eventually omitted in the interest of developing more parsimonious statistical models. Those variables, omitted for reasons associated with multicollinearity with other included items and

factors, included the following: a student's high school health service activity, his/her goal to aspire towards a science research career, the percentage of URMs enrolled at the institution, his/her faculty interactions outside of class, and other academic engagement behaviors, such as hours per week spent studying or doing homework.

Analyses

In order to maintain statistical power, missing values for all continuous variables were replaced using the EM algorithm. The EM algorithm represents a general method for obtaining maximum likelihood (ML) estimates when a small proportion of the data is missing (Dempster, Laird & Rubin, 1977, cited in Allison, 2002; McLachlan & Krishnan, 1997). Students who did not answer items related to the outcome variable were omitted from the sample. Missing case substitutions were not conducted for variables such as gender and race.

Because our dependent variable is a binary measure of first-year retention in a biomedical or behavioral science major, we employed logistical regression as our main analytical approach, which can be described as:

Logit (persistence) $= a + b^1$ *(background characteristics)* $+ b^2$ *(perception of institution)* $+ b^3$ *(institutional characteristics)* $+ b^4$ *(institutional race and selectivity)* $+ b^5$ *(college experiences)*

This same equation was applied twice: first, to examine persistence for the aggregate "all student" sample, and second, to focus more specifically on the underrepresented minority students in our sample.

<div align="center">Results</div>

The descriptive findings reported in Table 1 show that 82.3 percent of the students in our sample who indicated intentions of majoring in the biomedical or behavioral sciences upon entering college remained in those majors at the end of their first college year. That rate varied slightly across different race groups, with Latinos having the highest departure rate (approximately 21%) from those majors. The differences were more striking across the four biomedical and behavioral science majors. Here, psychology majors were more likely to switch majors than those in the non-behavioral sciences. Lastly, Table 1 also reports slight differences in persistence rates across institutional type. Students who attend a HBCUs have a higher rate (86.2%) of remaining in their initial biomedical or behavioral science major than students in other types of institutions. The differences reported here had implications for the multivariate analyses findings, as will be discussed further.

Insert Table 1 about here

All Students

The results for the first set of logistic regression analyses that included all students are reported in Table 2 (coefficients are exponentiated to reflect odds ratios). The model summaries reported in Table 2 show that each of the five models performed better than chance (50%) in predicting both persistence in the biomedical and behavioral science majors (in sample) and departure from those same majors (not in sample). Curiously, Model 1 was slightly better at predicting persistence (62.8%) than the other models, whereas each successive model improves prediction of departure from major. The overall percent predicted for both persistence and departure improved from 61.4

percent in Model 1 when only student background characteristics were considered to 62.7

percent in Model 5 after all other variables were accounted for. The greatest gain in

explained variance in the analyses was made in Model 5, after the inclusion of first-year

college experiences. Given the strengths of Model 1 for predicting persistence and Model

5 for predicting both persistence and departure, we now focus our discussion on the

results from these two models.

Insert Table 2 about here

Although the first model included only student background characteristics, it was

relatively proficient at predicting persistence in those science majors (62.8%). Of those

variables included in Model 1, four entering student characteristics proved to be

statistically significant as shown in Table 2. One of these was relatively robust, retaining

its statistical significance through each successive model. Conversely, the other three

were no longer significant by the final model after accounting for all other variables.

The more robust variable is students' report of their degree aspiration (p < .001).

Per each unit increase on degree aspiration (from bachelors to masters to

doctorate/professional degree), students are about 40 percent more likely to be retained

within a biomedical or behavioral science major. The three other variables that were

significant in Model 1 but were no longer by the final model are: students' level of

commitment to working to find a cure for a health problem, being Black, and number of

years studying mathematics in high school. Students who reported a stronger

commitment to finding a cure for a health problem are also more likely to persist within a

biological or behavioral science major than students with lower commitment levels; this

measure remains significant (p < .05) through the fourth model. Even though all racial/ethnic groups (with the exception of Latina/os) show an enhanced likelihood of retention within the biological/behavioral science majors as compared to their White student counterparts (referent group), only being a Black student was statistically significant (p < .01) after controlling for the full set of background characteristics. Black students are about 36 percent more likely than their White counterparts to be retained within these science majors. This relationship, however, was no longer statistically significant in Model 3, suggesting that institutional characteristics moderate this race effect. Also worth noting is that Latinos are the only group less likely to be retained within the science majors relative to White students, although this relationship is not statistically significant. With regard to precollege academic preparation, each additional year of study in math improves the chances of persistence by slightly over 20 percent through the fourth model in the analysis.

Moving now to the remainder of the results in Model 5, we first turn to institutional characteristics. The results reported in Table 2 shows that the average combined SAT score of a student body (selectivity) is statistically significant (p < .01). For every ten-point increase in average SAT score within an entering cohort of freshmen for a given institution, the likelihood of retention decreases by two percentage points. Therefore, all things being equal, a student has a 20 percent higher chance of departing from a biomedical or behavioral science major if he/she attends an institution where the average undergraduate combined SAT score is 1100 versus one with an average of 1000. This effect does not appear to be moderated by first-year college experiences.

Turning now to those experiences, Table 2 reports five additional statistically significant variables, suggesting that early experiences can make a difference in retaining students in the sciences. Most impressive here is that students who reported that they joined a pre-professional or departmental club during their first-year of college are close to 130 percent more likely than their peers to have persisted in their respective biological or behavioral science major (log odds ratio = 2.28, p < .001). Likewise, students who reported participating in a health science research program during their first college year are over 60 percent more likely (log odds ratio = 1.64, p < .01) than those who do not participate in such programs to have persisted in their science major. The combined findings suggest possible areas for programmatic intervention during the critical first-year of college to positively affect student retention within the science majors.

Three other college experience variables also had a significant effect on persistence. Students who are behavioral science (psychology) majors are around 30 percent less likely (log odds ratio = 0.73, p < .05) than biological science majors to remain within their initial major. Similarly, every half-grade increase in students' reported grade point average, from C- to C, or C to C+/B- for example, yields a positive likelihood (approximately 20% increase) of retention within major (p < .001). Curiously, we also found that receiving advice about an educational program from a professor has a negative effect on students' persistence. Students who reported that they occassionally or frequently received such advice during their first-year are over 20 percent less likely than their peers to have persisted in their initial major. It is possible that students get such advice from faculty because they are having academic difficulties or doubts about pursing

their major, but the fact that it is a single item question restricts more accurate

interpretations regarding the purpose or nature of this advice.

