HHS Public Access

Author manuscript

J Res Sci Teach. Author manuscript; available in PMC 2015 September 09.

Published in final edited form as:

J Res Sci Teach. 2014 October ; 51(8): 1021–1048. doi:10.1002/tea.21164.

Beyond Preparation: Identity, Cultural Capital, and Readiness for Graduate School in the Biomedical Sciences

J. Lynn Gazley[1], **Robin Remich**[1], **Michelle E. Naffziger-Hirsch**[1], **Jill Keller**[2], **Patricia B. Campbell**[3], and **Richard McGee**[4]

[1]Feinberg School of Medicine, Northwestern University, Chicago, Illinois

[2]Keller Consulting, Inc., Tucson, Arizona

[3]Campbell-Kibler Associates, Inc., Groton, Massachusetts

[4]Feinberg School of Medicine, Medical Education and Faculty Affairs, Northwestern University, Chicago, Illinois

Abstract

In this study, we conducted in-depth interviews with 52 college graduates as they entered a Postbaccalaureate Research Education Program (PREP). Our goal was to investigate what it means for these aspiring scientists, most of whom are from groups underrepresented in the sciences, to feel ready to apply to a doctoral program in the biomedical sciences. For our analysis, we developed and used a theoretical framework which integrates concepts from identity-in-practice literature with Bourdieu's formulation of cultural capital and also examined the impact of racial, ethnic, and gender identities on education and career trajectories. Five patterns of identity work for expected engagement with PREP grew out of our analysis: Credential Seekers, PI Aspirants, Path Builders, Discipline Changers, and Interest Testers. These patterns illuminate differences in perceptions of *doing*, *being*, and *becoming* within science; external and internal foci of identity work; and expectations for institutional and embodied cultural capital. Our findings show that preparing for graduate education is more complex than acquiring a set of credentials as it is infused with identity work which facilitates readiness *beyond preparation*. This deeper understanding of individual agency and perceptions allows us to shift the focus away from a deficit model where institutions and programs attempt to "fix" students, and to offer implications for programs designed to support college graduates aspiring to become scientists.

Keywords

science identity; cultural capital; postbaccalaureate science education; science diversity; minorities

Correspondence to: Richard McGee; r-mcgee@northwestern.edu.

The present address of J. Lynn Gazley is Department of Sociology & Anthropology, The College of New Jersey, Ewing Township, NJ

The present address of Michelle E. Naffziger-Hirsch is Department of Behavioral and Social Sciences, Oakton Community College, Des Plaines, IL

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site.

It is well known that African American, Hispanic, and Native American students are underrepresented in the sciences, including the biological sciences (Chen, 2009; National Academies of Science, 2011; National Science Foundation [NSF], 2013). This underrepresentation increases as students progress through higher education. While African American and Hispanic students receive around 16% of bachelor degrees in the biological sciences, they represent only about 11% of the graduate students in these fields and around 7% of the PhD recipients (NSF, 2013). At both the undergraduate and graduate levels, in the biological sciences, minority students are less apt to persist in the major to degree than are other students (Bass, Rutledge, Douglass, & Carter, 2007; Griffith, 2010). The literature on persistence identifies a number of factors contributing to these patterns including educational affordability; admissions policies and practices; educational experience and quality; social and academic integration; and faculty–student mentorship (Proirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2009).

While we acknowledge the role institutions play in student persistence, in this study, we aim to better understand individuals' experiences and perceptions at a specific decision point within a biomedical career trajectory that has not been researched. Specifically, we use in-depth one-on-one interviewing to explore why 52 academically talented college graduates with an interest in pursuing the PhD or MD/PhD in the biological sciences chose to enter a National Institutes of Health (NIH) funded Postbaccalaureate Research Education Program (PREP) instead of persisting directly to graduate school. PREP is one of the initiatives sponsored by the NIH via the National Institute of General Medical Sciences (NIGMS) that aim to increase the number of PhD-trained scientists from groups "underrepresented" in the biomedical and behavioral sciences, specifically African Americans, Hispanic Americans, Native Americans, Alaska Natives/Native Hawaiians, and citizens of the U.S. Pacific Islands, people with disabilities, and those from disadvantaged backgrounds (National Institutes of Health, 2012). PREP programs accept baccalaureate degree recipients who express a strong intent to pursue the PhD or MD/PhD in the biomedical or behavioral sciences.

In our study, we shift the focus from a deficit model where institutions and programs attempt to "fix" students to a deeper understanding of student agency and perceptions of what it means for these aspiring scientists, most of whom are from groups underrepresented in the sciences, to feel ready for next steps in their science educational and career trajectories. We draw heavily on our theoretical framework where we have integrated previous literature of identity for aspiring scientists with Pierre Bourdieu's formulation of cultural capital.

We first describe our theoretical and analytical frameworks, followed by methodology and background characteristics of our population. We then present our findings of five patterns describing how beginning PREP participants intend to engage with the resources of PREP. These patterns center around differences in internal and external recognition of identity and participants' perceptions of *doing* science, their sense of self as *being* a graduate student or scientist, and meanings ascribed to *becoming* a scientist. We conclude with a discussion of how readiness for graduate school goes *beyond preparation* and offer implications for postbaccalaureate programs in the sciences as well as directions for future research.

Theoretical Framework

We developed our theoretical framework via an iterative process as we analyzed our interview data from beginning PREP Scholars to understand how they intend to engage with the PREP program. We focused closely on individuals' decisions to commit to an intensive postbaccalaureate science research program, and their expectations of the program in terms of resources and its ability to support them as they commit to and get ready for their next step on their chosen path in science. As patterns emerged in the ways our participants talked about their senses of self; paths through and aspirations within science; and what resources they expected to need to enact these aspirations, we, like others engaged in work around science education and training, found an identity lens particularly useful (Carlone & Johnson, 2007; Jackson & Seiler, 2013; Tan & Barton, 2008a).

We recognize that individuals construct identities through an iterative interaction with social and material contexts, thus, we align closely with scholarship (Jackson & Seiler, 2013; Johnson, Brown, Carlone, & Cuevas, 2011; Tan & Barton, 2008a, 2008b), which draws on Holland, Lachicotte, Skinner, and Cain (1998) theory of identity-in-practice, particularly its attention to contexts as space for authoring an identity, and combine this theory with attention to identity trajectories (Wenger, 1998). Taken together, these conceptual tools offer a flexible and sensitive way to understand individuals' interactions with programs around their understandings of past, present, and future selves.

To complement this attention to identity, we found Pierre Bourdieu's conceptualization of cultural capital (Bourdieu, 1984, 1986; Bourdieu & Passeron, 1977) particularly its emphasis on context-specific, historically situated valuation shaped by powerful elites—helpful in thinking specifically about the resources individuals have and use to construct their identities and believe they will need to successfully move into a new context, such as PREP or, later on, to graduate school. Within the context of power and such related variables as race/ethnicity, gender, class, and their intersectionality, we call attention to two forms of cultural capital: institutionalized cultural capital, in the form of "academic qualifications," and embodied cultural capital in the form of "long-lasting dispositions of the mind and body" (Bourdieu, 1986, p. 17). Applied to scientific training, this distinction calls attention to the intertwined requirements to be seen as "being like" a scientist and to have the formal certifications required by admissions committees that one is a "qualified" candidate in order to progress. Such recognition is complicated by social structure, with dominant groups most likely to recognize those coming from a similar background.

Bourdieu's formulation of cultural capital shares identity scholarship's attention to skills, knowledge, and ways of being valued by a certain group and situated within a certain context. In addition, Bourdieu pays close attention to power within and between groups to set values for, to recognize, and to evaluate displays of cultural capital. In Bourdieu's formulation, cultural capital assumes long-term investment by the self and family which is in turn shaped by structural factors such as class. Lareau and Horvat (1999) and Lareau (2003) build on this insight, focusing on the intersections of race/ethnicity and class in how parents cultivate cultural capital in their children. Mismatches in the style of cultivation and habitus between Black and lower class parents and White middle class educators limit

educational opportunities for children via multiple mechanisms, including parents not knowing how or when to negotiate with teachers and administrators to secure access to opportunities such as enrichment programs. In addition, Carter's (2003) work examining cultural capital and historically marginalized students in Yonkers demonstrates that individuals carry an array of capital useful in multiple arenas; that they make strategic choices about when and how to activate this capital; and that operating in multiple fields carries an emotional toll. This sensitivity to intersectionality reminds us to carefully consider the role of structural inequalities in shaping the cultural capital young scientists bring with them to programs such as PREP, including how to interact with the program itself, but also in the expectations of what they will need to be successful in taking the next step.

Cultural capital and identity have both been used to understand educational achievement and persistence and share an attention to the performance of self; valuation of that performance by relevant communities; and the resources one needs to make a credible performance (Carlone & Johnson, 2007; Carter, 2003; Dimaggio, 1982; Lareau & Horvat, 1999; Tan & Barton, 2008b). For example, in their examination of an undergraduate science preparation program, Ovink and Veazey (2011) successfully utilize a cultural capital perspective to suggest that the program worked to cultivate cultural capital valuable within the world of academic science, and to provide a "safe space to practice" (p. 386) in which participants learn to deploy newly acquired skills and knowledge in a low-stakes environment. In this article, we demonstrate that cultural capital and an identity-in-practice perspective may be used together to understand individuals' expectations for programs and the resources they expect to need to enact their aspirations.

Analytical Framework

While all students must be prepared to attend graduate school with credentials recognizable to admissions committees, attention solely to preparation insufficiently explains student decisionmaking along educational and career trajectories (Brickhouse, 2001; Chang, Eagan, Lin, & Hurtado, 2011). Beyond preparation, students must feel ready for graduate school. We argue this readiness combines the institutionalized cultural capital resulting from academic preparation— such as grades, research experience, and letters of recommendation —with the processes of identity formation, which are composed of internal recognition of self-as-scientist; external recognition as a potential scientist; plus envisioning and committing to graduate school. Studying identity and cultural capital at the decision point when college graduates are entering a program to prepare them for the PhD or MD/PhD also lets us examine pressures they face when personal identities—including race, ethnicity, and gender—conflict with educational and career identities as aspiring research scientists (Brown, 2004; Johnson et al., 2011; Malone & Barabino, 2009).

Drawing on identity-in-practice and cultural capital, we describe five patterns which show the variety of how these college graduates, aspiring to be scientists, talk about their identities and the resources they think they need to create and pursue these paths. The interviews we draw upon represent individuals undertaking the "active re-constructive process" (Rahm, 2007, p. 521), the point at which these individuals are telling their histories anticipating future changes. By examining these aspiring scientists' reasons for joining PREP and

expectations of what they will gain from it, we obtain valuable insight into how they understand what they need to become ready for graduate school. We focus on expectations as a critical opening move in the process of deciding to apply for graduate school, as such expectations reveal anticipated identity trajectories and have been found to shape student aspirations and experiences in programs designed to support historically marginalized students (Naffziger, 2011).

