Unintended Consequences: How Science Professors Discourage Women of Color

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ABSTRACT: This study examined how 16 Black, Latina, and American Indian women science students reacted to their undergraduate science classes. I focused on the meanings they made of the common features of university science documented by Seymour and Hewitt (1997), including large, competitive, fast-paced classes, poor teaching, and an unsupportive culture. I also explored their responses to the values manifested in their science classes and laboratories. The research took place at a large, predominantly White research university; participants were recruited from a science enrichment program for high-achieving students. I interviewed the participants and attended science classes and laboratories with them. I analyzed the data using J. Spradley's semantic structural analysis method (1979, 1980) and validated it through triangulation and member-checking. The women in the study found three features of science classes particularly discouraging: the size of the lecture classes, asking and answering questions in class, and (in some cases) engaging in undergraduate research. They were negatively impacted by two cultural values: a narrow focus on decontextualized science and the construction of science as a gender-, ethnicity- and race-neutral meritocracy. *Sci Ed* **91:**805–821, 2007

INTRODUCTION

In January 2005, Harvard president Lawrence Summers suggested that the underrepresentation of women in the sciences might be due to biology, or, rather, that genetics should

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be explored as one possible explanation. The American Association for the Advancement of Science (AAAS) quickly responded: "We wish to make clear that while historically, gender has predicted *participation* in S&E careers, there is no evidence—nor has there ever been—that it predicts *aptitude* in science" (AAAS, 2005). Educational anthropologists have argued that lower participation despite equal aptitude has been perpetuated because the culture of university science education is better fitted to men than it is to women—and not just any men: White, middle-class men make up the overwhelming majority of practicing scientists. Ironically, while science professors teach students to be objective and logical, and to reason in ways which are neutral as to race, ethnicity, class, gender, and any other personal characteristic, the methods with they teach these skills are often not neutral to those same characteristics.

Women of color fit even less easily than White women into university science classes. In 2001, Black, Latina, and American Indian women made up less than 2% of employed scientists with doctoral degrees (National Science Foundation [NSF], 2005).[1] They constituted only 3.2% of those receiving doctoral degrees in the natural sciences that year, and only 8.3% of students receiving bachelor's degrees, compared with 10.1% of all college graduates. In contrast, 34% of 2001 bachelor's degrees were awarded to White men (who made up 30% of that year's college graduates). White men received 50% of all doctorates in the natural scientists that year and were 62% of all employed scientists with doctoral degrees. A great deal of research has been conducted investigating why women may be underrepresented in science (see Blickenstaff, 2005, for a recent review of this literature). There is a smaller body of research on Black, Latino, and American Indian scientists and science majors (Brown, 2002; Campbell, Denes, & Morrison, 2000; Johnson, 2006; Russell & Atwater, 2005). Still less attention has been paid to the particular situation of Black, Latino, and American Indian women in science; much of what exists focuses on Black women (Ambrose, Dunkle, Lazarus, Nair, & Harkus, 1997; Carlone & Johnson, in press; Chinn, 1999; Clewell & Ginorio, 1996; Johnson, 2001, 2006; Manning, 1989; Patterson, 1989; Sands, 1993). This ethnographic study of 16 women science majors of color explores their unique experiences in science in an attempt to better understand why Black, Latina, and American Indian women study science at lower rates than some other kinds of students.

Historically, women of color faced overt discrimination in science settings. Many biographical accounts, particularly about Black women, attest to this. Difficulties included the dependency on the patronage of older male professors, as experienced by Roger Arliner Young, a Black woman who began teaching zoology at Howard University in 1926 (Manning, 1989). Patterson reported on the "adversities of racism and economic hardship" faced by the 58 Black women to earn natural science doctorates between 1876 and 1969 (Patterson, 1989). These tangible obstacles were accompanied by a sense of difference from both the scientific community and home community (Malcolm, 1989) and the "loneliness, frustration, and self-doubt that often result from discrimination and the relative isolation of women in science and engineering" (Ambrose et al., 1997). Evelynn Hammonds described the changing combinations of poor preparation, racism, and sexism that plagued her through her physics studies in the 1970s, first at Spelman and Morehouse, then Georgia Tech, and finally at MIT (Sands, 1993).

[1] I use the term Black to include both African and African American women; when speaking of a particular woman, I specify whether she is African or African American. I use Latina and American Indian because they were preferred by those of my informants who expressed a preference. I do not indicate the particular tribal affiliations of my American Indian informants in order to protect their identities.

Reports of overt racism and sexism from professors or peers still surface, particularly from students in the physical sciences and engineering (see, for instance, Heyman, Martyna, & Bhatia, 2002). More insidious, however, is the evidence that factors associated with success in college science differ by race, ethnicity, and gender (Ferreira, 2002; Heyman et al., 2002; Huang, Taddese, & Walter, 2000; Leslie, McClure, & Oaxaca, 1998; Lips, 1995; Sax, 1994). Differences have been documented in motivation for studying science, patterns in taking science and mathematics courses, succeeding in college science, and persisting in or aspiring to science careers. These different factors and characteristics for success are causes for concern because while overt discrimination can be recognized and confronted, the phenomenon of differing responses to seemingly identical situations can prevent both professors and students from recognizing inequity. It can obscure the racial, ethnic, or gendered patterns of science persistence, making those patterns appear to be a series of individual decisions. It can also lead women of color to interpret their negative experiences in science as a result of their own inadequacies. Finally, of most concern in this article, it can result in well-intentioned science professors inadvertently discouraging women of color from studying science.