Underrepresented Minority Students

  To address whether there are unique factors that contribute to URM student

persistence in a biomedical or behavioral science major, a similar set of logistic

regression analyses as above was conducted for only the URM students in the sample

(African American, American Indian and Latinos). Again, five models of variables were

regressed on whether or not a student remained in a biomedical or behavioral science

major at the end of their first-year of college. The results for this second set of analyses

are reported in Table 3 (coefficients are exponentiated to reflect odds ratios).

Insert Table 3 about here

  The model summaries reported on the bottom of Table 3, shows that each of the

five models performed better than chance (50%) in predicting both persistence in the

biomedical and behavioral science majors (in sample) and departure from those same

majors (not in sample). Once all five models are included, the percent predicted for

persistence (64.7%) and departure (65.5%) are practically equal. The summaries also

show that for the most part, each successive model improves both types of prediction.

The overall percent predicted improved from 61.9 percent in Model 1 when only student

background characteristics were considered to 64.9 percent in Model 5 after all other

variables were accounted for. Given that Model 5 was the strongest of the five models,

we will focus our discussion on the results from this final model.

The coefficients shown in the last column of Table 3, report the results for Model 5. Starting with URM students' background characteristics, their degree aspiration is significantly related with persistence in the majors of interest ($p < .05$). URM students who aspire toward graduate work and degrees increase their chances of staying in the major by over 30 percent (log odds ratio = 1.31, $p < .05$). Also worth noting is the negative relationship between persistence and being Latino. Although the significance between these two variables diminishes after controlling for institutional selectivity in Model 4, it reinforces earlier findings with the full sample. Compared to their Black/African American peers (referent group), Latino students are less likely to persist in these majors, perhaps in part because Latino students are more likely to attend PWIs (85.5%) than their Black/African American (41%) peers (analysis not presented in text).

URM students' perception of their institution also had a significant effect on their chances of persisting. Students who attend what they consider to be their "first-choice" school are less likely to persist in a biomedical or behavioral science major. Conversely, students who view their school as having a good reputation (in terms of academics, rankings in national magazines, and ability to send graduates to top graduate and professional schools) are more likely to persist in the sciences through the first-year of college. While these student perceptions both seemingly refer to positive attributes of an institution, they also appear to have contradictory effects – one dampening and the other facilitating persistence. These contradictory effects become statistically stronger once other institutional characteristics are added in following models.

Before discussing the contributions that other institutional characteristics make to persistence, which will require closer examination, we first turn to college experiences.

Here, the findings are similar to those for the full sample. Again, joining a pre-professional or departmental club during the first-year of college has an impressive impact on persistence (log odds ratio = 2.56, p < .001). Participation in one of these clubs improved URM students' likelihood of persisting by over 150 percent. Additionally, a URM student's likelihood of persisting in the major increases just over 20 percent with each incremental change in his/her current college GPA. Lastly, receiving "occasional" or "frequent" advice about an educational program from a professor decreases a URM student's chances of staying in the major by 30 percent as compared to their peers who "rarely" or "never" sought such guidance.

We now turn to the institutional characteristics findings. Although only one variable has a statistically significant effect on persistence, the results appear to be more complicated than just this single finding. Similar to the results for the full sample, the influence of the average combined SAT score of a student body (selectivity) is statistically significant (p < .01). For every ten-point increase in average SAT score within an entering cohort of freshmen for a given institution, the likelihood of retention decreases by three percentage points. Therefore, all things being equal, a URM student has a 30 percent higher chance of departing from a biomedical or behavioral science major if he/she attends an institution where the average undergraduate combined SAT score is 1100 versus one with an average of 1000. This effect does not appear to be moderated by first-year college experiences.

Although no other institutional characteristic contributes significantly to predicting URM persistence, we were particularly interested, given our research interests, in the negative relationship between Minority-serving institutions (MSIs) and the

dependent measure. The results reported in Table 3 under Model 5 show that both HSIs and HBCUs have a negative but statistically insignificant effect on retention. Recent reports (see *Diverse*, 2006), by contrast, show that MSIs, particularly HBCUs, produce a disporportionally larger number of minority science graduates. Indeed, the simple correlation between persistence and matriculating at an HBCU is positive and statistically significant (r = .08, p < .01) for our sample, whereas there is no statistically meaningful relationship between persistence and attending an HSI.

Given that MSIs tend to be less selective than predominantly White institutions (PWIs), we plotted that relationship by URM persistence rate. Figure 1 shows the plot of URM retention in the major by selectivity for PWIs, HSIs, and HBCUs. The figure shows that as the level of selectivity increases for both PWIs and HSIs, the rate of persistence for URM students decreases at those institutions. By contrast, as the level of selectivity increases for HBCUs, the rate of persistence increases as well. Compared to PWIs and HSIs, it appears that higher average student body SAT scores have a very different effect on major persistence at HBCUs. Rather than increase the risk of departure in the biomedical and behavioral sciences, attending an HBCU where students have higher average test scores may improve URM students' chances of persisting in those majors.

Insert Figure 1 about here

Discussion

That the American science pipeline is "leakier than warped rubber tubing" has become serious enough to receive considerable attention from U.S. policy makers who have raised concerns about the future of our nation's economic competitiveness and

position in technological leadership (Epstein, 2006). This study examined factors that contribute to the chances of persisting in a biomedical or behavioral science major through the first-year of college. Of particular interest is the extent to which institutional status affects those chances for underrepresented minority students (URMs). On the one hand, Anticipatory Socialization Theory (Kamens, 1981) claims that attending "higher status" institutions improves one's chances of persisting because those institutions possess unique resources and socializing forces. On the other hand, the "mismatch hypothesis" (Sowell, 1993; Thernstrom, 1995) maintains that URM students increase their risk of abandoning their initial educational goals when they attend more selective institutions where the White and Asian students are academically better prepared.