Prior research suggests that a salient science identity plays an important role in persistence in science careers, particularly when taking into account the ways that gender, race, and ethnicity can shape students' engagement with and aspirations toward science (Archer et al., 2010; Brandt, 2008; Brickhouse & Potter, 2001; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Carlone & Johnson, 2007; Chang et al., 2011; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Johnson et al., 2011; Malone & Barabino, 2009; Tonso, 2006). However, there is less agreement and understanding of just what a science identity is and, since much of the work has been done at the precollege level, how it works to increase persistence into research careers. The research has varied widely in attention to the practices of *doing* science, the sense of self-as-scientist (or *being* a scientist), and how these relate to career aspirations (*becoming* a scientist). We argue these distinctions—between *doing*, *being*, and *becoming*—are essential for understanding science identity at this decision-making point. Furthermore, the relationships between these elements of a science identity remain unclear, and development among these components is not sequentially achieved nor stable. Archer et al. (2010) and Archer, DeWitt, and Willis (2014) suggested children's conceptions of science may be usefully divided into "doing science" and "being a scientist," but noted that enjoyment of *doing* science did not necessarily "translate into [student] uptake of a science identity" (Archer et al., 2010, p. 623) leading them to choose a science career. They also argued this disconnect between enjoyment of *doing* science and choosing it as a career occurs, in part, because conceptions of *doing* science and *being* a scientist were "comprehensively infused with issues of identity," particularly those of race, ethnicity, class, and gender, a conclusion shared by Aschbacher, Li, and Roth (2010).

As Barton et al. (2013) argue, identity work offers a useful window into the study of identity and can fruitfully be considered as made up of individuals' actions (including relationship formation) and use of resources toward authoring an identity, taking into account the material, social, and cultural constraints of each context. We focus on two general forms of identity work common to the PREP Scholars in the study. First, we focus on *internal identity work*, or how entering PREP Scholars see themselves and their competencies, specifically as future biomedical graduate students and scientists. Second, we focus on *external identity work*, or how entering PREP Scholars imagine they are seen and will be evaluated by "relevant" scientific others (Hurtado, Cabrera, Lin, Arellano, & Espinosa, 2009). In the dynamic process of identity construction (and re-construction), one not only compares him/herself to his/her perception of a scientist, but also aims to take up an identity that can be recognized and accessed by others (Carlone & Johnson, 2007; Malone & Barabino, 2009) and legitimized by these "others" (Johnson et al., 2011). This formulation draws on the importance of external recognition of science ability and potential as a scientist, and

includes concerns about future identity contingencies and stereotype threat (Steele, 1997; Steele & Aronson, 1995), such as not being seen as a credible scientist based on one's race.

Taken together, we analyzed our data using the *doing*, *being*, and *becoming* components of identity work, the *internal and external nature* of identity work, and cultural capital to construct five patterns to describe variations in identity work that PREP Scholars undertake as they get ready for graduate school and anticipate how the PREP program can be part of this process. Two broad questions guided our inquiry:

1. Why do some college graduates from underrepresented populations who aspire to biomedical research careers enter a PREP program rather than go to graduate programs directly from college?
2. What do these entering PREP Scholars expect from their postbaccalaureate experience to facilitate their education and career decision-making?

Methods

Research Context: The Postbaccalaureate Research Education Program (PREP)

Our participants are 52 college graduates drawn from a geographically representative sample of seven of the 28 PREP programs across the United States (http://www.nigms.nih.gov/Training/PREP/Pages/default.aspx). PREP is part of a family of programs funded through NIH aiming to increase the representation of historically marginalized populations in the biomedical professoriate. Each PREP Program accepts groups of up to ten participants, called "PREP Scholars," generally for a 1-year experience. The PREP experience centers on mentored research where participants pursue independent projects under the guidance of principal investigators (PIs). PREP is unique because Scholars are not degree-seeking students though they can take graduate classes. They receive a salary and benefits with expectations to devote 75% of their time to their research with the remaining hours available for one graduate course per semester and academic and support activities. Such activities include journal clubs, graduate school application and GRE preparation workshops, scientific writing development, and scientific conferences. Because PREP grants are available only to research intensive universities and medical schools, PREP Scholars work beside graduate students and postdoctoral fellows and can attend non-PREP sponsored research seminars.

The 52 PREP Scholars are part of our larger NIH-sponsored longitudinal study, the National Longitudinal Study of Young Life Scientists, which is following students to and through graduate school to better understand the career decision-making processes of aspiring biomedical research scientists. Data for this article come from a demographic questionnaire and one in-depth interview with each participant within their first few months of starting PREP.

Data Collection

Study participants were recruited via our standardized email forwarded by their PREP Director. This described the purpose of the research, expectations for their time, that participation was voluntary, and that compensation of a $25 gift card would be received

after the interview. After consenting, they were asked to complete our questionnaire self-reporting their undergraduate GPA, GRE scores, and demographic characteristics.

Three of the authors interviewed participants at their PREP universities during the fall of 2009 or 2010. These two White women and one White man, each has over 20 years of advising and supporting multicultural and low-income college and graduate students; one was a biomedical scientist and two have disciplinary backgrounds in education. The other authors include an educational researcher and two sociologists. The interviewers provided the questions in advance to the Scholars (see Supporting Information Methods for interview protocol). The audio-recorded interviews ranged from 37 to 92 minutes and averaged 70 minutes. Interviewers used a semi-structured protocol that covered experiences in research, courses, and science support programs; self-reflection on independence, creativity, and life balance; the role that gender, race and ethnicity played in students' education; perspectives on careers; and research mentors, role models, and teachers. We did not include direct questions on science identity or its components in our interviews. These themes grew out of our analysis.

We chose in-depth interviews to gather data on our participants' perceptions of themselves and factors in decision-making at an important transition point in their lives—graduating from college. We designed our questions and probed to solicit "accounts of events and experiences" (Beazeley, 2013, p. 201) to understand how these young adults were making sense of their experiences and how they were thinking about future possibilities and paths. Similar to McLeod's (2003) description of interviews, we focused our interviews on participants' present, retrospective, and prospective sense of self. For example, we asked participants to share what they like and dislike about research and want to get from PREP (present); how they became interested in science and their research experiences (retrospective); and what they see themselves doing after PREP and in the longer term (prospective). Through relating stories and details, our participants were "telling identities" (Sfard & Prusak, 2005, p. 14) and sharing "how one views oneself in context" (Tan, Barton, Kang, & O'Neill, 2013, p. 1147) as they selected what to share about their past, present, and possible futures within the context of choosing to engage with a doctoral preparation program.

The major focus of self-reported data involves gathering full and detailed accounts of participants' experiences and the meaning of their experiences (Polkinghorne, 2005). This focus is important to our study because one's identity is constituted in his/her accounts, or stories, and not in the experiences themselves (Sfard & Prusak, 2005). Therefore, understanding perceptions of self and decision-making processes could not have been accessible via another method, such as participant observation. A limitation of not including other data sources is that we cannot verify how these perceptions of self are actually enacted or evaluated by others. However, because this is the first interview in our longitudinal study, we will continue with annual interviews to follow how these perceptions and constructions of identity at this point in time shape our participants' future actions and interactions.

Data Analysis

Interviews were transcribed and checked for accuracy with the audio recording. Throughout analysis, we utilized a content analysis approach and constant comparative coding procedures (Charmaz, 2006; Glaser, 1965). Two of us began our coding by identifying themes from the data guided by, but not limited to, sensitizing concepts (Bowen, 2006; Charmaz, 2006) from the literature review and theoretical framework. As we each independently coded, we conferred to reach consensus on each transcript and then utilized QSR International's NVivo qualitative data analysis software (QSR International Pty Ltd., 2010). Through this process, we produced memos for each transcript; theoretical memos about emerging patterns, themes, and additional literature; and we continually refined definitions of each node by reviewing NVivo node reports. As we refined the node definitions, we returned to transcripts for additional coding. We completed full coding of 26 transcripts in this iterative manner for this sample that represented a mix of gender, race, ethnicity, and PREP sites. This yielded a coding scheme and preliminary findings with four patterns that we presented, discussed, and further developed with our colleagues. Then we returned to the transcripts and found further distinguishing themes within our largest pattern to reveal a fifth pattern. With the final coding scheme, we jointly coded the remaining 26 transcripts for selected themes to substantiate the initial findings and test the five patterns in our analytical framework.

To analyze our interview data, we began with the two broad questions, listed earlier. As we saw similarities and differences in these responses, patterns began to coalesce, and we examined more specific themes within the data. In particular, we looked at goals, goal certainty and sense of future selves in science; perceptions of preparation for graduate school; past experiences and influences; and racialized and gendered experiences. We used theoretical memoing to relate our data to our sensitizing concepts, including cultural capital, the perceived need for specific resources, and moments of recognition used to construct an identity as a scientist. In addition, we used memoing to develop new concepts, such as the meaning of preparation and readiness for graduate school and identity authoring via *doing*, *being*, and *becoming* in science.

Demographic Profile of the Study Participants

Data from the Scholar questionnaires reveal our sample is racially, ethnically, and socio-economically diverse with 94% (49) from a race and/or ethnicity considered underrepresented in science. Of those considered underrepresented, just over half (27) identify as Black or African American (going forward we use Black for those who self-reported as Black or African American), 42% (22) as Latino/a, and 8% (4) as Native American (the total is more than 49 because four identified more than one race/ethnicity). About 60% (32) are women (Table 1). All are U.S. citizens or permanent residents with approximately a third being US-born with US-born parents and two-thirds being 1st or 2nd generation immigrants. About half (25) identified as first generation to graduate from college. Of the 62% who provided family income data from tenth grade, half (16) came from families making below $45,000 with a third (11) making between $65,000 and $89,000.

Undergraduate backgrounds show most had studied science and done undergraduate research, and some had taken the GRE. Ninety percent (47) attained a bachelor's degree in a natural science or engineering field (biology, chemistry, physics, or engineering), three in psychology, and two in social science disciplines (both took biology classes after college). Table 2 shows about one-third (17) of study participants attended Most and Highly Competitive institutions, 13% (7) Very Competitive institutions, 38% (20) Competitive institutions, 4% (2) Noncompetitive institutions based on *Barron's Profiles of American Colleges* (2011). Twelve percent (6) graduated from institutions not rated by Barron's because they are not located within the 50 states. The average self-reported GPA from 49 students was 3.38/4.0. Twenty-four had taken the GRE prior to PREP, and of the 18 who reported results, the quantitative average was 604/ 800 and verbal 442/800. Ninety percent (47) engaged in at least one period of research in a biomedical or psychology lab during college with about 40% (20) reporting two or more summer research experiences.