I first present ethnographic work that explores how the culture of science is closely aligned with the cultural skills of White middle class men. Next, I describe the methods I used in this study. I present institutional practices and cultural values that were more discouraging for women of color than for other students. I end with a discussion of the potential for these practices and values to change, in order for science departments to be more accessible to women students of color.

BACKGROUND

In their study of well-prepared science, mathematics, and engineering students, Seymour and Hewitt (1997) found that their informants reported consistent experiences across the seven institutions their informants attended: material that was conceptually difficult; material that students perceived was "made unnecessarily hard so as to perpetuate the image of science as 'hard majors"' (1997, p. 99); competition and the weeding out process; a fast pace and demanding work loads; large classes; an unsupportive culture; poor faculty pedagogy (emphasis on research over teaching, didactic styles, poor class preparation); and the tradition of grading on a bell curve.

Seymour and Hewitt also found that, within their sample, both those students who persisted in science, mathematics, and engineering majors and those who dropped out of school or changed majors reported similar experiences and had similar qualifications and grades. The difference was not one of intellectual acuity or high school preparation, but of an individual's ability to tolerate the difficult aspects of majoring in science.

Survival under these disheartening conditions, Seymour and Hewitt argue, was easier for male students and White students. It required a skill associated with maleness: the ability to rise to a challenge without adult nurture, recognizing that success will eventually lead to acceptance by adult males. Therefore "in treating male and female student alike, faculty are, in effect, treating women in ways that are understood by the men, but not by the women" (1997, p. 260). Survival also required a single-minded focus on individual goals, which presented a conflict to some of the Black, Latino, and American Indian students in their study, who felt communitarian obligations to serve their communities and be a role model.

Other researchers have also illustrated how gender, class, ethnicity, and race may impact students' ability to cope with the institutional practices of science departments. Traweek, in a study of high-energy physicists, was told by one male scientist that

> a successful postdoc had to be rather immature: a mature person would have too much difficulty accepting the training without question and limiting doubts to a prescribed sphere. He felt that this precondition kept most women and minorities from doing well: their social experience had taught them to doubt authority only too thoroughly. (1988, pp. 91–92)

In a study of an undergraduate physics department, Nespor found that whereas "mainstream [middle class] male students were very insular, speaking from the perspective of the program," working class students were more openly critical (1994, p. 46). Treisman, in his work with undergraduate calculus students, found that Chinese American students were able to make use of certain ethnic features (cooperative work) to better tolerate the more unpleasant aspects of undergraduate science work (1992).

These ethnic and gendered responses to the conditions of science are typically invisible to the people they most affect. In their study of workplaces where women engage in science, Eisenhart and Finkel (1998) found that at three of their four sites, both men and women believed that women and men were treated equally. This gender neutrality discourse, however, obscured points of inequality, including male students doing more prestigious tasks in group projects; women's safety concerns being belittled despite past assaults; and long work hours being expected of all scientists despite the particular burdens this placed on women with children.

While previous work has focused on women, people of color, and working class men, little ethnographic work has been done at the intersections of these forces. Because most women in science are White, and at least historically most people of color in science were men, there is a dearth of knowledge about the experiences of women of color. In this study, I focused specifically on the experiences of Black, Latina, and American Indian women. I took the practices reported by Seymour and Hewitt (1997) as a point of departure. What meaning did Black, Latina, and American Indian women make of these common practices? I also investigated the cultural values inherent in university science settings. What are these values, and were any of them more discouraging or difficult to navigate for women of color than for other kinds of students? Finally, were gendered, racial, and ethnic patterns of meaning making obvious to participants in the setting, or were they, as Eisenhart and Finkel found, obscured?

METHODS

I was originally drawn to this study because of my rather unusual experiences as a physics instructor. I am a White woman but my science-teaching experiences have been with students of color. I taught high school physics (including advanced placement physics) for 7 years in a school that was predominantly non-White; I then taught physics enrichment seminars in a university program for high-achieving students of color. Thus, for the past 20 years, I have been actively engaged in increasing the access of women of color to the sciences. I have also been involved in feminist organizing and in increasing educational opportunities for girls and women of color. Because of these experiences, I was dubious about the most frequent explanation for the low numbers of Black, Latina, and American Indian women scientists: lack of interest and lack of adequate schooling to succeed in science. I knew many women students with strong interest in science and with previous schooling that was adequate to complete a science major. Thus, I suspected that at least part of the explanation for the underparticipation of women of color lay with science departments rather than with the students. Based on the accounts of students before I began this study, I expected I would find subtle and even overt discrimination on the part of professors. I took care throughout the study to bracket that expectation, by taking care during my field notes to record observable behaviors of professors while reserving judgment on the meaning of those behaviors.