Given the incongruous frameworks that inform this study, we took a broad view of institutional status and measured it in multiple ways. Overall, logistic regression results for all students and for URMs were comparable, and there was overlap in how the set of six institutional status variables affected each group's chances of persisting in a biomedical or behavioral science major. For both groups, a higher level of institutional selectivity resulted in a significant negative effect on persistence in a biomedical or behavioral science major. For the all student sample, the likelihood of retention in a science major decreased by two percent for every ten-point increase in the level of institutional selectivity. For the URM sample, the likelihood of retention decreased by three percent for every ten-point increase in institutional selectivity. Thus, students who attend institutions where the entering freshmen class has higher SAT scores are at a slightly, yet statistically significant risk of not persisting in their science major. This effect appears to be somewhat stronger for URM students.

There were also notable differences in how other status variables affected both samples' chances of persisting in a biomedical or behavioral science major after one year. Whereas none of these variables had a significant effect on the all student sample, two of these status measures proved to make a difference in URM students' chances of persisting. First, URM students who attended their "first-choice" campus were less likely to persist. This finding seems to reaffirm the effect of institutional selectivity, namely that "first-choice" campuses are perhaps likely to be more exclusive or selective than second- or third- choice campuses. So, a heightened sense of competition at "first-choice" institutions may trump the benefits that their status and prestige would otherwise offer URM students in terms of resources and opportunities.

Second, URM students who viewed their institution as having a good reputation with respect to academics, rankings in national magazines, and ability to send graduates to top graduate and professional schools, were more likely to persist in the sciences through the first-year of college. Unlike the other status measures, this one is perhaps more closely linked with future career and graduate school placement, which may point to a longer-term perspective for a chosen field of study. Here, acceptance to what URM students perceive to be a "high status" institution may be an important source of influence on their ambitions and self-concepts, perhaps triggering anticipatory socialization effects. According to Kamens (1981), attending a high status institution can serve as an important signal about the viability of career options, which in this case may improve URM students' positive self-concepts and aspirations relevant to a career in the sciences or health professions.

Unlike the results for all students, URM students' perceptions about an institution yielded significant effects independent of the level of institutional selectivity. Although these perceptual variables are correlated with selectivity, they do not appear to be as tightly bound with selectivity for URM students as they are for the full sample of students. Upon closer inspection, we found that the relationship (simple correlation) between perceptions of institutional reputation and selectivity were weaker for the URM sample than for the all student sample. This suggests that URM students' view of institutional status is more nuanced, and the linkage between academic reputation and institutional selectivity is weaker. This more nuanced relationship among status variables for URM students led to a more complex conception of institutional status, which likely contributes to students' college choice and subsequent persistence. URM students' choice of college is indeed more multifaceted, where considerations of family finances as well as current and future financial stability can complicate considerations of institutional status and selectivity in the decision-making process (Fries-Britt & Turner, 2002; Hurtado, Inkelas, & Rhee, 1997; St. John, Paulsen, & Carter, 2005).

The complex confluence among those factors is also evident at the institutional level. When we plotted URM science retention by institutional selectivity for PWIs, HSIs, and HBCUs, we found that as the level of selectivity increased for HBCUs, the rate of persistence for URM students also increased at those institutions. By contrast, the rate of persistence decreased as the level of selectivity increased for both PWIs and HSIs. Given the unique mission of HBCUs to identify and nurture overlooked academic talent, it is not surprising that having a larger proportion of high-achieving students who are working toward a common goal operates differently at those institutions and tend to

decrease rather than increase the risk of departure in the biomedical and behavioral

sciences. In contrast, the institutional mission of HSIs lacks the historical development of

HBCUs, and these campuses often function and appear more like PWIs than an MSI.

As expected, students' chances of persisting in the sciences are not determined

solely by institutional status, and we identified several background characteristics and

college experiences that also made a significant difference. The most notable among

them for educational practice was joining a pre-professional or departmental club during

the first-year of college. Although participation in student organizations of any form

enhances the level of involvement and engagement with the campus environment, which

in turn enhances the process of adjustment and transition for students (Astin, 1993; Tinto,

1993), professional or departmental participation appears especially relevant for

biomedical and behavioral science majors. In the findings for the all student sample,

those who joined such clubs improved their chances of persisting by 130 percent. For

URM students, participation in one of these clubs improved the likelihood of persisting

by over 150 percent. Joining these clubs may signal a stronger commitment or

identification with a student's field of study or future careers. At best, these student

groups may be important resources that serve to socialize and prepare students for future

opportunities in the sciences by developing a firmer science identity. Such groups may

also provide them with an opportunity to engage a peer group that shares similar

academic and career interests, which in turn can help to reinforce their science identity.

According to anticipatory socialization theory, mechanisms that socialize students for

their anticipated roles, improves students' chances of reaching their academic goals

(Kamens, 1981).

Lastly, with respect to the description of the American science pipeline as "warped rubber tubing," we found that first-year success in the sciences is largely a function of pre-college student characteristics, which predict over 60 percent of the chance of being retained. Although the focus of the science crisis has been mostly limited to discussions about poor academic preparation, we also found evidence that shaping students' aspirations and interests in substantive issues before they enter college is equally important. For example, students who entered college with anticipations of attending graduate school increased their chances of being retained within their science major. Also, students who reported a stronger commitment to finding a cure for health problems reduced their risk of departure, although this effect was much weaker when compared to students' degree aspirations at college entry. In short, the effects of students' precollege characteristics and pre-dispositions suggest that better early science preparation includes not only learning science content but also developing higher degree aspirations and understanding the practical value of science for improving society.

Conclusion

Our findings show that institutional status matters but not in ways that can be explained solely by either the anticipatory socialization theory or the mismatch hypothesis. There does seem to be a mismatch occurring in science education at the college level. The problem, however, is not only an issue of poorly-prepared URM students failing among high achievers, as suggested by the mismatch hypothesis. The problem is that all students, irrespective of their race, academic preparation, or motivation, are at greater risk of failing among high achievers at highly selective institutions where the undergraduate student body is mostly White and Asian. In other

words, even highly capable and talented White and Asian students—who would otherwise continue in a biomedical or behavioral science major at less selective institutions—are leaving the sciences at higher rates at more selective ones.