Findings

In Table 3, we present five patterns of expected engagement with PREP related to perceptions of *doing*, *being*, and *becoming* within science and variation in three aspects of identity work: actions; anticipated resources; and relationships. The pattern names—Credential Seekers, PI Aspirants, Path Builders, Discipline Changers, and Interest Testers—capture the essence of identity construction at the time of starting PREP. These names are not intended to be deterministic or stable for the individuals, but rather reflect this time within trajectories as each shared their expectations for PREP and what they needed to get ready for graduate school.

Variation in expectations for PREP reflect differences related to the identity work of what *doing* science means, who individuals are (*being*), and who they want to *become*. In four of the five patterns, one element of identity work is prominent as shown in Table 3 in the boldly outlined cells. *Doing* science is central for the Credential Seekers, defining both their current identity and what they want from graduate school. A longer term focus on *becoming* PIs influences the PI Aspirants' concern with how others might view them and how their scientific trajectory intersects with their racial identity. The concept of redeploying skills toward *doing* science defines the Discipline Changers and manifests in confidence to attend graduate school. The Interest Testers want to see if research aligns with *who they are*. Unlike the other four patterns, we have framed *doing*, *being*, and *becoming* in Table 3 for the Path Builders because they are unsure about their future and were not focused on just one of these elements.

In addition, we have grouped the patterns under shaded rows in Table 3 to show variation in external and/or internal identity focus. Three groups—Credential Seekers, PI Aspirants, and Discipline Changers—are concerned primarily with external identity work, and focus on how they will present themselves to graduate schools. The Path Builders focus on internal identity work to develop and commit to a trajectory that includes graduate school. The Interest Testers have the least research experience research and are early in the internal process of committing to a research career, but similar to those engaged in external identity work, they imagine themselves applying to graduate school.

Credential Seekers: Filling Portfolio Gaps to Continue Doing Science

About half (25) of the 52 Scholars shared expectations for PREP consistent with a program design that aims to fill gaps in skills, knowledge, and credentials for individuals who are committed to matriculating into graduate school. We called this group “Credential Seekers” to reflect these expectations. Their demographics closely match our sample, with 44% male, 60% Black, and 36% Hispanic (Supporting Information Table 1). Average age at the time of entering PREP was 23.6. Thirty-two percent of Credential Seekers graduated from schools ranked Most or Highly Competitive with an average GPA of 3.31/4.0.

Several of the Credential Seekers had taken actions prior to PREP toward enrolling in graduate school. Eight participated in undergraduate NIGMS programs for future PhD and MD/ PhD students, which may have shaped their decisions to pursue graduate school. Of these, three applied to PhD programs but were not accepted. This is not uncommon as many students from underrepresented groups take longer for their talents to be identified and developed (R. McGee, Saran, & Krulwich, 2012). Credential Seekers were more likely than those in our other patterns to have applied to PhD or MD/PhD programs prior to PREP. Forty percent (10) had applied, and only one received any acceptances.

The Credential Seekers communicated a strong internal identity as *doers* of science, but have not necessarily taken on an identity as a scientist (the *being*), nor have they linked PREP and admission to graduate school to a longer-term view of a particular professional role (the *becoming*). They expressed a love for *doing research*, and so while they may not have yet created a sense of self as a scientist that connects their current perceptions of themselves with what they want to become, they envisioned *doing science* in the future. They focused almost exclusively on acquiring credentials, particularly institutionalized cultural capital (Bourdieu, 1986) in the form of higher GRE scores, good grades in graduate-level classes, research experiences, and recommendation letters, which are necessary for being seen as a potentially successful science graduate student.

Credential Seekers expressed passion for and emotional connections to *doing* science; for example, Olivia (to protect anonymity, we use pseudonyms), a Black woman, called research “a rush for me,” and Leticia, a Black woman, said that research is “excitement and suspense every day.” They shared a joy of problem solving in research, and their vision of a future in science often involved more of the same. Victor, a Black man, explained that his first opportunity *doing* research “shocked my world and so it’s what I want to do for the rest of my life.” Overall, they communicated a love of *doing* science work, such as mastering techniques, carrying out protocols, spending time at the bench, and getting (or hoping to get) results. For many, *doing* research could be all-absorbing, as we heard from Andrea, a Black/ Native American woman:

> I’m sitting in a lab at 9 o’ clock in the morning willing to do pipettes and I’m just smiling and like this is awesome [laughter], and the next time I look at the clock I’m like oh my God, it’s five? And everybody’s leaving, and I realize I didn’t care about the time … I loved doing it [lab work] … I loved it. I just like—I just like doing it.

Consistent with their passion for *doing* science, Credential Seekers expected PREP to build their repertoire of laboratory skills as the primary means of developing themselves as scientists. David, a Latino, described this as getting the "tools of the trade," which reflects an embrace of the *doing* of science as the core of *becoming* a scientist. Some Credential Seekers also recognized that getting into graduate school requires a portfolio of other credentials, and typically expected PREP to aid them in improving this suite of discrete skills and behaviors. For example, David, who had applied to graduate school, stated:

> I know all the important things for grad school. You have to have good letters … Your grades have to be decent and then your personal statement is important too … I couldn't talk the talk and walk the walk kind of thing, you know? … but then in front of these professors I got like really nervous, and I got feedback later from the [Graduate] Program Director, and he told me my thoughts should be more cogent … that's one of the things that I'm looking forward to through PREP is to be able to explain things more clearly.

David and many of the Credential Seekers came to PREP believing they already "know all the important things for graduate school," and focused on acquiring resources and developing relationships that could be deployed as institutional cultural capital in a successful graduate school application. They shared less about how others had recognized them as potential scientists, though some received feedback about their application when they applied to graduate schools. They have embraced *doing* science and intend to apply to PhD or MD/PhD programs though many had not developed a long term or specific vision of *becoming* a science professional. We note some important ways Credential Seekers talk about *being* and *becoming* scientists compared with others in our sample. They rarely talk about scientific skills, attitudes, and ways of *being* that go beyond hands-on laboratory work into more conceptual areas required for producing knowledge, for example, designing experiments, reading the primary literature or desiring to be recognized for contributions in the lab beyond trouble-shooting. They aspire to graduate school because they love to do science and will get to do even more science as a graduate student. Thus, they anticipate maintaining and extending their *doing* identity, but these expectations have imperfect overlap with what *being* and *becoming* a scientist actually entails.

PI Aspirants: Striving to Become Top Scientists

In contrast to the Credential Seekers who imagined themselves as *doers* of laboratory research, those comprising our next pattern imagined themselves *being* scientists and *becoming* PIs in academic and/or industry settings. We argue that pressure to disprove stereotypes combined with their aspirations for prestigious leadership positions in biomedical research led these college graduates to PREP to enhance already strong graduate student portfolios. To describe these expectations and this anticipated alignment with being a scientist, we refer to these PREP Scholars as "PI Aspirants." Past actions supported this identity construction, as two described influential research experiences in high school, and all had summer and academic year research experiences at highly selective universities. Three of the four graduated from colleges or universities ranked Most or Highly Competitive and have an average GPA of 3.81/4.0. The PI Aspirants are all men and had the

youngest average age of 22. Three are U.S. born Blacks, identifying as African Americans, and one identifies as Latino.

The PI Aspirants envisioned graduate school as a training and proving ground to move beyond *doing* research as problem solver in the lab and toward *becoming* a lead scientist responsible for designing experiments and ultimately setting a research agenda. Nathan, a Black man, anticipates his role in the lab as "the one that can generate the knowledge" and described this as a main attraction of *becoming* an academic researcher:

> What's most attractive about [an academic position] is the level of control that you have over what you do. I can make my own questions as long as I can get good granting and good funding for them. I can basically do my own science. I can help train people … yeah, so also serve as [a] mentor and a really good professor.

Like Nathan, who wants to *become* a professor, the PI Aspirants spoke about their potential impact as teachers and mentors, recognizing these aspects of an academic career that were not emphasized similarly by others in our sample. As part of who he wants to *become*, Tyrone, a Black male, recognized these multiple roles in an academic career trajectory and the potential to be a role model through inspirational teaching and mentoring:

> Academia draws me because of research and teaching. The component of teaching, of explaining ideas is something … I really enjoy. Giving a scientific talk is still invigorating … this idea of bringing new insight, new knowledge to someone … so I think both experiences overlap [and] feed into each other … [My] primary career plan is once I get the PhD and post doc, then apply for junior faculty positions.

Tyrone and the other PI Aspirants found scientific research "fascinating" and "invigorating," but unlike the Credential Seekers, they preferred the aspects of *being* a scientist beyond the *doing* of science in the lab. When recounting past research, Mario, a Latino, enjoyed taking responsibility of "going into a really complex system," making connections to the scientific literature, and designing experiments "to integrate it [all] into a system that will actually mean something."

The PI Aspirants emphasized the relationships they had made, and recounted recognition of their contributions to the scientific process received during high school and college. Nathan described his involvement as a high school student in a university-sponsored research program, which garnered outside recognition and influenced his choice to persist in science:

> You design experiments. I got really into science there. Then [there's] a competition where the city congratulates the top [high school] students of chemistry in the county. I was one of the winners, and that's what really propelled me and let me know that this is something that I'm good in and maybe I should pursue.

Nathan's account emphasizes how outside recognition from "meaningful scientific others" (Carlone & Johnson, 2007, p. 1195) propelled him to pursue a scientific career. Similarly, Paul, a Black male, received recognition from his undergraduate research mentor and labmates who valued his thinking and appreciated his input. Further, Paul discovered one of his ideas had been published in a prestigious journal, leading him to recognize his thinking

was comparable to scientists beyond his lab. This external and internal recognition aligned with their work to construct an identity as *being* and *becoming* research scientists.

Among our groups, Black male PI Aspirants, especially, shared the impact of racialized, discriminatory experiences, which is consistent with how identities are defined "with respect to the intersection of multiple convergent and divergent trajectories," (Wenger, 1998, p. 154) and the assertion that Black men have "raced" and "gendered" experiences at all stages of the educational pipeline (Smith, Allen, & Danley, 2007). As might be inferred by the very low numbers of Black men in the sciences, the most common experience was one of isolation, which Tyrone described:

> I would say in most of my experiences … it hasn't been some sort of blatant form of discrimination or blatant form of racism … It's just being in a classroom or being in a conference room or being at a talk, and you look around, and it's just like wow! So at those moments you're just sort of hit with I am different, and you begin to ask, so why is it like this? Why isn't [sic] there more individuals that look like me that come from my kind of background? I think, uh, I live a pretty nice life and this field, it's pretty prestigious and lucrative and so why are there only certain people who get to enjoy this?

