

The Role of Altruistic Values in Motivating Underrepresented Minority Students for Biomedicine

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Understanding how cultural values influence undergraduate students' science research experiences and career interest is important in efforts to broaden participation and to diversify the biomedical research workforce. The results from our prospective longitudinal study demonstrated that underrepresented minority student (URM) research assistants who see the altruistic value of conducting biomedical research feel more psychologically involved with their research over time, which, in turn, enhances their interest in pursuing a scientific research career. These altruistic motives are uniquely influential to URM students and appear to play an important role in influencing their interest in scientific research careers. Furthermore, seeing how research can potentially affect society and help one's community does not replace typical motives for scientific discovery (e.g., passion, curiosity, achievement), which are important for all students. These findings point to simple strategies for educators, training directors, and faculty mentors to improve retention among undergraduate URM students in biomedicine and the related sciences.

Keywords: science education, research motivation, broadening participation, underrepresented minority students, science interest

Significant disparities exist in employment within scientific fields with respect to race and ethnicity. For example, Hispanics, African Americans, and American Indians collectively represent 26% of the US population but represent only 10% of the science and engineering workforce (NSF 2014). College students from these ethnic backgrounds that are traditionally underrepresented in science—or *underrepresented minority* (URM) students, as defined by the NSF—are initially choosing to pursue undergraduate science majors at higher rates than in the past; from 2002 to 2012, Hispanics increased from 36.4% to 41.6%, African Americans from 35.5% to 36.4%, and Native Americans from 30.6% to 33% (NSF 2014). However, this initial interest has not translated into matriculation at the undergraduate or graduate level (Ginther et al. 2009) and is certainly not poised to meet national scientific workforce diversity goals (NSF 2008).

Because of the high attrition rates of undergraduate science majors, recent national reports recommend focusing on retention efforts as the most effective strategy to build and diversify the scientific workforce (PCAST 2012). Although national data suggest that inadequate precollege math and science preparation may account for much of the higher level of attrition that URM students face than do white students during their first years of college (NCES 2013),

there is also evidence for a disproportional URM dropout rate at the later stages of education (Garrison 2013). This is especially troubling because these students have successfully completed the foundational math and science coursework. Our study is focused on this later stage of undergraduate education; we examine the role of a biomedical research experience in promoting URM students' motivation for—and, ultimately, persistence within—the discipline (McGee et al. 2012, Graham et al. 2013). Specifically, we study research and research career motivation among students who have already demonstrated skills and a level of achievement and scientific sophistication that would allow them to be accepted by a faculty member as student researchers in biomedical faculty laboratories. The research experience is a crucial juncture in undergraduate student decisionmaking processes on whether to pursue graduate-level research and research careers (Graham et al. 2013).

How do we increase retention among URMs pursuing biomedical research-related training and careers? There have been various approaches proposed to this question. Traditional approaches have attempted to identify predictors of achievement that were “missing” in URMs. National funding for training programs was, in turn, directed to supplement these assumed missing attributes (e.g., resources, mentorship, rewards, skill and confidence training), without specific

attention to the cultural context in which these students live and learn. In contrast, newer approaches have emphasized the importance of cultural influences that shape many URM student experiences and that are intended to clarify what aspects of science education and science research training facilitate—or hinder—the career interests of students from groups who have not traditionally been part of mainstream science (Harper 2010). This new approach subtly shifts attention away from the goal of changing URM students to be more like the majority white students and toward ideas of how to change science education and research training. It is supported by the leadership of the National Institutes of Health (NIH) Training, Workforce Development, and Diversity Division, as described by the TWD Director at the 2013 annual program directors' meeting, and derives from the growing recognition that science and science education are not value or culture free but, instead, may inadvertently perpetuate the status quo (Lee and Luykx 2007, Boutte et al. 2010). In this article, we focus on one possible cultural influence that may affect some URM students' motivation for biomedicine—namely, the cultural importance of undertaking research that involves altruism (called altruistic goals, which we consider more closely below).