Ironically, the more selective institutions tend to be viewed by students as possessing more "status qualities," which, according to anticipatory socialization theory, should facilitate degree completion. However, contrary to expectations of that theoretical orientation, our findings indicate that the more selective institutions may not be making the most of those qualities to socialize and advance students toward their anticipated educational goals. The underlying cause of this problem is not just an attribute of having high achieving students. After all, selective HBCUs manage to balance the enrollment of high achieving students with high rates of science completion. Instead, we suspect that the underlying issues have more to do with how highly selective institutions that enroll high achieving students tend to function.

That is, highly competitive environments tend to further sort out students in order to identify the very best ones, often providing limited resources to compensate for students' prior preparation. Therefore by design, only a few can succeed with the assumption that admitted students received comparable educational preparation and are on equal footing to compete. Even when students are well matched and highly qualified, only some will actually "make the cut" when institutions subscribe to a competitive educational model. By contrast, more selective HBCUs, as indicated in our findings, appear to approach the process differently and seem to focus less on further "weeding out" students. Once a rich talent pool has been identified, they seem to do a better job

socializing and cultivating that talent to improve students' chances of succeeding in the sciences.

Although two measures of institutional status had negative effects on science persistence, we also found that one of them, students' perception of reputation, yielded a positive effect on URM students' chances of persisting, independent of the other status measures. This finding lends some support to the anticipatory socialization theory, namely that URM students' chances of persisting in the sciences are significantly improved at an institution that is regarded by the student as having a good reputation in academics, rankings, and sending graduates to top graduate and professional schools. Those features of an institution may, as suggested by anticipatory socialization theory, improve the socialization and commitment of URM students toward their anticipated goals. It also appears that when the notion of institutional status is decoupled from selectivity or exclusivity, some forms of status may actually improve the chances of persisting in a biomedical or behavioral science major.

From a policy standpoint, our findings suggest that there are important countervailing forces to consider in a stratified higher education system. Although the nation's top research universities and most selective colleges have the resources, reputation, and normative advantages that position them well to train future scientists, most of them also appear to foster an educational context and process that can potentially increase students' risk of abandoning studies in the sciences. This context can include a highly competitive peer environment where only a few are designed to succeed, faculty who are more focused on research than teaching, and limited numbers of role models and especially individuals of color. By contrast, other types of institutions that are less

exclusive or prestigious may do a better job retaining students in science majors, but are more likely to be perceived by the broader academic community as being less legitimate or reputable, which disadvantages their students, especially when applying for graduate studies in the sciences. If the broader policy objective is to prevent leakages in the science pipeline, it seems then that our research universities should take a much harder look at why those students who should otherwise complete a science major are not doing so on their campuses. Additionally, they can benefit greatly both from examining the practices of exemplary institutions that succeed in graduating science majors and from reconsidering a rigid stratified view of institutions that penalizes those graduate school applicants who received their degrees from institutions that are not widely held in high regard even though they provide exemplary undergraduate education.

Limitations and Future Directions

A few limitations to our study should be acknowledged. First, due to small sample sizes, we are not able to disaggregate our URM sample by individual race/ethnicity, thereby limiting our understanding and comparisons between the unique experiences of African American, Latino, and American Indian students. The higher rates of departure for Latino/a students is a specific area of inquiry that could be further examined with a disaggregated sample.

Second, while our data allow us to make inferences regarding science persistence/departure after one year of college, we are not able to further deduce exactly when during the first year that students make the decision to stay or switch from a biomedical or behavioral science major, which would provide important information regarding if/when a particular institutional intervention prompts the students' decision.

While persisting through the first year of college in a biomedical or behavioral science major is a crucial juncture point, our findings show that over 80 percent of students are remaining in their majors. We know, however, that another 20 to 30 percent will typically exit before the end of the second year (Center for Institutional Data Exchange and Analysis, 2000). Following up with these students would further help isolate the factors and moments that science students decide to leave their majors and where they are going, whether to another science major, a completely different field of study, or leaving the institution all together.

Lastly, the emphasis of this study was on the role that institutional status plays in affecting persistence in the major. Having additional items to account for the various dimensions of institutional status (for example percentage of faculty of color in the sciences, financial support for science students, percentage of science graduates who go on to graduate school) might help clarify or further complicate the notions of anticipatory socialization or mismatch that play a role in the discussion.

References

Allison, P. D. (2002). *Missing data*. Thousand Oaks, CA: Sage Publications.

Alon, S., & Tienda, M. (2005). Assessing the "Mismatch" hypothesis: Differences in
     college graduation rates by institutional selectivity. *Sociology of Education,
     78*(October), 294-315.

American Association for the Advancement of Science (2001). *In pursuit of a diverse
     science, technology, engineering, and mathematics workforce: Recommended
     research priorities to enhance participation by underrepresented minorities*.
     http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP_report.pdf

Astin, A. W. (1993). *What matters in college: Four critical years revisited*. San
     Francisco: Jossey Bass.

Babbie, E. (2001). *The Practice of Social Research*. Belmont, CA: Wadsworth.

Bonous-Hammarth, M. (2000). Pathways to success: Affirming opportunities for science,
     mathematics, and engineering majors. *Journal of Negro Education 69*(1), 92-111.

Bonous-Hammarth, M. (2006) Promoting student participation in science, technology,
     engineering and mathematics careers. In W.R. Allen, M. Bonous-Hammarth, &
     R.T. Teranishi, (Eds.), *Higher education in a global society: Achieving diversity,
     equity, and excellence* (pp. 269-282). Oxford: Elsevier Ltd.

Bowen, W. G., & Bok, D. (1998). *The shape of the river: Long-term consequences of
     considering race in college and university admissions*. Princeton, NJ: Princeton
     University Press.

Braxton, J. M. (2000). *Reworking the student departure puzzle*. Nashville, TN:
     Vanderbilt University Press.

Brint, S., & Karabel, J. (1989). *The diverted dream: Community colleges and the promise of educational opportunity in America, 1900-1985*. New York, NY: Oxford University Press.

Center for Institutional Data Exchange and Analysis (2000). *1999-2000 SMET retention report*. Norman, OK: University of Oklahoma.