Tyrone's sense of "I am different" demonstrates how Black men can experience campus communities with reminders of "fitting the description of an unwanted element" or as "outsiders who appeared to be out of place" (Smith et al., 2007). Paul described being "the only Black person in the entire natural science building" and how he faced stereotyping in his classes:

> There's been a lot of classes where I've been the only Black person in the class. And a lot of people wouldn't understand the impact … but it has a huge impact. Because it makes you the first and the only … Like the labs that I had in class, often times I would [be] the only Black person, and I would go into the class, and I would sit down, and I would usually be first. People would file in, and I would usually be the only person that didn't have a partner … it would be quite hurtful, and those are things that I've had to deal with … and those are things that I' m sure I will deal with again in graduate school, people being reluctant to be my partner because of assumed stereotypes.

Paul's and others' certainty they would "have to deal with" stereotyping, judgments of others based on their skin color that they were less capable, in graduate school encouraged them to be vigilant about their own performances. Stereotype threat (Steele, 1997; Steele & Aronson, 1995), where individuals are aware that others expect them to underperform has been shown to disproportionately affect the highest performers (Syed, Azmitia, & Cooper, 2011) and those, like the PI Aspirants, who most highly identify with a domain (Chang et al., 2011; Steele, 1997).

For the PI Aspirants, the effect of living with isolation and fighting stereotypes resulted in pervasive pressure, described by Tyrone as an "expectation" to fail and his "psychological battle" that he "even dwells on sometimes":

> It's a psychological battle, the pressure that I do feel is the pressure to fail, right? The pressure that you are an anomaly, right? And you won't make it, right? You come this far, but because most individuals who come from your background will not get to this level and therefore, you know, you will at some point, uh, fail, right?

We suggest this constant physiological, psychological, cultural and emotional coping in less-than-ideal and racially hostile or unsupportive environments—or "racial battle fatigue" (Smith, Hung, & Franklin, 2011) has created extra burdens for these Scholars throughout their scientific development. Nathan explained: "I was just told down the line from people above me, even in elementary school, you have to work twice as hard as others, [meaning] mainly Caucasians." Working twice as hard with added psychological pressure took up time and energy that left the PI Aspirants with no time to prepare for the GRE as college seniors, or to thoughtfully consider and apply to the highly competitive graduate programs they desired. Feeling pressure to disprove a stereotype can result in not having "much mind left over for other things" (Steele, 2010, p. 124). While they want to be resilient (E. O. McGee, 2011) in the face of potential racial obstacles and are determined to prove their competence, these experiences contribute to academically prepared seniors choosing PREP before continuing on to graduate school. They expected PREP to help them, as Mario explains, "hit the ground running," believing a strong start will help them manage stereotypes they will face in graduate school.

Of Scholars in the study, PI Aspirants spoke most directly about identity contingencies based on how their race intersected with their sense of self as scientists, and their expectations that these issues of isolation and being stereotyped would be things they would have to "deal with again in graduate school." Even with strong academic and research preparation consonant with graduate school matriculates, the PI Aspirants joined PREP as a strategy for readiness to be more competitive for the best programs so that they could excel early in graduate school with awareness they might face stereotyping.

Path Builders: Exploring a Potential Future in Science

The Credential Seekers and PI Aspirants spoke clearly of their commitment to graduate school as a step in a trajectory that aligns present and aspirational selves (though these selves are quite different in respect to *doing*, *being*, and *becoming* aspects of science identity), and their focus on how others will evaluate their graduate school applications. In contrast, those we call "Path Builders" were uncertain about their trajectories and focused primarily on internal, rather than external, recognition of a potential future in science. Without this commitment, these 15 sought resources to support them in deciding whether to include graduate school in their plans.

Eighty percent of the Path Builders are women; representation of Blacks and Hispanics is similar to our population (47% and 40%). Average age was 23.6. Twenty-seven percent attended undergraduate institutions ranked in the top two tiers, and the average GPA was 3.44/4.0. However, nine graduated from Competitive or Noncompetitive undergraduate schools, which may have provided fewer resources for scientific research and learning what graduate school entails.

Path Builders anticipated PREP as a time and space to get what Karim, a Black man, called, "a decision and an experience." For Path Builders, especially, graduate school readiness involved deciding—for themselves—that graduate school is right for them and fits into a longer term career plan that resonates with how they see themselves now, what they like to do, and what future role they envision for themselves. Crystal, a Black woman described her decision to join PREP as "long story short; I wanted to make sure that I was ready [for graduate school]."

The Path Builders described needing a sense of ownership and commitment to a self-constructed future, not one that has been prescribed for them by programs or mentors. As Courtney, a Latina, stated, "I need to be my own driving force and not let other people be the driving force." The Path Builders' prioritization of internal commitment, rather than external recognition, was seen in this quote from Salina, a White woman:

> I found out about PREP because I wasn't ready for graduate school. I knew my PIs … were gonna push me to apply to grad school and [wanted me to] go straight in because that's the purpose of the [undergraduate] program … I just feel like I wasn't ready. So I was looking at other options [for] what I could do before I actually apply to grad school.

Most Path Builders majored in science fields and did undergraduate research, yet this preparation and *doing* of science did not yield an "uptake of a science identity" (Archer et al., 2010) leading to graduate school. Most described their prior research experiences as too short and perceived graduate school research as quite different. In particular, the Path Builders did not yet see themselves as graduate students: they imagined unattainable standards for graduate students; questioned their fit with potential colleagues; and/or lacked understanding and knowledge about graduate school. Though generally confident in their preparation, they frequently described being "afraid" or "scared" to commit to a trajectory that included graduate school. Joanna, a Black woman, imagined "freaking out" in graduate school, and as Ricky, a Latino, said, "when it was my turn to graduate, I sort of became completely unsure of myself." Further, he explained:

> [My department] is actually the best department there is in that university … we're constantly put in situations where they required us to try and think like a grad student and, quite frankly, when I got to that level, I got scared because I had had research experience, I had been alone in the lab, but it's not the same, the whole situation as to when you're an undergrad as when you're a grad.

Many Path Builders shared Ricky's belief that being a graduate student is "not the same … situation" and wanted further experience in a practice space (Ovink & Veazey, 2011) that more closely resembled graduate school. Stephanie, a Latina, valued her liberal arts college experiences, particularly her research mentor's attention and how classes were "academically harder than some schools," but could not imagine herself in graduate school labs. Of doing undergraduate research, Martin, a Native American man, said, "You're in and you're out, like it really doesn't give you that full experience." Crystal's statement summed up Path Builders' expectations for PREP: "I'll get to see research, pretty much every day

and for a more extended period of time than the summer programs, to see if this is really what's right for me."

Beyond further practice *being* a graduate student, Path Builders used PREP as part of a strategy to find a niche in science and clarify goals as Bridgette, a Black woman, said:

> That's kind of one of the reasons why I came to the PREP program because I am still broad, very broad, and right now actually I'm working in a pharmacology lab where it's—it's different also, but um I'm just trying—right now I'm just trying to find my niche.

For Marie, a Latina, her search for a "focus" involved finding "something I really love to [make] it easy for me to just [do] research." Finding a 'place of their own' in science varied for these Path Builders: one sought to identify with a kind of lab (pharmacology) and another for research that she could "love." Others, like Katrina, a Black woman, shaped their trajectory in terms of a career choice: "I wanna figure out if [research] is what I wanna do. Bottom line … or choose something completely different altogether."

Practicing *being* a graduate student; gaining goal clarity; and resolving trajectory indecision were the Path Builders' main expectations for PREP. As Courtney said, "I don't go into something that I don't know I want 100%," and Martin said, "I guess [I joined PREP] to be more focused, you know … I want things to be a lot more clear for me, as far as my future [before I can go to graduate school]." They imagined the PREP experience will support them in the internal identity work necessary to align the *doing*, *being*, and *becoming* aspects of their science identities and settle on a trajectory—one that maps out, as Bridgette describes, "exactly what it is I am doing and where I'm going." For them, this internal sense of self as capable of succeeding and belonging as a graduate student is necessary before they take up the external work of seeking recognition of their credentials for graduate school.

Discipline Changers: Redeploying Cultural Capital for Doing Science

The Credential Seekers, PI Aspirants, and Path Builders came to PREP with biomedical research experience, giving them an opportunity to develop and practice with critical skills and dispositions in a context akin to graduate school and future careers in research science. The Discipline Changers, along with the Interest Testers, began PREP without this research experience, leaving them with less cultural capital to apply for graduate school. However, they, too, aspire to graduate school, and expect PREP to foster their transition. With these two groups we attend closely to questions of cultural capital as their primary focus is on redeploying and acquiring resources as they author identities and exemplify the complex, and slightly different, educational paths of latecomers to science (Jackson & Seiler, 2013).

Five in our study came to PREP with academic dispositions and research experience from social science and applied science, and therefore, we refer to them as "Discipline Changers" because of their desire to change direction toward biomedical fields. Older on average (27 years old vs. 23 years old) than others in our sample, four in this pattern did not join PREP right after college, and two had applied to PhD programs (one turned down a graduate school offer). Two attended top ranked undergraduate institutions, and the average GPA was 3.48/4.0. Four are women, and four identify as Hispanic and one as Black. Despite their

backgrounds outside of biomedical research, they had acquired cultural capital, both embodied and institutional (Bourdieu, 1986), ready to be redeployed for science research and graduate studies.

While the Discipline Changers did not bring extensive scientific experience, they brought a sense of valuing learning for the sake of discovery, which we understand as a form of embodied cultural capital, or disposition (Bourdieu, 1986), that contributed to their enjoyment of school and comfort in an academic environment. Francisco, a Latino, described this discovery disposition as being pulled away from a "practical" goal:

> I love social sciences just as much as I do the regular—the hard sciences … I studied anthropology when I got my first undergraduate degree, but I [continued taking] science courses because I was a pre-med … but about halfway through my undergraduate career, I realized I didn't want to be a doctor, so I kind of did the science part just cause I still enjoyed learning about it [even though] my main focus was the anthropology.