This study took place at a large, predominantly White research university in the west. Although the university is only 15% non-White, it is considerably more diverse than the city or state in which it is located. Most informants for this study belonged to the enrichment program for high-achieving students of color in the sciences in which I taught physics from 1997 to 2002. The mission of the program was to increase the numbers of scientists of color by recruiting well-prepared students and providing them with additional enrichment beyond that offered in their large introductory science classes.

I invited to participate in the study all the women in the program who were juniors or seniors, who were still taking science classes, but (in order to avoid coercion) had already completed physics or did not plan to take it. Because I taught in this program, these women had already had a chance to evaluate my trustworthiness and establish a rapport with me before agreeing to participate in the study (LeCompte & Shensul, 1999). Nineteen women in the program agreed to be in the study: six Black women (including one African immigrant and five African Americans), seven Latinas (Mexican Americans and southwestern Hispanas), two American Indian women (both raised on or near their home reservation), and four Asian American women of various ethnicities. One of the American Indian women recruited her friend, another American Indian, for a total of 20 informants. For this study, I concentrated on the interviews and experiences of the 16 Black, Latina, and American Indian women. However, all the women in the science enrichment program studied and went to class together, and because of my participant observation in these study sessions and classes, experiences of the Asian American women occasionally found their way into my data set. Some of my informants were no longer majoring in science (for instance, majors in anthropology or psychology who were completing the prerequisites for medical school).

Because of their participation in the program, I was able to establish that all these women had come to college with an interest in majoring in science and with adequate academic preparation to succeed in science. According to data provided to me by the university's department of institutional research, the average predicted first-year grade point average of these women, based on test scores and high school grades, was virtually identical to that of other students with first declared majors in science (2.88 vs. 2.90 on a 4.00 scale) and considerably higher than that of other students of color with first declared major in science (2.75). I inferred that my informants would not experience academic difficulties any worse than those of other science majors.

Twelve of the twenty women agreed to be formally interviewed. Interviews focused on reasons for studying science, experiences studying science and being at college, and the impact of a student's ethnicity on those reasons and experiences. I recorded and transcribed these interviews. Informants were invited to read and respond to transcripts; some did, and I incorporated their changes into the transcripts. I also attended class with the participants, eventually conducting participant observation in eight classes: general chemistry, honors chemistry, physics, introductory environmental biology, introductory molecular biology, organic chemistry, plant anatomy, and human anatomy. For classes with a laboratory component, I observed in both class and laboratory, paying particular attention to the institutional practices and recurrent personal interactions in common across the settings. For introductory classes which all of the women had already completed, I attended with younger women of color in the same academic enrichment program. I collected data from June to December of 1999 and again in March of 2000.

During and after data collection I read and reread field notes and interview transcripts. I used Spradley's method of semantic structure analysis, searching for categories of cultural meanings, or domains (Spradley, 1979, 1980). I organized and collapsed my domains through a taxonomic analysis. Finally, I conducted a componential analysis, comparing and

contrasting the included terms in various domains along potent dimensions of contrast. I first coded by hand and then, once few new codes were being generated and theoretical saturation seemed near (Glaser & Strauss, 1967), completed coding using qualitative analysis software, QSR Nud*ist N4. Based on this coding, I engaged in a thematic analysis, looking in particular for themes that emerged in a variety of different domains (Spradley, 1980). I also generated assertions that I then checked against old and new data, looking in particular for discrepant cases (Erickson, 1986). These assertions and themes became my major findings.

As a White woman studying women of color, I was particularly careful in drawing conclusions. I made all my findings available to informants at every stage of analysis and discussed findings with informants as they emerged during analysis. I member-checked by sending out particularly startling findings (for instance, an assertion, based on several different interviews and participant observation episodes, that some White students seemed to deliberately avoid direct contact with students of color, such as being in laboratory groups, sharing a seat on a bus or a table in the library) to email lists of participants. I also triangulated data from interviews and participant observation, coding those two data pools separately and then seeing which themes and assertions emerged from both. I elicited feedback on my initial findings at focus groups of women who had not been formally interviewed. Informants read and commented on drafts of every written product that emerged from this study and were present at public presentations of this work.

In my analysis, I made distinctions between race, culture, and ethnicity. Experiences related to a student's appearance, her skin tone, and other physical characteristics, I classified as racial. Experiences and interpretations that emerged from the beliefs, values, meanings, and patterns of behavior a woman associated with her ethnicity, I classified as ethnic. Experiences related to the beliefs, values, meanings, and patterns of behavior shared by a bounded, ethnically diverse group, I classified as cultural. In particular, I was interested in the shared culture of science departments and undergraduate science students. For some of the women in this study (some of the Latinas, in particular), ethnicity was more a factor in how they interpreted their experiences in science than race. For other women (some of the African Americans, for instance), both race and ethnicity shaped their interpretations. The culture of science was a factor in the lives of all the women in the study.

RESULTS

I identified three practices of science departments that the women in my study found particularly discouraging: large lecture classes, asking and answering questions in class, and engaging in research as undergraduates (which was an obstacle for some students and a cherished experience for others). I also identified two cultural values that impacted them negatively: a narrow focus on decontextualized science and the construction of science as a gender-, ethnicity- and race-neutral meritocracy. Some of these practices and values result from university economics. Others are artifacts of the ways science has "always" been taught. Some are rooted in the women's racial markedness; others in their ethnic beliefs. Some may seem reasonable, even inevitable, for the effective teaching and practice of science. Nonetheless, they serve to make the playing field less level, even when they sometimes appear to be doing the opposite. I will discuss each of these in detail.