To identify whether and how some cultural influences might increase or decrease scientific research interest among URM students and why these same factors may differ from those that predict research interest among white students, we derive study predictions from goal congruity theory (Diekmann et al. 2010). This theory suggests that career motivation derives, in part, from the perceived congruity between individuals' most highly valued career goals and the degree to which a given career is perceived to afford (or fulfill) these goals. This theory can not only be used to predict the career interest of specific individuals by examining their individual-level profiles of goals and perceived goal affordances, but it can also be used to predict group-level differences in career interest in cases in which groups differ in the mean values of their goal importance or in the perceptions of whether a career is more or less likely to afford those goals. For example, research shows that women, who tend to more highly value the goals of working with and helping others (social and altruistic goals) than do men, report greater interest in science careers when they perceive greater social and altruistic goal affordance in science and that gender differences in science career interest can be partially accounted for by differences in goal congruity (Morgan et al. 2001, Weisgram and Bigler 2006, Diekmann et al. 2010).

Accordingly, cultural differences between the career values of students from URM backgrounds and white students may lead to lower perceived levels of congruity for URM students than whites in science research careers. Empirical data suggest that, although students from URM backgrounds value intrinsic motives (e.g., curiosity, enjoyment of problem solving, passion for discovery) for pursuing careers as much as white students do, their career interests are also more likely to be influenced by highly altruistic cultural values (Johnson

2002, Smith et al. 2014). This is concordant with Latino, Native American, and African American cultures' placing greater significance on the altruistic value of helping others through one's work, particularly of contributing to one's community (Martin and Martin 1985, Harper 2005, Fryberg and Markus 2007, Torres 2009, Villaruel et al. 2009, Mohatt et al. 2011).

This cultural orientation toward valuing altruistic career goals may be problematic for URM students in science, because scientific research careers are generally perceived as being focused on the individual scientist and on individual achievement, rather than on altruistic goals (Morgan et al. 2001, McGee and Keller 2007, Weisgram et al. 2010, Diekmann et al. 2010, Diekmann et al. 2011, Gibbs and Griffin 2013). Most science educators and education materials give little attention to developing altruistic connections for students (Harding 2006). Furthermore, successful assimilation into the scientific culture typically requires a focus on the narrow, exclusive, and objective disciplinary culture (Carlone 2003). Influenced by social stereotypes (imparted by historical media portrayals) about scientists as older white men working in isolation on theoretical laboratory research, detached from any community outside of science (Barman 1997, Rahm and Charbonneau 1997), undergraduate students' views of science careers are likely to be incongruent with altruistic career goals. This broad perception of science research careers is incongruent with URM students' cultural value inclination toward careers that afford altruistic opportunities.

Support for the importance of altruistic goals in science career interest is highlighted in a survey of 201 high-achieving alumni of an undergraduate biology enrichment program for URM students (Villarejo et al. 2008). Among a much broader range of questions about undergraduate research experience, advising, career paths, and career goals, these alumni were asked to select, from a series of hypothetical statements, what attributes would make a career as a PhD scientific researcher appealing for them. The two most highly selected attributes for these URM alumni were (1) their satisfaction and an interest in doing science (selected by 63% of the alumni) and (2) knowing that the scientific knowledge that they created would help members of their community (selected by 66% of the alumni). Villarejo and colleagues (2008) further reported that, in follow-up interviews with alumni who left the scientific research career path, several cited a desire to help others in a more direct manner as a reason for which they chose an alternative career path. Although the primary focus of Villarejo and colleagues' (2008) study with URM program alumni was not the role of altruistic goals or affordance perceptions, this exploratory analysis of appealing attributes and reasons for leaving the scientific research path provides initial support for the importance of altruistic goals in science research interest.