Cole, S., & Barber, E. (2003). *Increasing faculty diversity: The occupational choices of high-achieving minority students*. Cambridge: Harvard University Press

Dempster, A. P., Laird, N. M., & Rubin, D. B. (1977). Maximum likelihood from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society 39*(1), 1-38.

Dey, E. L. (1997). Working with low survey response rates: The efficacy of weighting adjustments. *Research in Higher Education 38*(2), 215-227.

Diverse (2006). Biological and biomedical sciences: African-American baccalaureate. *23*(8), 54.

Eide, E., Brewer, D. J., & Ehrenberg, R. G. (1998). Does it pay to attend an elite private college? Evidence on the effects of undergraduate college quality on graduate school attendance. *Economics of Education Review, 17*(4), 371-376.

Epstein, D. (2006, July 26). So that's why they're leaving. *Inside Higher Education.*

Ethington, C., & Smart, J. (1986). Persistence to graduate education. *Research in Higher Education, 24*, 287-303.

Fries-Britt, S.F., & Turner, B. (2002). Uneven Stories: Successful Black Collegians at a Black and a White Campus. *The Review of Higher Education*, 25 (3), 315–330.

Grandy, J. (1998). Persistence in science of high-ability minority students. *The Journal of Higher Education, 69* (6), 589-620.

Hurtado, S. (in press). The sociology of the study of college impact. In P. Gumport (Ed.), *Sociology of higher education.*

Hurtado, S., Inkelas, K. K., & Rhee, B. S. (1997). Differences in College Access and Choice Among Racial/Ethnic Groups: Identifying Continuing Barriers. *Research in higher education., 38*(1), 43-75.

Hurtado, S., Cerna, O. S., Chang, J. C., Sàenz, V. B., Lopez, L. R., Mosqueda, C., Oseguera, L., Chang, M. J., & Korn, W. S. (2006). *Aspiring scientists: Characteristics of college freshmen interested in the biomedical and behavioral sciences.* Los Angeles: Higher Education Research Institute.

Hurtado, S., Han, J. C., Sáenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O. S. (in press). Predicting transition and adjustment to college: Biomedical and behavioral science aspirants' and minority students' first year of college. *Research in Higher Education.*

Kamens, D. H. (1981). Organizational and institutional socialization in education. *Research in Sociology of Educational and Socialization, 2*, 111-126.

Kane, T. J. (1998). Misconceptions in the debate over affirmative action in college admissions. In G. Orfield & E. Miller (Eds.), *Chilling admissions: The affirmative action crisis and the search for alternatives* (pp. 17-31). Cambridge, MA: Harvard Education Publishing Group.

Klitgaard, R. (1985). *Choosing elites*. New York: Basic Books.

Lang, D. (1987). Stratification and prestige hierarchies in graduate and professional

education. *Sociological Inquiry, 57*, 12-31.

Massey, D. S., Charles, C. Z., Lundy, G. F., & Fischer, M. J. (2003). *The source of the

river: The social origins of freshmen at America's selctive colleges and

universities*. Princeton, NJ: Princeton University Press.

McLachlan, G. J., & Krishnan, T. (1997). *The EM algorithm and extensions*. New York:

Wiley.

Nelson, D. J. (2004) *Nelson Diversity Surveys*. Diversity in Science Association:

Norman, OK; http://cheminfo.chem.ou.edu/~djn/diversity/top50.html.

Nora, A., Barlow, L. & Crisp, G. (2005). Student persistence and degree attainment

beyond the first year in college. In A. Seidman (Ed.). *College student retention:

Formula for success* (pp. 129-153). Westport, CT: Praeger Publications.

Seymour, E. (1992). The problem iceberg in science, mathematics, and engineering

education: Student explanations for high attrition rates. *Journal of Computer

Science and Technology*(February).

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave

the sciences*. Boulder, CO: Westview Press.

Smart, J. (1986). College effects on occupational status attainment. *Research in Higher

Education, 24*, 73-95.

Sowell, T. (1993). *Inside American education: The decline, the deception, the dogmas*.

New York: The Free Press.

Steele, C. M., & Aronson, J. (1998). Stereotype threat and the test performance of

academically successful African Americans. In C. Jencks & M. Phillips (Eds.),

The Black-White test score gap. Washington, D.C.: Brookings Institution Press.

St. John, E., Paulsen, M. B., & Carter, D. F. (2005). Diversity, college costs, and

postsecondary opportunity: An examination of the financial nexus between

college choice and persistence for African Americans and Whites. *The Journal of*

Higher Education, 76(5), 545-569.

Sullivan Commission (2004). *Missing persons: Minorities in the health professions.*

http://www.sullivancommission.org/.

Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*

(2nd ed.). Chicago, IL: The University of Chicago Press.

Thernstrom, S. (1995). The black-white student mismatch problem in university

admissions. *The Journal of Blacks in Higher Education, 6*(Winter), 62-65.

Trent, W., Owens-Nicholson, D., Eatman, T. K., Burke, M., Daugherty, J., & Norman, K.

(2003). Justice, equality of educational opportunity and Affirmative Action in

higher education. In M. J. Chang, D. Witt, J. Jones & K. Hakuta (Eds.),

Compelling interests: Examining the evidence on racial dynamics in colleges and

universities (pp. 22-48). Stanford, CA: Stanford University Press.

Upcraft, M. L., & Gardner, J. N. (1989). *The freshman year experience: Helping students*

survive and succeed in college. San Francisco: Jossey-Bass Publishers.

Zhang, L. (2005). Advance to graduate education: The effect of college quality and

undergraduate majors. *The Review of Higher Education, 28*(3), 313-338.

Table 1: Description of sample

	Total*	Number of students retained	% Retained
Aggregate Sample	2,964	2,440	82.3
Race/Ethnicity			
American Indian/Alaska Native	124	107	86.3
Asian/Asian American	304	254	83.6
Black/African American	930	795	85.5
Latino	638	502	78.7
White/Caucasian	968	782	80.8
Science Major			
Biology, biochemistry, biomedical, pre-professional health	2176	1843	84.7
Behavioral Science (Psychology)	787	598	76.0
Institutional Type			
PWI	2188	1,775	81.1
HBCU	565	487	86.2
HSI	210	178	84.8

*Note: Data is weighted. Some numbers may not add to total due to rounding.