Large Lecture Classes

The first practice I want to examine is the use of large lecture sections to teach introductory science classes. This is done to spread further the limited teaching resources of science departments. At the university where my research was conducted, all the lower level science

classes (with the exception of a few honors sections, open to around 40 students) were taught in huge lecture halls seating several hundred students. I suspect that most professors agree with most students in disliking this; however, the reasons for it—tradition, economies of scale—do not appear on the surface to be intended to impact differentially on different groups of students. Efforts are made on the part of science departments to blunt the overall impact of the enormous lecture sessions. Laboratory and recitation sections, for instance, are much smaller: 15–30 students (however, they are typically taught by graduate students). Despite this, these large classes had a negative impact on Black, Latina, and American Indian women.

Many of the women in this study expressed strong desires to get to know their professors. While they told me, in one part of their interviews, just how important their friends and families were to them, they told me in other parts how those large lecture classes made them feel like the audience at a play; not students in a class. Many of these women came from rural or urban high schools where they were accustomed to a lot of attention and praise. One of them told me that when she graduated from high school, practically her entire reservation packed the auditorium. Many of the women in this study were drawn to science majors as a way to use their talents to help others, particularly in health professions. These women found, in giant lectures, an inconsistency between the ends they foresaw for their studies—individual service to others—and the means they used to reach those ends—consenting to be a face in a crowd. Here is an account from an American Indian woman who grew up in a rural area:

> It was a shock, literally a shock walking into my first class and seeing the teacher down there with the microphone, and seeing him like put up the screen on this huge—I mean, it's bigger than our little theater in our town, I'm just like "oh my god," you know, I mean it was *huge*, and I just couldn't adjust to that. And I couldn't adjust to the fact that I couldn't talk to this teacher, you know, face-to-face. One, I didn't have the time, and then they didn't have the time. Because they were always doing other things, and they had like five hundred students in the first class, so it's just like, they can't take that much time just for you, you know.

Any rural or small-town student may have shared this woman's dismay. However, for some women in this study, their judgments about being in large lecture classes were inextricably tied up with their experiences as women of color. In the next passage, an African American biology major tells a story about how conspicuous and alienated she and her friend Alexis, also African American, felt in class.[2]

> Alexis was in cell biology with us that year. And towards the last exam, Alexis and I went to go talk to the professor who was teaching—he's a really good teacher. He [said] "strange, I don't recognize you guys from my class. Do you sit in the back?" And in retrospect, I was like "Dang!" How could he miss us?? Me, Alexis and Derartu were the only Black people in the whole class! I was like "do you not look up?" I don't know. "Next time we'll sit on your little podium." Even though, you know, maybe he didn't recognize us legitimately, OK? There's like three hundred people to stare at every day for six months or whatever. But still, I still just felt like not involved in the class, you know? Just kind of like a spectator of the class, like I'm not really a part of the learning process, I'm just kind of watching and hopefully getting a good grade.

For this student, her professor's failure to recognize her, rather than minimizing her alienation, increased it: She found doubly discouraging the fact that the professor was so uninvolved with his students that he did not even notice the only Black students.

[2] All names are pseudonyms.

Seymour and Hewitt reported that women science students of all races and ethnicities might experience an uncomfortable transition from high school to the large anonymous science classes available to freshmen. "Most women we encountered had entered college at a peak of self-confidence, based on good high school performances, good or adequate SAT scores and a great deal of encouragement and praise from high school teachers, family and friends" (1997, pp. 255–256). Kubanek and Waller (1995) discuss how girls are given a conflicting message about the study of science. They are told by parents and teachers that "girls can do anything they want" and are encouraged to study science, but are not prepared for the grueling realities of university science classes. The shock of my informants upon leaving the warmth and encouragement of high school for the echoing auditoriums of their first science classes is perhaps a common experience for women science students, amplified in this case by feeling conspicuous as a student of color.

Asking and Answering Questions in Lecture

Over and over, I heard professors punctuate their lectures with "any questions?" Some threw this in abruptly and moved on; others waited for responses. Occasionally I even saw professors pose questions to an auditorium full of students. This habit of inviting student participation seems a laudable attempt to break down the barriers between professor and students. However, it has an unintended consequence. Some kinds of students take advantage of the offer far more often; and, thus, garner for themselves that most precious of commodities: professorial recognition. Apart from office hours and snatched encounters in the hallway, speaking up in class can be the only way for professors to get to know students. Being known to professors is crucial for success in science and is not valuable just for the pleasure of recognition: medical school, graduate school, and science-related jobs all necessitate good letters of reference. However, despite the fact that women were in the majority in most science classrooms, I saw few women answer questions posed by the professors; this was the realm of White male students. White women were much more likely to ask than answer questions, and I never saw a woman of color either ask or answer a question, with the notable exception of Mariah, an Asian American biochemistry major who would shout out questions frequently in her organic chemistry class.