Francisco's attraction to learning science for the sake of knowledge and his choice not to continue as a pre-med, point to a genuine love of multiple subjects that are not necessarily directly connected to a career, but we argue, represent their constructing an identity as good academic students. Likewise, two others described changing direction from their professionally oriented majors in the nutrition field because they became bored with the repetition of patient-centered work. Detra, a Black woman, discussed her frustrations with her clinical rotations as a dietician-in-training with a professor who introduced her to a research path:

> I took [food sciences] … [and we] had to do rotations in hospitals … I couldn't take it when many [patients] were sick. I'm like, "There's gotta be a better way." This is good that we're helping them once they're sick, but I always felt like there's gotta be a prevention method. I [thought what] if I go into research—that's when I was talking to my instructors, and they're like research is trying to prevent it, [but] it may take years.

Detra's choice to pursue research showed her curiosity goes beyond treating patients to understanding the science behind nutrition. She decided to make this change though she knows that finding answers with research may "take years."

In addition to their discovery disposition, the Discipline Changers talked about discrete skills they had gained from their research in their disciplines. Theresa, a Latina, imagined applying the "statistical analysis and data collection" from her economics thesis to biological research. Reflecting on a year-long anthropology research project, Marissa, a Latina, said, "[I'm] pretty confident about my writing for sure," a skill that some aspiring scientists find challenging.

The Discipline Changers approached PREP seeking to develop and apply higher order thinking skills in research. Like the PI Aspirants, and unlike the Credential Seekers, they wanted more from PREP than just getting trained in a set of techniques. Marissa expected networking and collaboration to stimulate her ability for independent and creative thinking:

> I guess collaboration also um and just like different ideas either through like the grad students in my lab or even the PREP students cause everybody's really doing something different … I mean just being able to do things more independently in the lab is also something like I'm really looking forward to and thinking more creatively on my own.

Whereas others were more likely to be anxious about academic credentials needed for graduate school applications, Discipline Changers exuded confidence. Detra spoke about the extra effort she puts into classes to compensate for English being her second language. She said she goes over things "10 times" but "once I get it, I'm always the one getting the highest grade in class." Similarly, Theresa's confidence that "I'm gonna have a better GRE score, a high GRE score … " contrasts with many other Scholars who worried about the test. With confidence in their academic skills and abilities, Discipline Changers can see themselves as successful graduate students, and view this as a logical step on their trajectory.

Rather than a detriment, these Scholars envisioned their multidisciplinary backgrounds as a distinguishing characteristic, and planned to integrate these into their career trajectories. For example, Francisco explained, "I love anthropology a lot, and if I can get into biology and maybe use some of my anthropology background at the same time that that would make me really happy." Similarly, Marissa described how she will use her background as she imagines working in epidemiology, which she feels is "a good combination of infectious disease and anthropology [because] you have to be in tune with the culture of a specific population."

While Discipline Changers have not named career roles for themselves, they imagined processes and environments that will make them happy with PREP as a strategy for *becoming* the kind of people they want to be. Theresa shared the enjoyment of *being* in the laboratory and connected this to *becoming* a scientist:

> Science is … taking all these different factors, putting them together and trying to make the reaction work. And so I realized I like being methodical and in control and still kinda trying out different things. I feel like scientists are very creative because you have to do things that no one's done before. You have to think outside of the box.

The positive regard Francisco developed for his professors, which was also described by the other Discipline Changers, shaped his thoughts about his future career. He said, "I realized these are the people that I admire [referring to his professors] so maybe this is the kind of person I want to become … [this] kind of draws me to the academic life."

PREP offers Discipline Changers an opportunity to build upon their academic identities and transform these to shift their career trajectory toward *becoming* scientists. They represent a version of latecomers to science (Jackson & Seiler, 2013) though not necessarily new to research. They aim to redeploy key cultural capital—including a discovery disposition, as well as academic and research skills—in biomedical research, and expect PREP to provide both appropriate experiences and the necessary credentials, enabling them to be recognized

by others (external) as capable graduate students. Choosing PREP, then, is part of a strategy toward developing a well-received application as a life science graduate student.

Interest Testers: Trying Out Being a Researcher

The last three Scholars were biology majors and aspiring doctors in college but had no research experience beyond class labs. By their senior year, they wanted to explore alternatives to clinical professions and found PREP as a way to "test" *being* a researcher, which is why we chose "Interest Testers" to describe them. We assert they represent another version of latecomers—those looking to stay in science but in a new way. None of the Interest Testers attended undergraduate institutions ranked in the top two tiers, though their schools were ranked in the third tier (Very Competitive); their average GPA was 3.1/4.0, and average age was 23. Two are women, and two identify as Hispanic and one as Black.

The Interest Testers expected PREP to provide their first research experiences and sought the training, knowledge and information available from immersion in the research context. Unlike Discipline Changers, who want to redeploy cultural capital, Interest Testers must develop these research skills and behaviors. They hoped that *doing* science during PREP will get them to graduate school and new career options.

Until late in their senior year, Interest Testers had envisioned *becoming* medical professionals. However, by the time of graduation, they had become uncertain about this path. Anita, a Latina, admitted to being "lost" by her senior year and considered going into business with her biology degree. She said, "It's kind of like the PREP Program has been a way to kind of rescue those students from becoming lost." Viewing PREP as a "rescue"—or as Antonio, a Native American/Latino, described it, a "second chance"—distinguishes this group.

The Interest Testers desired information and experience to guide their next steps. Unlike the Path Builders who had research experiences and joined PREP to "be sure" that research is right for them, these Scholars wanted to "try" research to possibly pursue a new career trajectory. We saw some confusion about this decision as Jasmine, a Black woman, considered doing the MD and PhD:

> I think I wanna do, like fertility research or like asthma research, but like until I've tried all of the research, I can't say what I actually wanna do. I mean most schools have like umbrella programs, like integrative medicine programs, that incorporate biochemistry, pharmacology, like anything basically you can get with an MD. Or with a PhD. So like in the long run I may, you know, go back and try to pursue an MD but I guess for right now, I wanna do, I guess, something more on like the research level.

Similarly, we heard long-term career indecision from Antonio as he questioned whether he can see himself *being* "just a researcher" for his "entire career":

> I've got like five different paths that are plotted out, so I'm taking it as it comes … I like the shotgun method, so I'm gonna try to get into as many possible roads as possible and take it from there … I love science, I love research, I love the

> detective work. But I don't know that I would want to be just a researcher for my entire career.

These Interest Testers lacked early opportunities to develop skills, attitudes and procedural knowledge about *being* an aspiring researcher. For Jasmine, negative assumptions and lack of exposure to research led her away from research until her senior year:

> I never knew what research was all about. Like, I just thought, you know, the common misconception of like, me and a mouse, or me and a rat in a lab. That kind of freaked me out. So I like never pursued it … until, my senior year, I started working [to set up class labs for my professor]. And that really sparked my interest, and some of my teachers, they held PhD's, and they told me about, like, the real, I guess, research. Like, not just you and like a rat and like a crazy dark room.

Likewise, Anita cited her lack of exposure to research beyond labs for courses and anticipated getting "real research" in PREP. Perhaps because of their pre-professional paths where they anticipated "training" for clinical work, they, like Jasmine, wanted "as much research training as I can do" from PREP. This expectation for an opportunity for "training" differs from the Discipline Changers and PI Aspirants who seek more than training in laboratory techniques.

Whereas PREP was a strategic choice for PREP Scholars internally committed to graduate school, the choice for Interest Testers was more "serendipitous" (Antonio). Describing her online search for an alternative to pursing medical school, Jasmine stated, "I didn't know anyone who ever even did a research program like this. I didn't even know they existed." With this confusion about their futures and the "serendipity" of finding PREP, the Interest Testers have two expectations: to try "real" research for the first time and get research training.

Without research experience, the Interest Testers could not assess their strengths and weaknesses regarding research, but they were cautiously optimistic, as Antonio describes: "Every day I show up and give 100% … I feel confident that *I might be able to* get into a [graduate] program [at the end of PREP]. I came here to refine my skills, get experience." Like Antonio, Anita and Jasmine considered their hard work and determination important strengths. While these are dispositions that may benefit them as researchers, they need the authentic research experience provided through PREP to apply these strengths and develop other cultural capital. And like each person in our population, they have employed agency to take steps that will allow them to make critical decisions in their educational and career trajectories.

Discussion and Implications

These findings deepen the understanding of individuals' identity work in anticipation of, and expectations for, science preparatory programs, and yield useful insights into the uptake and deployment of cultural capital in authoring identity. Variation among individuals' identification with the *doing*, *being*, and *becoming* aspects of a science identity led to different understandings of the resources these individuals think they will need to be successful in their efforts to be accepted by and attend a PhD or MD/PhD program.

Focusing on this moment of anticipated *becoming* offers a window into the active re-construction process, where students evaluate past experiences in terms of their commitment to and readiness for a next step in their science career trajectories. Late in his career, Bourdieu (1991, 2004) turned his conceptual tools to the study of science. His notion of the scientific field emphasizes the structuring of "possibles" open to agents, depending on their placement within that field. Combining aspects of identity-in-practice and Bourdieu's theory of practice, we offer a flexible, sensitive, agent-centered framework for examining aspirations and persistence toward such possibles/future positions in science. In this section, we review our findings and their theoretical implications, suggest new research directions, and offer implications for directors of PREP Programs and similar efforts designed to provide resources and experiences for aspiring scientists, particularly those who are considering graduate work and scientific research careers.

Expectations for PREP: Variations in Identity Work and Cultural Capital

We begin by examining what our participants' expectations for PREP reveal about the actions, resources, and relationships they feel they need to sustain or change their identity trajectories as they perceive themselves *doing*, *being*, and *becoming* within science. We emphasize three aspects useful for researchers studying science aspirations and persistence: variations in alignment with *doing*, *being*, and/or *becoming* aspects of a science identity; the cultural capital individuals anticipate needing to further themselves in their chosen trajectory; and expectations for the program as a space in which to gain this cultural capital. Furthermore, we discuss the influence and implications of race, ethnicity, and gender on this identity work.