Table 2: Retention in a biological, biomedical or behavioral science major

ALL STUDENTS, N=3,176 (unweighted)	Simple r		Model 1	Model 2	Model 3	Model 4	Model 5	
Background Characteristics								
(Male)	---		---	---	---	---	---	
Female	-0.01		1.00	0.98	0.98	0.95	0.94	
White/Caucasian	---		---	---	---	---	---	
American Indian/Alaska Native	0.02		1.41	1.41	1.37	1.39	1.50	
Asian/Asian American	0.02		1.30	1.26	1.22	1.28	1.26	
Black/African American	0.05	**	1.36 *	1.32 *	1.22	1.14	1.25	
Latino/a	-0.06	**	0.82	0.82	0.81	0.83	0.89	
Entering degree aspiration	0.12	**	1.42 ***	1.39 ***	1.39 ***	1.41 ***	1.35 ***	
Socioeconomic status	0.01		0.98	0.97	0.98	1.01	0.96	
Personal goal: Be Very Well Off Financially	0.03		1.02	1.01	1.00	0.98	0.99	
Personal goal: Make Theoretical Contrib to Science	0.07	**	1.06	1.06	1.06	1.05	1.03	
Personal goal: Work to Find Cure for Health Problem	0.10	**	1.16 *	1.15 *	1.14 *	1.14 *	1.08	
Average High School Grade	0.06	**	1.08	1.08	1.08 *	1.13 **	1.04	
High school research program participation	0.03		0.97	0.97	0.95	0.95	0.88	
Entering social self-concept	0.05	**	1.03	1.03	1.03	1.02	1.02	
Entering academic self-concept	0.09	**	1.10	1.10	1.09	1.10	1.06	
Yrs. study high school mathematics	0.06	**	1.20 *	1.20 *	1.21 *	1.24 *	1.19	
Yrs. study high school biological science	0.04	*	1.06	1.06	1.06	1.07	1.04	
Number of schools applied	0.01		0.99	0.98	0.98	1.00	1.00	
Perceptions of institution								
Choice of This Institution: 1st choice	-0.03			0.81	0.80 *	0.82	0.83	
Institutional reputation	0.08	**		1.07	1.06	1.11	1.10	
Institutional characteristics								
Institutional Control: Private	0.03				0.98	1.03	1.04	
Percent of bachelors awarded in science	0.06	**			2.01 *	1.48	1.56	
Institutional Race and Selectivity								
(Predominantly White Institution)	---					---	---	
Hispanic Serving Institution	0.00					1.08	1.02	
Historically Black College/University	0.07	**				1.02	0.91	
Selectivity index	-0.03					0.98 **	0.98 **	
College experiences								
(Biological science major)	---						---	
Behavioral science major (psychology)	-0.11	**					0.73 *	
Received tutoring	0.02						1.10	
Received negative feedback about academic work	-0.05	**					0.96	
Received advice about educational program from a professor	-0.01						0.77 *	
Enrolled in learning community	0.03						1.24	
Taken a college adjustment seminar	0.02						0.97	
Participated in a health science research program	0.05	**					1.64 **	
Joined a pre-professional or departmental club	0.14	**					2.28 ***	
Participated in an academic support program for URMs	0.01						0.90	
Sense of belonging	0.05	**					1.05	
View: Racial tension on this campus	-0.03						0.83	
View: Strong competition for high grades	0.04	*					1.12	
Current GPA	0.11	**					1.19 ***	
Academic success	0.07	**					1.05	
Job responsibilities interfered w/schoolwork	-0.03						0.87	

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

All student model summaries

	Model 1	Model 2	Model 3	Model 4	Model 5
Cox & Snell R Square	0.030	0.032	0.033	0.037	0.064
Percent predicted overall	61.4	61.7	61.2	61.6	62.7
Percent predicted in sample	62.8	62.8	61.8	61.8	61.9
Percent predicted not in sample	54.9	56.3	58.2	60.6	66.8