I attribute this silence by women of color to a combination of factors. As women, they have been socialized not to draw attention to themselves. Some, particularly the darker students, reported feeling conspicuous enough already; others felt anomalous. Finally, they almost universally reported a secret fear that they alone—out of 250 students—were confused. Thus, an institutional practice that was ostensibly open to all students, regardless of personal characteristics, actually functioned as a means for more assertive individuals to gain status as science students at the expense of people who, like my informants, were less comfortable having 200 pairs of eyes turned on them.

For example, I observed a male student who asked and answered more questions than anyone else in his honors chemistry class. Near the end of one class, he put his hand in the air and the professor called on him. My field notes read as follows:

> He says to the professor "you may not be able to answer this question because it's really recent stuff," then says something (completely unrelated to the previous lecture) about fossils of "really old land animals," and asks if they would have been here without "an ozone blanket."

In this case, the professor, perhaps irritated by the student's attempted slight of his professional knowledge, soundly rebuked the student, telling him that no DNA-based

animals could have evolved without an oxygenatmosphere, then moved briskly on to the next chapter. Women in my study reported that interactions like this left them unsettled. One African American biology major, Alethia, described feeling "dragged along" in classes where she felt she was one of the nonelect:

> Like the classes were, you know, there's a select few over-achievers who laugh at all the jokes, who ask questions, who ask the "challenge the professor" questions, who probably clone genes at home, I don't know—it's like those select few and the professor, and everybody else is just either asleep or just scribing every word they can get. And that's just what I felt like—the class is just following along, and I'm just sort of like along for the ride.

This nonparticipation by Black, Latina, and American Indian women is easy to interpret as a personal choice. However, I see it as a feature of women's socialization to not draw attention to themselves, a disinclination that is heightened for students who already feel conspicuous. Furthermore, these women may have been wise to avoid asking questions. Seymour and Hewitt found that women science majors sometimes unwittingly reduced their status in the eyes of their male classmates by asking questions in class. "Among young men, doing well by working hard 'counted' for less than doing well because you were inherently 'smart'.... Women could unwittingly break the rules of the male status system by openly discussing their problems, or by asking questions in class" (1997, pp. 250–251). It is through answering, not asking, questions that status is built.

Doing Research

A number of the women in this study worked in research laboratories during their undergraduate years. This is a good way for science students to get to know their professors, learn scientific skills, and become comfortable applying new knowledge. A successful stint as an undergraduate research assistant can have an enormous impact on a student's career. It can help her get good letters of recommendation for graduate or medical school; find employment using the techniques she developed; and taste the joy of research, enhancing and deepening her love for science. Several of my informants had excellent experiences as undergraduate research assistants. Others, however, had bad—even horrific—experiences. One was publicly humiliated by her mentor for her squeamishness at killing mice by hand; her experience was so notorious that I heard a biology professor bring her example up in a meeting several years later.

For an undergraduate woman of color majoring in science, to enter into a research laboratory can be intimidating. She is probably going to be the youngest person in the laboratory, the only minority, and quite possibly the only woman. She will be called on to demonstrate the difficult and abstract information she has been working so hard to learn, and she may be asked to understand and perform tasks that are beyond her preparation. When she sees other, more well-established members of her research laboratory acting out of a belief that science in that setting is paramount—working long, grim hours, paying little attention to others in the laboratory, centering all interactions on the science rather than on individuals—the woman may interpret this as a personal dismissal of her. Several women told me about being placed with researchers to whom they had hoped to turn for career advice or, at the minimum, support for the tasks they were asked to do, only to find that their supervisors were impatient and continually pressed for time. While the researchers might have thought of this as a result of the pressures of research, this is not how my informants interpreted it. Instead, they assumed that the researchers did not like them, possibly because of their ethnicity. Here I will give examples of the power of positive as well as negative experiences. The positive account comes from Nancy, a Latina biology major:

> I like working in the lab because I get to go in there and I get to do all this stuff that you have no idea what you're doing—because you work with things that you can't see, right? And so you do a lot of stuff, and you don't know what you're doing, you don't know if it's going to work or whatever, and then you find out that it *works*, and you're just kind of like "Wow, I did that, and it worked! And now I know that this species is not related to this species...." It was just all this work on trying to find out [using DNA sequencing] if some species were related, and how closely they were related. It was just learning—learning about things that you *can't* see by using things that you *can* see. . . . After I graduate, I want to come back and do a doctorate, probably in genetics, some kind of genetics. And then I want to do research. I just find it fascinating! You're always learning! That's what I like—I like learning. Finding things out.

By contrast, Conchita, a Latina kinesiology major, had a series of less-than-positive experiences in research laboratories.

> I did research my freshmen year in an environmental biology lab and it was sooooo boring to me. I was looking into a microscope 3–4 hours a day looking at fungi. How fun is that? I would go to the professor in charge of the lab with intent of getting course advice or help as far as what else my biology degree would get me. I was expecting a mentor, but that didn't happen. He was too busy for little ol' me. Also one of his grad students accused me of stealing his favorite pen, which ended up being in his lab pocket the whole time and he eventually apologized. That is why I switched my major.
>
> Then I did paid research in a kinesiology lab my second year. That was cool, it was in a human cardiovascular lab. Then another student and I wrote a grant to go to Mexico—that was the best experience ever. And now I am doing my own independent stuff on diabetes in the Latino/Hispanic community (I hate the word Hispanic, but it is used so often in my discipline). Anyway, my mentor is acting like it is such a hassle to work with me, so I don't know or care what is up with him. He just seems so distant. The whole purpose of having a mentor is to have that person MENTOR you. My lab now is highly male dominated. Sometimes I just feel so inferior, not only because I am a female, but because I am an undergraduate. I feel at times I have a double stereotype, a woman of color.