In two of the patterns, PREP Scholars came to PREP already committed to graduate school as an appropriate enactment of their scientist identities. But these differed among those who came to PREP imagining themselves *doing* science (Credential Seekers) and those imagining *becoming* lead scientists (PI Aspirants) in the future. Like other scholars who have found a disconnect between love of *doing* science and science aspirations in younger students (Archer et al., 2010, 2014), we also note a complex relationship between *doing* and *becoming* at the postbaccalaureate level. The Credential Seekers expressed strong enjoyment of *doing* science in the lab, such as getting lost within the problem solving and tweaking required for hands-on laboratory work, and regarded graduate school as a destination for *doing* more science rather than as a point along a trajectory toward a specific science career. In contrast, the PI Aspirants anticipated enjoyment from designing experiments, setting a research agenda, and overseeing a laboratory, so *becoming* lead scientists was central to their current and anticipated identity trajectories, and thus regarded graduate school as a critical step along this path. Individuals in these patterns share a focus on external recognition, based on their expectations that PREP will aid them in assembling portfolios of cultural capital appropriate for graduate school admission and success, but differ in emphasis. The Credential Seekers prioritized the acquisition of institutionalized cultural capital in the form of improving or adding credentials such as GRE scores, GPA, or letters of recommendation (though some also list less measurable credentials such as improving presentation skills and comfort "talking about science"). The PI Aspirants came to PREP already prepared with much of this institutionalized cultural capital, but, we argue, they did

not feel ready because they wanted to develop embodied cultural capital in the form of dispositions that they anticipate admissions personnel will recognize as the type of student to accept into their highly competitive graduate programs. These two patterns suggest that both *doing* and *becoming* aspects of identity may support science persistence, but with very different expectations for resources. This attention to individuals as strategic consumers of resources may be fruitfully combined with analyses of programs as sites of cultural capital cultivation (Ovink & Veazey, 2011). As participants in their own cultivation, individuals seek out resources they expect will be useful.

While the Credential Seekers and PI Aspirants exemplify those wanting to sustain an identity through their engagement in PREP, the Discipline Changers aim to shift direction, re-constructing their past history as a strong academic student by adding experiences in science disciplines. We assert this process may be understood as one of re-deploying cultural capital to suit new fields. Beyond simply possessing cultural capital, to gain maximum benefit individuals must know how best to deploy it within the particular context. As Carter (2003) notes, cultural capital is "context-specific, and its currency varies across different social spaces where struggles for legitimation and power exist" (p. 137). The Discipline Changers have academic dispositions and skills which they want to apply to—and which are desired within—scientific research, but must learn to deploy this cultural capital to their advantage in this new field. Further, they expect participation in the program to certify their interest and competence in scientific research, an extremely valuable piece of the price of admission to graduate school.

The Path Builders and Interest Testers included individuals with less clarity about their future trajectory in scientific research. Rather than engaging with PREP to sustain or shift a science career trajectory, they hoped to confirm or test an identity trajectory consonant with *doing*, *being*, and/or *becoming* within science. The Path Builders' research experiences and positive messages from mentors prompted them to explore *doing* science and *becoming* a graduate student, but they did not feel ready to commit to graduate school. In their expectations for PREP, this internal focus took precedence over concerns about how others would perceive their preparation. The Path Builders sought accurate information about graduate school, and desired an extended research experience as an opportunity to practice *being* a graduate student and assess whether their skills and dispositions fit with this role. Like the women in Carlone & Johnson's (2007) work, we find that recognition from "meaningful others … as a science person" (p. 1192) does not necessarily translate into the uptake of an identity as a research scientist. Rather, the Path Builders sought time in which to align recognition of self with this positive recognition by others. Here, PREP provides not just a practice space (Ovink & Veazey, 2011) or figured world and "realm of interpretation" (Holland et al., 1998, p. 58) where the Path Builders can *try on* roles as graduate students and knowledge producers, but where they can *confirm* earlier positive experiences. The Interest Testers comprise those seeking to author a new identity by trying out research during PREP. They have a positive outlook that PREP will provide a second chance for college graduates seeking new ways to continue in science. Being less aware of what research and a research trajectory entail, they focused on "getting trained," which to them meant developing lab skills by *doing* research, and their expectation that experience with

doing will lead them to choose the PhD path. Where many researchers have emphasized the value of programs challenging canonical notions of doing science to "open up possibilities for outsider students to take up identities as insiders to science" (Gonsalves, Rahm, & Carvalho, 2013, p. 1094; see also Rahm, 2010), we note that some students seek programs that offer an experience reflecting the "real world" of working scientists. We encourage future researchers to tease apart these various needs and their relationships to science aspirations and persistence over the lifecourse.

While we heard detailed re-constructions of these Scholars' histories and their identity work around *doing*, *being*, and *becoming* scientists, we carefully probed for their perceptions of how race, ethnic, and gender contingencies may have shaped these histories. Literature on race, gender and science makes it quite clear that gender is an important component of *doing*, *being*, and *becoming* a scientist. Gender and race stereotypes about who does and should do science, stereotype threat, and differential treatment infiltrate identity and cognitive development (Clewell & Campbell, 2002; Scantlebury, Kahle, & Martin, 2010; Steele & Aronson, 1995).

Race and/or gender were particularly salient in the PI Aspirant and Path Builder patterns. The four PI Aspirants were all men with three identifying as African American. As noted in our findings, the intersection of being Black and male for three PI Aspirants mattered even after they achieved success in college and undergraduate research. Experiencing discrimination, feeling like the only one, and living with the idea that they had to be better than the rest had shaped their aspirations to *become* graduate students and future scientists. We note here that no women in our study expressed such a strong identity to become academic scientists as the male PI Aspirants, which may indicate that the meaning of *becoming* a scientist is more socially available to men than to women (Carlone, 2004). Women, across races, were disproportionately Path Builders, yet unlike the PI Aspirants, their accounts did not indicate an awareness of how gender had, or perhaps would, shape their scientific trajectories. The Path Builders, similar to most others in our study, shared sentiments with Amare (Black man, Credential Seeker), who said, "I don't think that [gender and ethnicity] has any effect on [my education or experiences]. It hasn't affected me at all." We have several hypotheses to explain this.

In terms of gender, women in PREP are neither tokens nor underrepresented. PREP Scholars both in our study and in general are predominately women, as they are in many of the biomedical graduate school programs they wish to attend (NSF, 2013). Too, unlike White and Asian students, Black women are more apt to be enrolled in science, technology, engineering, and math (STEM) graduate programs than Black men while the rate for Hispanic women and men is about equal. Being in the majority may reduce conflict between identity as a woman and potential identity as a graduate student for Black and Hispanic women. At the same time, we speculate that gender may become more salient for the women in our study as they continue in science. Evidence from fields where women have made gains in breaking through the "glass ceiling" into previously male-dominated professions and positions suggests that scholars must look beyond numbers and focus instead on the experience of women (and men) in these positions. Women's employment in such roles often carries additional strain. For example, female candidates are most likely to be

appointed to leadership roles in more precarious and contentious work situations than their male counterparts (Bruckmüller, Ryan, Rink, & Haslam, 2014), while early career women are assessed as less capable and deserving of mentoring than equivalent men (Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012). Gendered pressures to balance work and family will be felt especially keenly by women in the "hyperprofessional" world of academic science, which allows—and rewards—overwork (Gornall & Salisbury, 2012). However, strategies to reduce work family conflict only reduce such strain in supportive cultures (Glass, Sassler, Levitte, & Michelmore, 2013; Westring et al., 2014), and, though progress has been made, many science cultures remain "chilly" to women (Bagilhole & Goode, 2001; Carlone, 2004; Cech & Blair-Loy, 2010; Etzkowitz, Kemegor, & Uzzi, 2000; Jorgenson, 2002; Rhoton, 2011; Seymour & Hewitt, 1997). Tonso (2006) in her work with student engineers, carefully details the ways in which implicit gendered cultural forms limit recognition of women as engineers, and that "recognition … conferred belonging" (p. 303).

Aside from the PI Aspirants, participants deemphasized the impact of race. The majority of Scholars are Black and/or Latino/a, and in PREP they have opportunities to interact with role models of color. Additionally, many Scholars are either the children of immigrants or are immigrants themselves, which can mean fewer experiences and influences that would create conflicts between their race/ethnicity and the potential identity as a graduate student (Waters, 1994). Bourdieu (1986) offers a useful window into this finding in his description of social fields as a "game" with rules held by the dominant group. However, "games obscure the conditions of their own playing through the very process of securing participation" (Burawoy, 2012, p. 189). Thus, participants can lose sight of how access to resources is shaped by the power relations inherent in the intersections of race/ethnicity, class, and gender, and instead see natural talent. This "misrecognition" may act in an especially synergistic fashion with fields such as science which embrace norms of objectivity and meritocracy.

While a nuanced exploration of these hypotheses is beyond the scope of this article, we intend— and encourage others—to do so in future work. This article represents a cross-sectional analysis of PREP Scholars at the beginning of their participation in the program. As we continue to follow these young scientists through PREP, into graduate school, and into their careers, we intend to examine, for instance, the interplay of internal and external recognition for men and women, how expectations for PREP dovetailed with experience of the program, and how intersectionalities of race/ethnicity, class, and gender shaped the experience of graduate school readiness. We anticipate that as these young scientists progress in their training, more will accumulate—and recognize— raced and gendered experiences. This accumulation may lead them to decide, like the PI Aspirants, that they must play a different way in order to win or choose to play another game.

Across gender and race/ethnicity, dividing science identity into three dimensions—*doing*, *being*, and *becoming*—and examining their interplay offers a flexible, sensitive approach to the myriad ways individuals come to know themselves as scientists. Distinguishing external and internal identity work allows for consideration of the individual and collective nature of recognition. Finally, linking questions of identity with availability, uptake, and deployment of resources brings useful tangibility, and a clear point of connection between practitioner

and scholarly work. As these examples suggest, use of this framework supports collaboration between scholars and practitioners in refining programs.

Using the Patterns: Implications for PREP and Related Programs

Individuals come to programs like PREP with a certain set of resources and varying abilities and ideas about how to redeploy these resources as cultural capital required for identity work associated with matriculation as a graduate student. In other words, they have varying understandings of what it means to be ready or to become ready for graduate work in the biomedical sciences. We suggest successful programs will strive to identify participants' expectations, engage them as agents, and make clear how program activities can help them persist toward scientific research careers, or for some, another career. We are not advocating every person will perfectly fit into one of our patterns, but we believe that variations as exemplified by the patterns can be useful tools for Program Directors at the postbaccalaureate and undergraduate level. By understanding the nuances and differences of student expectations, programs can assess whether their offerings align with the patterns of identity work, and they could consider honing their programs for particular needs or expanding their offerings to meet a variety of needs.

Most college graduates seeking a PREP program convey their desire to continue onto graduate school though as we have shown they have different understandings of how to get there. For example, a PREP Scholar who communicates a strong love of *doing* science may want to work on experiments in her PREP lab because she thinks getting more of this experience is what she needs. But, we suggest this Scholar is vulnerable of not progressing if she only pursues lab experiences where she is comfortable using existing skills. A mentor who works with this student should challenge and support her to author an identity beyond that of a *doer* of good research, especially helping her understand research in a broader context of existing literature and to coach her to develop appropriate research questions and think about ways to address these in her research. Similarly, the new Scholar who identifies with *becoming* a lead scientist conveys his desire to attend graduate school; however, he joined PREP to get more comfortable demonstrating this identity without a doubt to himself and in preparation for admissions to high prestige programs where he can feel ready to handle racial biases. Programs can assist mentors to see and understand these similarities and differences and customize their mentoring styles and lab experiences to foster development and readiness for graduate school.