Table 3: Retention in a biological, biomedical or behavioral science major

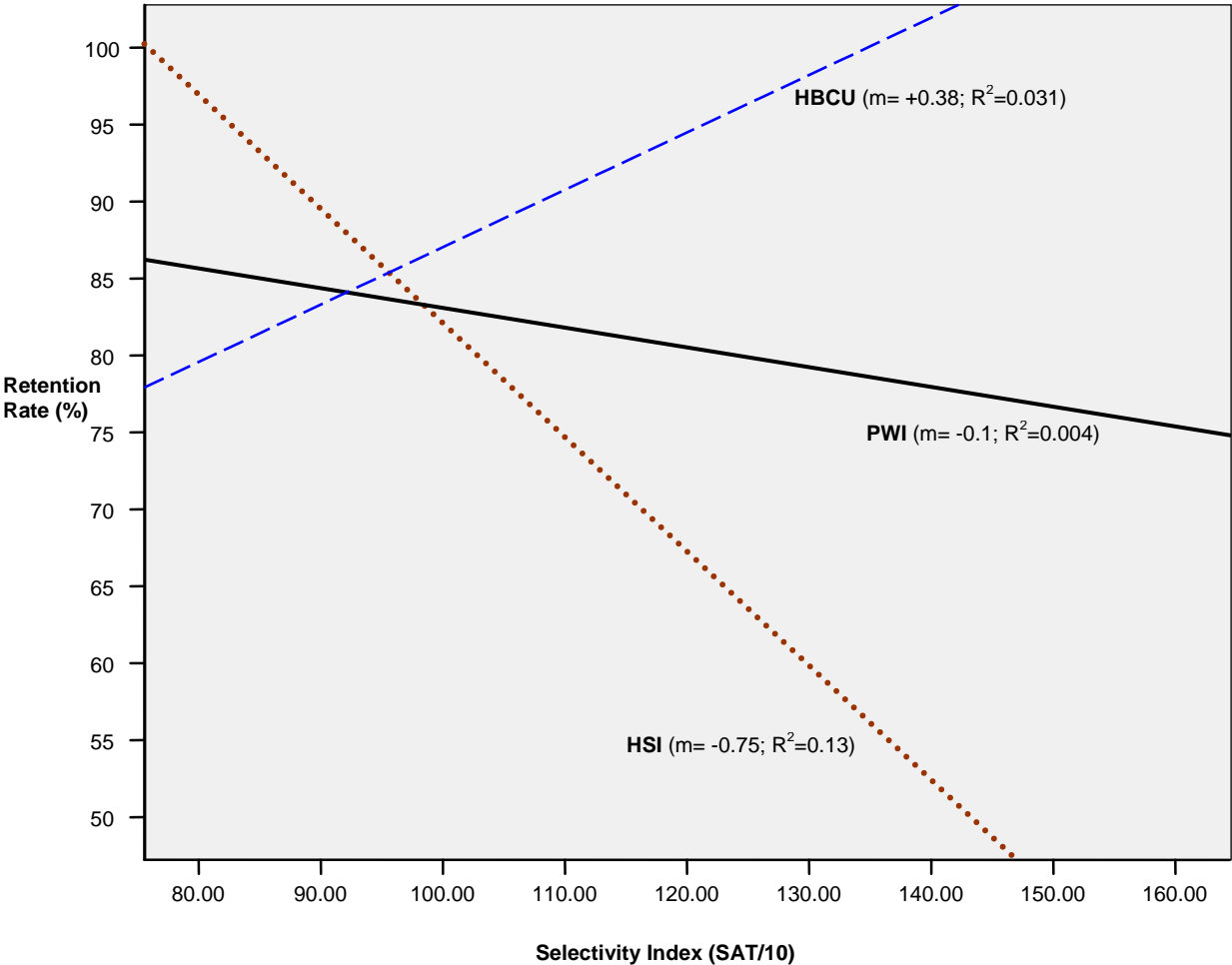| URM STUDENTS, N=1,775 (unweighted)	Simple r	Model 1	Model 2	Model 3	Model 4	Model 5
Background Characteristics						
(Male)	---	---	---	---	---	---
Female	-0.02	0.96	0.93	0.93	0.86	0.87
(Black/African American)	---	---	---	---	---	---
American Indian/Alaska Native	0.02	1.03	1.08	1.13	1.20	1.22
Latino/a	-0.09 **	0.64 **	0.66 **	0.70 *	0.77	0.74
Entering degree aspiration	0.09 **	1.33 **	1.30 *	1.31 *	1.32 *	1.31 *
Socioeconomic status	0.04	1.04	1.03	1.04	1.07	1.00
Personal goal: Be Very Well Off Financially	0.04	1.08	1.06	1.06	1.02	1.05
Personal goal: Make Theoretical Contrib to Science	0.08 **	1.13	1.13	1.13	1.12	1.11
Personal goal: Work to Find Cure for Health Problem	0.09 **	1.14	1.11	1.11	1.10	1.05
Average High School Grade	0.04	1.04	1.04	1.05	1.12 *	1.03
High school research program participation	0.02	0.93	0.93	0.91	0.91	0.82
Entering social self-concept	0.05 *	0.99	0.99	0.99	0.99	1.00
Entering academic self-concept	0.09 **	1.11	1.11	1.11	1.12	1.08
Yrs. study high school mathematics	0.05	1.14	1.14	1.15	1.21	1.21
Yrs. study high school biological science	0.03	1.02	1.02	1.03	1.04	1.00
Number of schools applied	-0.02	0.96	0.94 *	0.94 *	0.97	0.97
Perceptions of institution						
Choice of This Institution: 1st choice	-0.04		0.66 **	0.66 **	0.69 *	0.69 *
Institutional reputation	0.08 **		1.14	1.12	1.21 *	1.23 *
Institutional characteristics						
Institutional Control: Private	0.04			0.97	1.10	1.12
Percent of bachelors awarded in science	0.07 **			1.83	1.45	1.76
Institutional race and selectivity						
(Predominantly White Institution)	---				---	---
Hispanic serving institution	-0.02				0.74	0.67
Historically Black College/University	0.08 **				0.68	0.59
Selectivity index	-0.08 **				0.97 ***	0.97 ***
College experiences						
(Biological science major)	---					---
Behavioral science major	-0.09 **					0.78
Received tutoring	0.01					1.14
Received negative feedback about academic work	-0.04					1.07
Received advice about educational program from a professor	-0.02					0.70 *
Enrolled in learning community	0.02					1.26
Taken a college adjustment seminar	0.03					0.96
Participated in a health science research program	0.03					1.52
Joined a pre-professional or departmental club	0.14 **					2.56 ***
Participated in an academic support program for URMs	0.00					0.91
Sense of belonging	.056*					1.04
View: Racial tension on this campus	-0.03					0.96
View: Strong competition for high grades	0.00					0.98
Current GPA	0.12 **					1.23 ***
Academic success	0.09 **					1.12
Job responsibilities interfered w/schoolwork	-0.03					0.95

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

URM Student Model Summaries

	Model 1	Model 2	Model 3	Model 4	Model 5
Cox & Snell R Square	0.028	0.033	0.034	0.043	0.076
Percent Predicted Overall	61.9	62.6	62.2	63.4	64.9
Percent Predicted In Sample	63.6	63.7	62.9	63.9	64.7
Percent Predicted Not in Sample	53.4	57.4	59.1	60.8	65.5