While a bad research experience caused her to leave a major, a good one drew her to her current major. Although she did not find the study of fungi particularly interesting, it was the nature of the personal interactions she had in laboratories to which she chiefly objected. Rather than being bound closer to science, as was Nancy, she lost contact with some of what had originally drawn her to it. In fact, for the students who participated in research as undergraduates, it emerged as the most important factor, either positive or negative, in their pursuing careers in science. The same things they found difficult or attractive about their science majors overall leapt to even greater prominence when they attempted to move in the intimate spaces of scientific research laboratories.

A Narrow Focus on Decontextualized Science

In the science classes I observed, the business of the day, every day, was the intricacies of scientific information. How these details might fit together into a big picture, what one might do with that big picture, and why we might be interested—these were conspicuously absent from science lectures and laboratories. I came to think of this as the assumption that science, as a depersonalized abstraction, should be paramount in all encounters in science settings. While this may seem reasonable from the perspective of science professors—Why else would they have chosen this profession but that they find it fascinating and important?—it ended up discouraging some of the women in my study. Alethia described

her professors as "just pouring information at you in a sort of condescending way, you know, like 'I discovered chromosome 21, so [sniff] who are you?"'

Most of my informants were drawn to science because they saw it as a means to a career in the health professions, or because they were interested in the human body or in living beings. They sometimes took the acontextual way science was taught as a slight to their own interests. A professor may not have intended, by presenting all the minutiae of a particular chemical reaction or a certain organelle, to express disdain for practical applications of science. Yet, this is the message that some of my informants took from classes in which science was presented as paramount to all else.

The science professors I observed tended to center their relationships with students around learning science, rather than around the students. Again, this seems reasonable, even laudable. What better gift, I can imagine them thinking, could they give to their students than a nuanced understanding of science? I was often puzzled, in fact, when I heard my informants disparage particular professors, whom I had seen working very hard to help them learn science. However, I finally realized that in a community where my informants often felt misunderstood, and among women who placed such a high value on relationships, they found this sort of interaction unsatisfying. They did not want to be seen only as learners of science; they wanted to be seen as themselves, unique beings. They did not want their professors to help them out of a general sense of duty, but because they genuinely wished the best for them as individuals. Jaya, a biology major whose parents are from South Asia, told me:

> Some science professors only look to the science aspects, they're only into the intellectual thing. I guess they have to be if they're teaching that, but—I cannot expect them to be open-minded about different things, like your life, when you do get advice from them. Many people are just like "OK, this is the career, this very intellectual, Ph.D., Master's, that kind of thing." I think they should ask the question like "what do you want to do? What makes you happy?"

Jaya's comment is particularly significant because she is currently working toward a Ph.D. in science; it was not that she was uninterested in pursuing science as a career, but that she wanted her professors to see her first as an individual, rather than always viewed through the paramount lenses of science.

One day as I was spending time with some of the women in this study, I had the following exchange with Merima, an African immigrant with a molecular biology major; me; Monica, her Pacific Islander housemate, a premed anthropology major; and Chris, a slightly older Hispanic molecular biology major.

> Merima: Whenever I go talk to molecular biology professors, they make me feel, I don't know—he's a nice teacher, but they make me feel stupid. [Chris & Monica: Uh-huh.] I couldn't even divide ten thousand by ten—I was so nervous. One time he said "did you understand what I just said?" I said "uh-huh," so he said "repeat in your own words," and I couldn't. The hard thing is that for med school, they want you to have two science recommendations. This summer I'm going to work with somebody, but I don't know who else I could get a recommendation from. I'm not just going to go up to somebody, just because I went to their office hours.
> Angela: What are they doing that makes you feel stupid?
> Monica: They put you on the spot.
> Merima: And they're not too friendly. If you don't know the answer, they just wait.
> Chris: It's like they expect you to know the answer. And then, if you don't, they just wait. They don't tell you the answer.

> Merima: And I can tell you a lot of molecular biology students feel like this. It's not just me or Chris.

In this example, the professor's intent focus on science, and on doing what he may have perceived as helping Merima to improve her scientific abilities, blinded him to the fact that Merima had become too flustered to get anything useful out of their encounter. An interaction that could have led to Merima distinguishing herself in the eyes of her professor—she was an unusually able student with exemplary grades—instead confirmed her suspicion of biology professors. She left the professor's office regretting her decision to major in molecular biology.

Fortunately, only certain professors presented themselves and their subject matter in this way; others were careful to contextualize what they were teaching, to welcome students, and to take the time to speak with students respectfully and kindly. Despite some bad experiences, many of my informants managed to find within their departments professors whom they perceived to "really care," and returned to these people over and over. (As a result, particular professors were swamped with students, and thus had less time to engage in their research, which meant that they had less opportunity to build their own reputations and enhance their own status in the culture of science: another unintended consequence.)