Those with a less developed sense of where they see themselves in the future also present opportunities for PREP and similar support efforts. Those new to research may benefit from activities that introduce lab skills and techniques as well as insider information to ease their adjustment to "real" scientific research experiences. Mentors and PREP personnel could focus on helping these college graduates build from their previous experience and transfer skills to the research setting. Offering an introductory research "boot camp" might be appropriate as well as extending a postbaccalaureate experience into 2 years for those trying on the researcher and scientist identities as they decide on next steps. A second year in PREP and other options for extending beyond 1 year are features of some PREP programs.

We found that some viewed *being* a graduate student and *becoming* a scientist as more distant and come to PREP wanting to know what it is like to be a graduate student, and they desire to leave PREP with more clarity about their next steps. Programs recognizing this would want to provide realistic information and a safe practice space for *being* a graduate student, so that those like Joanna, a Black woman Path Builder, can get "the whole experience (as a graduate student) to see if I'm really cut out to handle the ups and downs of research [and] what's going to be expected … in graduate classes and all of that." As they begin to imagine themselves being comfortable as graduate students, they can then focus on how their credentials and experiences align with graduate school entrance requirements.

More broadly beyond implications for postbaccalaureate and undergraduate science programs, our research furthers awareness of opportunities and vulnerabilities inherent in identity work for those persisting toward research careers in science. We assert that programs, like PREP, have the potential to expand opportunities outside the traditional degree-seeking educational pipeline. These opportunities are needed because attainment of a bachelor's degree is only part of what contributes to readiness for graduate work. Even when students' histories include choosing appropriate majors, participating in science support activities, and pursuing undergraduate research, they seek readiness beyond this preparation. Our work has shown that to move beyond preparation involves helping individuals understand the context and "rules of the game" in which to demonstrate preparation to themselves and to others.

A vulnerable point for some aspiring scientists, as portrayed by our PI Aspirants, may occur when race, ethnic, and/or gender contingencies intersect with taking on new roles such as becoming a graduate student or scientist, especially when these roles have traditionally been seen as more available to White males. This fosters concern for some about how others will view them due to race or gender contingencies. Providing multiple experiences to interact with graduate students and faculty and talk about their science in a safe environment is a way that programs can enhance readiness for being accepted into graduate school and scientific communities. Programs supporting students in college and beyond for progression to science research careers should be aware that challenges due to social contingencies may ebb and flow, especially since these can be veiled within the perceived meritocracy of scientific research. Programs and mentors working with these aspiring scientists may want to offer opportunities for discussion of how historically underrepresented and female scientists have managed challenges of isolation and stereotyping along their career trajectories, and train graduate program personnel to understand these potential challenges for their trainees.

In future work, when we have longitudinal data, we will focus on student experiences in PREP and consider program outcomes. We already know that more than 80% of the PREP Scholars have begun PhD or MD/PhD training. Proportions entering graduate school are similar across the five patterns except for Credentials Seekers who persist slightly less frequently (72%). In future studies we will examine the types of resources the PREP program provides to participants as they prepare themselves and get ready for graduate school and how they engage with those resources. We will investigate whether there is variation in who applies to graduate school; whether PREP Scholars accessed the cultural

capital they were seeking and if so, how; and how Scholars' engagement with PREP influenced their development of trajectories that align the *being*, *doing*, and *becoming* aspects of identity work.

With our attention to the role of identity and cultural capital in the trajectories of young scientists from historically marginalized groups, we aim to broaden the collective scholarly and practitioner conversation about how to facilitate the diversification of the scientific community. By moving beyond preparation as a primary focus, we offer a more nuanced and detailed view of science identity, its relationship to cultural capital, and graduate school readiness.

Acknowledgments

This research was supported by grants from the National Institutes of Health, R01 GM085385 and R01 GM085385-02S1 (ARRA). We also thank our colleagues Sandra LaBlance, Steven P. Lee, Ebony McGee, Jennifer Richardson, Bhoomi Thakore, Simon Williams, and Christine Wood for invaluable discussions throughout the study and comments on drafts of this manuscript, and Bryan Breau for superb logistical and data management support.

References

Archer L, DeWitt J, Osborne J, Dillon J, Willis B, Wong B. "Doing" science versus "being" a scientist: Examining 10/11-year-old school children's constructions of science through the lens of identity. Science Education. 2010; 94(4):617–639.

Archer L, DeWitt J, Willis B. Adolescent boys' science aspirations: Masculinity, capital, and power. Journal of Research in Science Teaching. 2014; 51(1):1–30.

Aschbacher PR, Li E, Roth EJ. Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. Journal of Research in Science Teaching. 2010; 47(5):564–582.

Bagilhole B, Goode J. The contradiction of the myth of individual merit, and the reality of a patriarchal support system in academic careers. European Journal of Women's Studies. 2001; 8(2):161–180.

Barron's Educational Services. Barron's Profiles of American Colleges. 29th ed.. Hauppauge, NY: Author; 2011.

Barton AC, Kang H, Tan E, O'Neill TB, Bautista-Guerra J, Brecklin C. Crafting a future in science: Tracing middle school girls' identity work over time and space. American Educational Research Journal. 2013; 50(1):37–75.

Bass, SA.; Rutledge, JC.; Douglass, EB.; Carter, WY. The university as mentor: Lessons learned from UMBC inclusiveness initiatives. Washington, DC: The Council of Graduate Schools; 2007. Retrieved from http://www.cgsnet.org/cgs-occasional-paper-series/university-maryland-baltimore-county/introduction

Beazeley, P. Qualitative analysis: Practical strategies. Los Angeles: Sage; 2013.

Bourdieu, P. Distinction: A social critique of the judgement of taste. Cambridge, MA: Harvard University Press; 1984.

Bourdieu, P. The forms of capital (R. Nice, Trans.). In: Richardson, J., editor. Handbook of theory and research for the sociology of education. New York, NY: Greenwood; 1986. p. 241-258.

Bourdieu P. The peculiar history of scientific reason. Sociological Forum. 1991; 6(1):3–26.

Bourdieu, P. Science of science and reflexivity. Chicago: University of Chicago Press; 2004.

Bourdieu, P.; Passeron, JC. Reproduction in education, society and culture. London, England: Sage Publications; 1977.

Bowen GA. Grounded theory and sensitizing concepts. International Journal of Qualitative Methods. 2006; 5(3):1–9.

Brandt C. Discursive geographies in science: Space, identity, and scientific discourse among indigenous women in higher education. Cultural Studies of Science Education. 2008; 3(3):703–730.

Brickhouse NW. Embodying science: A feminist perspective on learning. Journal of Research in Science Teaching. 2001; 38(3):282–295.

Brickhouse NW, Potter J. Young women's scientific identity formation in an urban context. Journal of Research in Science Teaching. 2001; 38(8):965–980.

Brown BA. Discursive identity: Assimilation into the culture of science and its implications for minority students. Journal of Research in Science Teaching. 2004; 41(8):810–834.

Bruckmüller S, Ryan MK, Rink F, Haslam SA. Beyond the glass ceiling: The glass cliff and its lessons for organizational policy. Social Issues and Policy Review. 2014; 8(1):202–232.

Burawoy M. The roots of domination: Beyond Bourdieu and Gramsci. Sociology. 2012; 46(2):187–206.

Byars-Winston A, Estrada Y, Howard C, Davis D, Zalapa J. Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: A multiple-groups analysis. Journal of Counseling Psychology. 2010; 57(2):205–218. [PubMed: 20495610]

Carlone HB. The cultural production of science in reform-based physics: Girls' access, participation, and resistance. Journal of Research in Science Teaching. 2004; 41(4):392–414.

Carlone HB, Johnson A. Understanding the science experiences of successful women of color: Science identity as an analytic lens. Journal of Research in Science Teaching. 2007; 44(8):1187–1218.

Carter PL. "Black" cultural capital, status positioning, and schooling conflicts for low-income African American youth. Social Problems. 2003; 50(1):136–155.

Cech EA, Blair-Loy M. Perceiving glass ceilings? Meritocratic versus structural explanations of gender inequality among women in science and technology. Social Problems. 2010; 57(3):371–397.

Chang MJ, Eagan MK, Lin MH, Hurtado S. Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral science aspirants. Journal of Higher Education. 2011; 82(5):564–596. [PubMed: 23226874]

Charmaz, K. Constructing grounded theory: A practical guide through qualitative analysis. London: Sage Publications; 2006.

Chemers MM, Zurbriggen EL, Syed M, Goza BK, Bearman S. The role of efficacy and identity in science career commitment among underrepresented minority students. Journal of Social Issues. 2011; 67(3):469–491.

Chen, X. Students who study science, technology, engineering and mathematics (STEM) in post-secondary education. (NCES 2009-161). Washington, DC: U.S. Department of Education, National Center for Education Statistics; 2009.

Clewell BC, Campbell PB. Taking stock, where we've been, where we are, where we're going. Journal of Women and Minorities in Science and Engineering. 2002; 8(3/4):255–283.

Dimaggio P. Cultural capital and school success: The impact of status culture participation on the grades of United States high school students. American Sociological Review. 1982; 47(2):189–201.

Etzkowitz, H.; Kemelgor, C.; Uzzi, B. Athena unbound: The advancement of women in science and technology. Cambridge, UK: Cambridge University Press; 2000.

Glaser BG. The constant comparative method of qualitative analysis. Social problems. 1965; 12(4): 436–445.

Glass JL, Sassler S, Levitte Y, Michelmore KM. What's so special about STEM? A comparison of women's retention in STEM and professional occupations. Social Forces. 2013; 92(2):723–756.

Gonsalves A, Rahm J, Carvalho A. "We could think of things that could be science:" Girls' re-figuring of science in an out-of-school-time club. Journal of Research in Science Teaching. 2013; 50(9): 1068–1097.

Gornall L, Salisbury J. Compulsive working, 'hyperprofessionality' and the unseen pleasures of academic work. Higher Education Quarterly. 2012; 66(2):135–154.