Although they are important, the conclusions that can be drawn from this study are limited, and further studies are necessary that incorporate two key design elements. First,

a prospective study design is needed to counterbalance the limitations of retrospective self-reports and interview data. Second, multivariate quantitative analyses are needed to distinguish between the effects of altruistic goal affordance perceptions and other goals on career interests. Scientific research and research careers are motivated by multiple goals, including passion or curiosity (intrinsic goals) and money or prestige (extrinsic goals), and multivariate statistical analyses are required to explicate the potentially overdetermined effects of multiple goals on career interests that emerge in interviews or correlational analyses from data collected at a single point in time. A multivariate approach permits the unique effects of altruistic affordances to be isolated while controlling for perceptions of whether research affords these intrinsic and extrinsic values.

In addition to building on prior work with these crucial methodological features, we also examine a new theoretical link to explain why making altruistic connections to one's research may predict greater interest in a science career. Greater perceived congruity between one's valued goals and what the situation (or career) affords is posited to create a deeper psychological experience of involvement in one's research work. At an extreme, psychological involvement may be experienced as *flow* (Csikszentmihalyi 1990), such that the student feels completely immersed in her or his research. On a continuum, students may feel more or less psychologically involved in their research, and variability across students in psychological involvement reliability predicts their subsequent science interest (Smith et al. 2007). Therefore, if a student highly values altruistic goals and perceives her research work as more likely to afford those goals, the resulting congruity should lead to greater feelings of psychological involvement in her research, which should, in turn, predict greater science research career interest.

The present study was designed to address the research question of whether variability across students' perceptions of altruistic affordances for their research predicts greater psychological involvement in their research laboratory and more interest in a scientific career, even when accounting for multivariate effects of intrinsic and extrinsic affordance perceptions. By longitudinally evaluating the perceptions of a diverse sample of undergraduate students working in faculty biomedical research laboratories, in this study we prospectively test whether the perceptions of undertaking research that affords altruistic goals (at time 1) leads to greater psychological involvement in that research and heightened career interest later (at time 2, 10–12 weeks after the initial survey). We predicted that the URMs would feel less psychologically involved in their research and would lose interest in continuing a science research career if they failed to see the benefits of their research activities to others and, in particular, to their community. Alternatively, when URM students do make these altruistic connections, we predicted that they would be more likely to maintain a high level of psychological involvement with their research over time, which would enhance their interest in research careers.

Study participants and procedures

The participants were 337 undergraduate students (46% female; the median age was 22) working in 44 different faculty biomedical research laboratories at two universities and seven tribal colleges. Of these research assistants (RAs), 100 were classified as being from a URM group (38 Latinos; 31 American Indian or Alaska Natives; 9 African American; 6 Pacific Islanders; and 16 of mixed ethnicity, including at least one of the URM groups), and 165 were classified as being white. With institutional review board approval for human subjects research at all data collection sites, all of the student RAs were recruited via their faculty research mentors for a survey study of undergraduate research experiences. The participants were told that the purpose of the study was to “examine the relationship among students research assistants' everyday experiences, perceptions of research, and future career motivations.” The analysis covered one academic semester. At time 1 (5–6 weeks into the semester), all of the students completed an initial online survey that probed measures of beliefs about whether the research that they were conducting in the laboratory afforded (or fulfilled) three types of goals: altruistic, intrinsic, and extrinsic. Simple demographic information, including gender, ethnicity, and their year in school was also collected. The time 2 survey, which contained measures of psychological involvement in the students' research laboratory and science research career interest, was administered approximately 10 weeks later, at the end of the semester. One hundred seventy-five (64 URM, 111 white) of the initially recruited students participated in the time 2 survey. An analysis of the missing data confirmed that those who completed the time 2 survey did not differ from those who did not complete the second survey on any of the study variables collected at time 1, including their perceptions of altruistic affordances, psychological involvement in the research laboratory, or career interest. Additional details on the materials, methods, and analysis are available in the online supplemental material.