Figure 1: URM Retention Rate by Selectivity Index

Appendix A: Description of variables and factors

Variables	Scale
Dependent Variable	
Retention in biological, biomedical or behavioral science major:	
Indicate probable field of study (CIRP): biology (general), biochemistry or biophysics, microbiology or bacteriology, zoology, medicine, dentistry, veterinary medicine, pharmacy, psychology	1=marked, 0=not marked
Since entering this college have you (YFCY):	1=marked, 0=not marked
Decided to pursue a different major	
Intended to major in a Health, Biomedical, or Behavioral Science	
Independent Variables	
Background characteristics and pre-college experiences	
Gender: Female	1=no, 2=yes
Ethnic Background: White/Caucasian, American Indian/Alaska Native, Asian/Asian American, Black/African American, Latino	1=no, 2=yes
What is the highest academic degree you intend to obtain?	1=bachelors degree or less, 2=masters, 3=doctorate/ professional degree
Socioeconomic status	A composite measure of three variables that assess family income, father's education and mother's education.
Indicate the importance to you personally of the following:	
Being very well off financially	1=not important, 4=essential
Making a theoretical contribution to science	
Working to find a cure to a health problem	
High school grade point average	1=D; 8=A or A+
Have you participated in a summer research or health science research program?	1=no, 2=yes
Entering social self-concept	A composite measure of three variables that assess students' self-rated leadership ability, social self-confidence and intellectual self-confidence. The three variables are measured separately on a five-point scale: 1=lowest 10% to 5=highest 10%.
Entering academic self-concept	A composite measure of four variables that assess students' self-rated academic ability, mathematics ability, intellectual self-confidence and writing ability. The four variables are measured separately on a five-point scale: 1=lowest 10% to 5=highest 10%.
Years of math in high school	1=none; 7=five or more
Years of science in high school	1=none; 7=five or more
To how many college other than this one did you apply for admission?	1=none, 9=11 or more
Perception of institution	

Is this college your first choice?	1=no, 2=yes
Institutional reputation	A composite measure of three variables that assess the importance of an institution's academic reputation, ability to send graduates to top graduate / professional schools, national rankings in magazines. The three variables are measured separately on a three-point scale: 1=not important, 3=very important

Institutional characteristics

Institutional control	1=public, 2=private
Percent bachelors awarded in science	Range 0 to 1.00

Institutional race and selectivity

Hispanic serving institution	1=no, 2=yes
Historically Black College or University	1=no, 2=yes
Selectivity Index: Average combined SAT score of entering 2004 cohort divided by 10	Range 40 to 160

College experiences

Behavioral science major	1=no, 2=yes
Since entering college, indicate how often you:	
Received tutoring	1=not at all to rarely,
Received negative feedback about your academic work	2=occasionally or frequently
Received advice and guidance about your educational program from a professor	
Since entering this college have you:	
Enrolled in a formal program where a group of students takes 2 or more courses together (e.g., learning community)	1=not marked, 2=marked
Taken a college course/seminar specifically designed to help first-year students adjust to college	
Participated in a health science research program sponsored by this college	
Joined a pre-professional or departmental club	
Participated in an academic enrichment/support program for racial/ethnic minority students	
Sense of belonging	A composite measure of three variables that assess students' agreement with the statements: I see myself as a part of the campus community, I feel that I am a member of this college, and I feel I have a sense of belonging to this college. The three variables are measured separately on a four-point scale: 1=strongly disagree to 4=strongly agree.
Indicate the extent to which you agree or disagree with the following statements:	
There is a lot of racial tension on this campus	1=disagree, 2=agree
There is strong competition among most of the students for high grades	

Current grade average	1=no grades, 7=A
Success at managing the academic environment	A composite measure of five variables that assess students' success at understanding what your professors expect of you academically, developing effective study skills, adjusting to the academic demands of college, managing your time effectively and getting to know faculty. The five variables are measured separately on a three-point scale: 1=unsuccessful to 3=completely successful
Since entering this college, how often have you felt:	
That your job responsibilities interfered with your schoolwork	1=not at all to rarely, 2=occasionally or frequently

Components & Alpha Reliability†	Factor Loadings
Socioecomonomic status (α =0.71)	
Parental income	0.57
Father's education	0.75
Mother's education	0.70
Academic self-concept (α=0.60)	
Academic ability	0.70
Mathematics ability	0.40
Self-rated intellectual self-confidence	0.50
Self-rated writing ability	0.32
Social self-concept (α=0.72)	
Leadership ability	0.69
Self-rated social self-confidence	0.59
Self-rated intellectual self-confidence	0.66
Institutional Reputation (α=0.66)	
How important was each reason in your decision to come here?	62
This college has a very good academic reputation	.66
This college's graduates gain admission to top graduate/professional schools	.53
Rankings in national magazines	
Sense of belonging (α=0.84)	
Level of agreement with the following statements:	
I see myself as part of the campus community	.69
I feel I am a member of this college	.80
I feel I have a sense of belonging to this college	.78
Success at managing academic environment (α=0.78)	
Since entering this college, how successful have you felt at:	
Understanding what your professors expect of you academically	.67
Developing effective study skills	.82

Adjusting to the academic demands of college	.81
Managing your time effectively	.77
Getting to know faculty	.56

†Factors were equally reliable for disaggregated samples by race.

Appendix B: Descriptive statistics of variables

Variable	Mean	St. Dev.
Retention in major	0.83	0.37
Gender: Female	1.77	0.42
American Indian/Alaska Native	1.04	0.20
Asian/Asian American	1.11	0.31
Black/African American	1.31	0.46
Latino	1.21	0.41
Degree aspirations	2.69	0.59
Socioeconomic status factor	0.00	1.00
Personal goal: Be very well off financially	3.17	0.83
Personal goal: Make theoretical contribution to science	2.26	0.94
Personal goal: Work to find a cure for health problem	2.70	1.00
Average high school grade	6.72	1.31
High school research program participation	1.15	0.36
Entering social self-concept factor	0.00	1.00
Entering academic self-concept factor	0.00	1.00
Years study high school math	5.93	0.55
Years study high school biology	3.79	1.03
Number of schools applied	4.67	2.39
Choice of this institution: 1st choice	1.65	0.48
Institutional reputation factor	0.00	1.00
Institutional control: Private	1.54	0.50
Percent of bachelors awarded in science	0.26	0.17
Hispanic serving institution	1.06	0.24
Historically Black College/University	1.20	0.40
Selectivity index	111.94	12.72
Behavioral science major	1.24	0.42
Received tutoring	1.35	0.48
Received negative feedback about academic work	1.24	0.43
Received advice about educational program from a professor	1.40	0.49
Enrolled in learning community	1.09	0.29
Taken a college adjustment seminar	1.50	0.50
Participated in a health science research program	1.12	0.32
Joined a pre-professional/departmental club	1.24	0.43
Participated in an academic support program for URMs	1.16	0.37
Sense of belonging factor	0.00	1.00
View: Racial tension on this campus	1.12	0.32
View: Strong competition for high grades	1.64	0.48
Current GPA	5.13	1.32
Academic success factor	0.00	1.00
Job responsibilities interfered with school	1.24	0.43