Science As a Meritocracy, Neutral to Race, Ethnicity, and Gender

Science is presented within large classes as though an individual's characteristics—including but not limited to race and gender—are irrelevant. What is important is one's scientific acuity. Professors keep personal information about themselves out of class; they focus almost entirely on the subject matter of their lectures. However, this does not mean that science does not have status and hierarchies, or that no personal characteristics are important in science. Within the culture of the science classroom, science is presented as neutral to characteristics based on appearance, upbringing or heritage, and concerned, instead, with talent in science.

This may result from the best of intentions on the part of the professors. However, these intentions often backfire. Some of my informants felt that the silence surrounding race, ethnicity, and gender made people of color start to look like special cases, with White men as the norm. Some of them even questioned whether they should bring up issues of race and ethnicity in science. Alethia told me:

> I was doing my report on Graves' Disease a couple weeks ago. There's different genes related to Graves' Disease, for different ethnicities, and for a long time, they were like "OK, it's just this one gene," but it was only found with white people. And I thought that was really interesting. But then in my presentation, I was like "should I mention the part about African Americans having a different gene?" And women get affected a lot more. And I thought "damn, that's kind of messed up, that I should re-think presenting—it's as normal to the disease as its symptoms, know what I'm saying?" But still, I sort of felt "damn, should I not mention that?"

Alethia later suggested that this might be due to the assumption that if race no longer has much to do with science, talking about it in science would be bringing the nonobjective—the political, the social—into science. While this may be kindly meant, it is not actually working either to diminish the racist beliefs of particular science students or to make science a more comfortable place for students of color.

The assumption that success in science is based on merit conflicts with the racial dynamics that govern how science students interact with one another. Kathy, an American Indian woman, told me:

> In class, if there's one black person and you're the only other colored person, you know that you're going to get to know that person, just by that person being brown, because it's just like—you *always* get called out in class, and you have nobody else to talk to, because they don't know how it is to be brown, and in school, and it *is* totally different. Somebody says that they're white, and "yeah, we experience racial stuff," and it's just like "no you don't, you're white," you know?

Here is an example of what Kathy might call "racial stuff." One day, I walked into a huge lecture hall and saw, down at the front, one of my informants, Zina, a tall, dark-skinned African American woman. She was sitting in an aisle seat; the rest of the row she sat in was empty. I sat through class with her, and at the end of class she told me that whatever row she sits in, she clears it out—no one will sit within five or six seats of her. She explained that she used to sit in the sixth row, all by herself. Recently she had moved up to the fourth row, which had previously had habitual occupants. Now, as I saw for myself when I looked around, the sixth row held a number of students and the fourth row was empty.

I asked other African American students whether this happened to them. One told me an interesting story. She said that her roommate, also African American, said to her one day "let's go down to the library and clear out a table." She was puzzled, but they went together and sat down at a table in the library where several other students were working. Within a few minutes, all of them had left. From then on, my informant told me, she started to notice that whenever she sat down at a table, although no one appeared to notice her, within 15 minutes she was always the only person at the table even if all the other tables were crowded. Judging from these reports, students of color sit together because of affinity, but also because other students avoid sitting with them. Race, ethnicity, and gender may not be permitted to play overt parts in who succeeds in science classes, but they are certainly affecting the experiences of students of color in those classes.

This is also true in laboratory settings. Chris, who is so light skinned that she is sometimes taken for White, told me:

> In a class where there's me and then like one or two other people of color, we all seem to stick together, and somehow we all end up being lab partners, or something like that. Some people may feel like they're being left out, or they can't interact with the white people in the class, or something like that, because it seems like whenever I'm sitting there and it's time to pick your lab partner, whoever else is the minority in the classroom will come and find me. Most of my lab partners have been minorities.

Another informant strongly encouraged me to attend her kinesiology laboratory because this phenomenon was so prevalent. She told me that the four Latinas in her class always ended up working together because no one else would work with them—"too dark," she explained. One day when I went to laboratory with her, there was a shortage of laboratory equipment. The teaching assistant exhorted some of the White students in a larger group to join the Latina group, because they would be able to finish their laboratory sooner. None of them would do so, even though it meant staying later. There was no outright defiance; the White women just silently ignored the teaching assistant's suggestion.

Belief in the meritocracy of science made the way that some laboratories were divided by race and ethnicity seem like a matter of personal choice (which, in a sense, it probably was).

When students felt otherwise—like the student who suggested I attend her kinesiology laboratory—there was no room for these suspicions within the race-neutral culture of science.

The veneer of meritocracy also obscures more innocent patterns along race, ethnicity, and gender lines, patterns that might give professors a way to hold on to their more vulnerable populations. A reluctance to see race and gender in science obscures, for example, common reasons for studying science among certain groups, like prehealth ambitions and interest in using science to make a better world. Both motives suggest minor changes that science professors could make to retain these students and even to convert them, with their fine minds and their commitment and passion, into scientists.