Analyses and results

The data were analyzed in SPSS (IBM Corporation, Armonk, New York), using multiple regression analyses with dummy codes representing the participants' ethnicity (0, *white*; 1, *URM*), a continuous variable representing the altruistic affordance measure, and the multiplicative interaction term created from the participants' ethnicity and altruistic affordance scores. The focal predictor was the interaction between the participants' ethnicity and their altruistic affordance. We predicted that this interaction term would be significant and positive, such that greater perceived altruistic affordances in one's research would predict greater research laboratory psychological involvement and science career interest for URMs. For the white RAs, this pattern was not expected to be significant. We report standardized regression estimates (β), which allow for comparisons of predictor strength on a standardized metric, for the key study variables in the main text below. The more-detailed results that appear

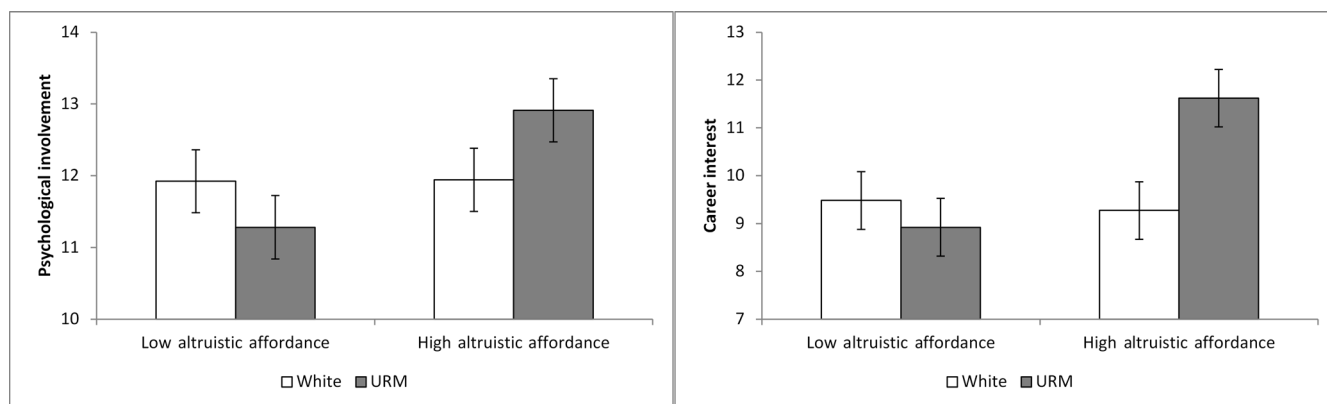


Figure 1. Psychological involvement in the research laboratory (left) and research career interest (right) as predicted by student ethnicity and perceived altruistic affordance. The predicted values were computed from the multiple regression equation for the interaction between student ethnicity (underrepresented minority student [URM] or white) and altruistic affordance (a low of 1 standard deviation below the mean and a high of one standard deviation above the mean) on psychological involvement and career interest. The error bars each represents two standard errors of the mean (0.22 for psychological involvement and 0.30 for career interest).

in the supplemental material also include unstandardized regression estimates (*b*) and their standard errors for all terms in the regression models.

As was predicted, a significant positive interaction emerged between participant ethnicity and altruistic affordance at time 1 for research laboratory psychological involvement ($\beta = .20, p = .04$) and for research career interest ($\beta = .24, p = .01$) 10 weeks later, such that for the URMs, greater altruistic affordance predicted greater psychological involvement ($\beta = .37, p = .02$) and greater career interest ($\beta = .39, p = .006$). For the white students, altruistic affordance did not correlate with psychological involvement ($\beta = .003, p = .97$) or career interest ($\beta = -.03, p = .73$). To illustrate this pattern, we computed the predicted values for URM and white students at representative high and low values (one standard deviation above and below the mean) from the regression equations using the unstandardized coefficients (see figure 1). Furthermore, to demonstrate the scope of this effect for the URM students, we computed odds ratios by dichotomizing both dependent variables (laboratory psychological involvement and career interest), as well as the altruistic affordance predictor variable, into high and low categories with a mean split and repeated the multiple regression analyses as a logistic regression. These results show that the URM students were 3.32 times more likely to have a high level of laboratory psychological involvement and 2.55 times more likely to have a high level of career interest if they perceived a high level of altruistic affordance in research.