Griffith, AL. Persistence of women and minorities in STEM field majors: Is it the school that matters?. 2010. Retrieved from Cornell University, School of Industrial and Labor Relations website: http://digitalcommons.ilr.cornell.edu/workingpapers/122/

Holland, D.; Lachicotte, W.; Skinner, D.; Cain, C. Identity and agency in cultural worlds. Cambridge, MA: Harvard University Press; 1998.

Hurtado S, Cabrera NL, Lin MH, Arellano L, Espinosa LL. Diversifying science: Underrepresented student experiences in structured research programs. Research in Higher Education. 2009; 50(2): 189–214. [PubMed: 23503690]

Jackson PA, Seiler G. Science identity trajectories of latecomers to science in college. Journal of Research in Science Teaching. 2013; 50(7):826–857.

Johnson A, Brown J, Carlone H, Cuevas AK. Authoring identity amidst the treacherous terrain of science: A multiracial feminist examination of the journeys of three women of color in science. Journal of Research in Science Teaching. 2011; 48(4):339–366.

Jorgenson J. Engineering selves: Negotiating gender and identity in technical work. Management Communication Quarterly. 2002; 15(3):350–380.

Lareau, A. Unequal childhoods: Class, race, and family life. Berkeley, CA: University of California Press; 2003.

Lareau A, Horvat EM. Moments of social inclusion and exclusion race, class, and cultural capital in family-school relationships. Sociology of Education. 1999; 72(1):37–53.

Malone KR, Barabino G. Narrations of race in STEM research settings: Identity formation and its discontents. Science Education. 2009; 93(3):485–510.

McGee EO. “You would not believe what I have to go through to provemy intellectual value!” Stereotype management among academically successful black mathematics and engineering students. American Educational Research Journal. 2011; 48(6):1347–1389.

McGee R, Saran S, Krulwich TA. Diversity in the biomedical research workforce: Developing talent. Mount Sinai Journal of Medicine. 2012; 79:397–411. [PubMed: 22678863]

McLeod J. Why we interview now—Reflexivity and perspective in a longitudinal study. International Journal of Social Research Methodology. 2003; 6(3):201–211.

Moss-Racusin CA, Dovidio JF, Brescoll VL, Graham MJ, Handelsman J. Science faculty’s subtle gender biases favor male students. Proceedings of the National Academy of Sciences. 2012; 109(41):16474–16479.

Naffziger, ME. Creating overlapping schemas and strategies to improve college access and choice for low-income students (doctoral dissertation, sociology). Evanston, IL: Northwestern University; 2011.

National Academies of Science. Expanding underrepresented minority participation: America’s science and technology talent at the crossroads. Washington, DC: The National Academies Press; 2011.

National Institutes of Health Office of the Director. NIH proposes critical initiatives to sustain future of U.S. biomedical research. 2012. Retrieved January 25, 2012, from http://www.nih.gov/news/health/dec2012/od-07.htm

National Science Foundation, National Center for Science and Engineering Statistics. Women, minorities, and persons with disabilities in science and engineering: 2013 (Special Report NSF 13–304). 2013. Retrieved from http://www.nsf.gov/statistics/wmpd/

Ovink SM, Veazey BD. More than “getting us through:” A case study in cultural capital enrichment of underrepresented minority undergraduates. Research in Higher Education. 2011; 52(4):370–394. [PubMed: 24954971]

QSR International Pty Ltd. NVivo qualitative data analysis software (Version 9). 2010.

Poirier, JM.; Tanenbaum, C.; Storey, C.; Kirshstein, R.; Rodriguez, C. The road to the stem professoriate for underrepresented minorities: A review of the literature. 2009. Retrieved from the American Institutes for Research website: http://www.air.org/files/AGEP_Lit_Review_10-26-09.pdf

Polkinghorne DE. Language and meaning: Data collection in qualitative research. Journal of Counseling Psychology. 2005; 50(52):137–145.

Rahm J. Youths' and scientists' authoring of and positioning within science and scientists' work. Cultural Studies of Science Education. 2007; 1(3):517–544.

Rahm, J. Science in the making at the margin: A multisited ethnography of learning and becoming in an after school program, a garden, and a math and science Upward Bound Program. Rotterdam, the Netherlands: Sense Publishers; 2010.

Rhoton LA. Distancing as a gendered barrier: Understanding women scientists' gender practices. Gender & Society. 2011; 25(6):696–716.

Scantlebury, K.; Kahle, JB.; Martin, S., editors. Re-visioning science education from feminist perspectives: Challenges, choices and careers. New York: Sense Publishers; 2010.

Seymour, E.; Hewitt, NM. Talking about leaving: Why undergraduates leave science. Boulder, CO: Westview Press; 1997.

Sfard A, Prusak A. Telling identities: In search of an analytic tool for investigating learning as a culturally shaped activity. Educational Researcher. 2005; 34(4):14–22.

Smith WA, Allen WR, Danley LL. "Assume the position … you fit the description." Psychosocial experiences and racial battle fatigue among African American male college students. American Behavioral Scientist. 2007; 51(4):551–578.

Smith WA, Hung M, Franklin JD. Racial battle fatigue and the MISEducation of Black Men: Racial microaggressions, societal problems, and environmental stress. The Journal of Negro Education. 2011; 80(1):63–82.

Steele CM. A threat in the air: How stereotypes shape intellectual identity and performance. American Psychologist. 1997; 52(6):613–629. [PubMed: 9174398]

Steele, CM. Whistling vivaldi. NewYork, NY: W.W. Norton & Company; 2010.

Steele CM, Aronson JA. Stereotype threat and the intellectual test performance of African Americans. Journal of Personality and Social Psychology. 1995; 69(5):797–811. [PubMed: 7473032]

Syed M, Azmitia M, Cooper CR. Identity and academic success among underrepresented ethnic minorities: An interdisciplinary review and integration. Journal of Social Issues. 2011; 67(3):442–468.

Tan E, Barton AC. From peripheral to central, the story of Melanie's metamorphosis in an urban middle school science class. Science Education. 2008a; 92(4):567–590.

Tan E, Barton AC. Unpacking science for all through the lens of identities-in-practice: The stories of Amelia and Ginny. Cultural Studies of Science Education. 2008b; 3(1):43–71.

Tan E, Barton AC, Kang H, O'Neill T. Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. Journal of Research in Science Teaching. 2013; 50(10):1143–1179.

Tonso K. Student engineers and engineer identity: Campus engineer identities as figured world. Cultural Studies of Science Education. 2006; 1(2):273–307.

Waters MC. Ethnic and racial identities of second-generation black immigrants in New York City. International Migration Review. 1994; 24(4):795–820.

Wenger, E. Communities of practice: Learning, meaning and identity. New York, NY: Cambridge University Press; 1998.

Westring AF, Speck RM, Sammel MD, Scott P, Conant EF, Tuton LU, Grisso JA. Culture matters: The pivotal role of culture for women's careers in academic medicine. Academic Medicine. 2014; 89(4):658–663. [PubMed: 24556773]

Table 1

Race, ethnicity, and gender as reported by study participants

	Women	Men	Total*
African American/Black	17	10	27 (52%)
Hispanic/Latina(o)	13	9	22 (42%)
Native American	1	3	4 (8%)
Asian	2	0	2 (4%)
White Not Hispanic	1	0	1 (2%)

* Five indicated more than one race/ethnicity and were listed under multiple categories.

Table 2

Five Patterns by undergraduate GPA and competitiveness of undergraduate institution

		Institutional Competitiveness (Barron's 2011 Profiles of American Colleges)						
	GPA*	**Most Competitive (*N*=9)**	**Highly Competitive (*N*=8)**	**Very Competitive (*N*=8)**	**Competitive (*N*=8)**	**Less Competitive (*N*=0)**	**Non Competitive (*N*=2)**	**Not Ranked** (*N*=6)**
Credential Seekers (*N*=25)	3.31	4 (16%)	4 (16%)	1 (4%)	11 (44%)	0	1 (4%)	4 (16%)
PI Aspirants (*N*=4)	3.81	2 (50%)	1 (25%)	0	0	0	0	1 (25%)
Path Builders (*N*=15)	3.44	1 (7%)	3 (20%)	1 (7%)	8 (53%)	0	1 (7%)	1 (7%)
Discipline Changers (*N*=5)	3.48	2 (40%)	0	2 (40%)	1 (20%)	0	0	0
Interest Testers (*N*=3)	3.1	0	0	3 (100%)	0	0	0	0

* GPAs were self-reported and provided by 48 of the 52 PREP Scholars.

** Institutions outside of the 50 states are not ranked by Barron's.

J Res Sci Teach. Author manuscript; available in PMC 2015 September 09.

Table 3

Patterns of expected engagement with PREP

	#	What Doing Science Means to Them? (Doing)	Who They Are? (Being)	Who They Want to Become? (Becoming)	Strategy for Engagement With PREP
Focus on External Identity Work					
Credential Seekers: *Right now it's like, do the science, and do it really well, and don't worry about anything else*	25	Hands-on benchwork and problem solving	Lovers of bench science striving to get into graduate school	Graduate students in PhD or MD/PhD programs; less certain about career goals beyond graduate school	Focus on preparation for graduate school through building credentials that will be recognized by graduate programs
PI Aspirants:*I would enjoy having my own lab and creating scientists for tomorrow … love to be at a top university*	4	Designing experiments to extend understandings available in current scientific literature	Scientific thinkers aware of being judged by others due to multiple identity contingencies along their educational and career paths	Graduate students in top PhD programs; careers as PI who will lead research labs and train/ mentor young scientists	Focus on getting high quality research experiences for entrance to top schools where they will quickly be recognized as competent scientific thinkers
Discipline Changers: *[I want to see] how everything I learned can be applied to [science] research*	5	Opportunity to re-deploy skills for discovery and independent thinking in science	Competent academic students who enjoy learning across disciplines	Graduate students in a PhD program; they can see themselves working longer term in an academic setting	Focus on applying their academic and research skills in biomedical research necessary for graduate school
Focus on Internal Identity Work					
Path Builders: *[PREP] will allow me to explore, investigate and definitely see where I want to be*	15	Unsure about how "doing science" connects with who they are and who they want to become	Capable individuals who are deciding if graduate school is the right choice and fit	Undecided about graduate school and their career path	Focus on practicing being a graduate student in PREP to clarify educational and career traiectories
Focus on Both Internal and External Identity Work					
Interest Testers:*I came here [to PREP] to refine my skills and get experience*	3	A new experience in "real labs" that will be different than doing class labs	Individuals with a "second chance" to pursue a new career interest	Graduate students in a PhD program; little knowledge about where the PhD will lead them in their careers	Focus on a "second chance" to get their first exposure and training in research (external/ internal identity work)

Thick borders indicate the pattern focus on an aspect(s) of doing, being and/or becoming.