To determine whether perceived altruistic affordance uniquely contributes to research laboratory psychological involvement and science research career interest above and beyond other important goals, we added to the regression model both intrinsic and extrinsic affordances. As can be seen in supplemental tables S4 and S5, even when controlling for the effects of intrinsic and extrinsic affordances, the results

supported the analyses reported above, which demonstrates that altruistic affordance perceptions accurately predicted research psychological involvement and research career interest for the URM but not for the white students. In addition, although intrinsic and extrinsic affordances were included in the analysis primarily as control variables to test the research question about the unique effects of altruistic goals, greater intrinsic affordance perceptions predicted greater research laboratory psychological involvement (see table S4), and greater extrinsic affordances uniquely predicted greater research career interest (see table S5). Additional detail on this analysis is provided in the supplemental material.

Next, to examine the influential process predicting effects on science research career interest, we tested a mediated moderation model, whereby laboratory psychological involvement (at time 2) was predicted to mediate the effect of altruistic affordance (at time 1) on science career interest (at time 2) for the URM but not for the white students. We used the computational tool PROCESS (Hayes 2013), an SPSS macro utility, to estimate the indirect effects of altruistic affordances on career interest via psychological involvement for the URM and white students, respectively. The results support the complete mediated moderation hypothesis. A significant positive indirect effect of altruistic affordance on science career interest through laboratory psychological involvement was found for the URMs; the 95% bias corrected bootstrap confidence interval was above zero (.02 to .42). For the white students, however, this indirect effect was not significant; the 95% bootstrap confidence interval (-.10 to .09) contained zero.

Conclusions

Our results demonstrate that URM students who recognize that their research fulfills the altruistic goals of helping others and giving back to the community are more

psychologically involved in their research, which, in turn, leads to greater interest in pursuing science research careers. Therefore, students from cultural backgrounds that traditionally place a high value on helping others through work can be retained in science when their research experience embraces this cultural strength. These altruistic motives appear to be important to these students in addition to—and not instead of—the intrinsic and extrinsic drivers that are crucial for all emerging scientists (McGee and Keller 2007).

Previous science education intervention research suggests that all students benefit from activities that increase the relevance (or utility value) of science to their everyday lives (Hulleman et al. 2009, 2010), and such interventions targeted at the parents of high school students also increase their children's participation in math and science (Harackiewicz et al. 2012). Our findings suggest that this influence is not equal across ethnic groups and that establishing this particular aspect of utility value—the altruistic societal relevance of research—is particularly beneficial in promoting persistence in science for URM students. Inversely, consideration must be given to the potential negative influence of stereotypical images of disconnected scientists on the recruitment and retention of URM students. For example, even well-intentioned mentors who advocate that the main purpose for science research is pure intellectual curiosity may inadvertently hinder the scientific interest of a URM student by failing to capitalize on an important motivational factor for retaining that student. By recognizing the importance of this motivational factor, mentors may help in promoting the retention of URM students in the sciences without changing the nature of the scientific endeavor or the content of the research experience. Such altruistic connections could be made by science educators or research training programs' or mentors' assigning students individual or group projects that require them to identify the societal or communal benefits of their laboratory experiences in a personal and culturally meaningful way.

National agencies, such as the NSF and the NIH, already place a high level of importance on their funded projects' translating specific research objectives into broader impacts. However, during the formative stages of their research experience, students are unlikely to fully understand the broader implications and significance of their research duties. A simple approach would be for educators and mentors to help them understand the possible long-range significance and benefits of the research. Such efforts require no additional money, just recognition that a personal investment in a student and support for her or his culturally connected values can make a meaningful impact on diversifying the biomedical workforce.

Supplemental material

The supplemental material is available online at <http://bioscience.oxfordjournals.org/lookup/suppl/doi:10.1093/biosci/biu199/-/DC1>.

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