This commitment to the meritocracy of science was certainly not unique to my research site. Traweek found in her study of high-energy physicists that "[m]ost physicists would argue that there are no cultural influences on their activities as scientists" (1988, p. 78). Nespor found that physics professors considered high failure rates "a 'natural' feature of physics programs" (1994, p. 33). The notion of a meritocracy serves to direct attention away from ways in which science could be made more open and equitable.

CONCLUSION

Seymour and Hewitt describe university science education as an "institutionalized national (possibly international) teaching and learning system which has evolved over a long time period as an approved way to induct young men into the adult fraternities of science, mathematics and engineering" (1997, p. 259). I have portrayed some ways in which Black, Latina, and American Indian women have difficulty fitting themselves into that system. Like all science students, they face the rigors of weed-out freshman courses, multiple-choice examinations, and inaccessible professors. However, they face the additional obstacles laid out here: a sense of being conspicuous, a hesitancy to draw attention to themselves, a conflict between the altruistic reasons that have drawn them to the study of science and their professors' valuing science in and of itself, interpretation of professors' narrow focus on science as hostility and lack of caring, and skepticism regarding science's claim to be neutral to race, ethnicity, and gender. Some of these obstacles are racial, rooted in the perceptions by the women in this study of their sense of themselves as conspicuous as women of color; others are ethnic. The obstacles emerge from pragmatic practices (large lecture classes), as well as from the good intentions of professors (asking for questions and taking on undergraduates as researchers). They emerge as well from the frustrations of women of color with two dominant cultural values in science: a narrow, decontextualized construction of science and the belief that science is race, ethnicity, and gender neutral.

Thus, without the need to impute ill will, prejudice, or discrimination, Black, Latina, and American Indian women are being disadvantaged. Success in the science settings I have described demands comfort in drawing attention to oneself in public; knowledge of how to succeed in a predominantly White, male-dominated competitive environment without encouragement; enjoyment of personal interactions centered on information rather than relationships; and obliviousness or callousness toward a lack of acknowledgement of race, ethnicity, and gender. These characteristics do not fit my informants; the students they do fit are likely to be White, male, and middle class.

This match between Whiteness, maleness, and the characteristics needed for success in science was hidden in this setting by the silence about race, ethnicity, and gender, which was in turn hidden by the rhetoric of meritocracy. This silence prevented students and professors from seeing how ethnic, racial, and gendered dynamics helped determine which

students found it easier to thrive. Rather than understanding that institutional practices impacted more on Black, Latina, and American Indian women than on other students, both professors and women of color invoked explanations based on individual characteristics. Science professors attributed the low numbers of Black, Latina, and American Indian women to lack of interest and lack of preparation. The women in this study interpreted their difficulties as resulting from their own lack of ability. They reported that professors did not care about them, only about science. They also reported that professors resented premed students and valued only students who wanted to pursue graduate work in science.

This mutual lack of understanding went further. Many professors, I believe, saw themselves as extending help to all students to the best of their ability. This took the form of posing and asking for questions, even in large lecture halls; giving students opportunities to engage in real scientific research as undergraduates; posing challenging questions to them in office hours; and never considering race, gender, or ethnicity in the attempt to build a new scientific community that leaves behind science's history of exclusion and bias. The women of color in this study interpreted these same actions as rooted in a lack of caring. They felt that professors who asked difficult questions without first establishing a rapport were trying to trap them; mentors who focused their interactions on the processes of science (rather than on the students' needs and questions) were uncaring and possibly racist; and silence about race, gender, and ethnicity reinforced an assumption that these characteristics do not belong in science.

Less change is required to encourage Black, Latina, and American Indian women than I suspect many professors may think: it is not the magnitude of the change, but the direction, which is important. However, though the changes that I recommend below are not difficult to put into practice, they must be preceded by changes in how professors understand the culture of science and how race, ethnicity, and gender interact with that culture, changes that professors may resist.

To start with, however, the good news: not all my informants were put off by the practices I have described; not all of them found these practices and cultural values off-putting. One, for example, was shy and liked the fact that in large lecture classes she was anonymous; she felt more comfortable than in smaller seminar classes, where attention inevitably fell on her. Two American Indian women both majored in science partly because of the presumed absence of the ethnic; they liked how it was based on fact, and sometimes found other classes to be tainted with particular ethnic characteristics that were presented as universal. Nor am I arguing that the methods of scientific reasoning must be changed in order to draw more women of color into the sciences. Keller has argued that processes of objectivity are necessarily male (1985). However, biographical accounts of Black, Latina, and American Indian women scientists (Ambrose et al., 1997; Cobb, 1989; King, 1989; Malcolm, 1989; Patterson, 1989) support my own finding that many women of color are interested in science and accept the power and promise of objective scientific reasoning. This research indicates that women of color could be more encouraged in their pursuit of science majors simply by altering some of the practices of science education.

The first step in making science more encouraging to Black, Latina, and American Indian women is for scientists to recognize that science has a culture, and that certain types of students may find it challenging to understand and navigate this culture. Without this understanding, the difficulties of Black, Latina, and American Indian women seem like personal, individual problems, and therefore indications that particular students are not suited to science. Similarly, if scientists cannot let go of narrow, decontextualized presentations of science, they will have difficulty winning the respect of women who see their interest in science as inextricably united to their altruism. This second value is, I think, easier to transcend than the belief that success in science is determined only by merit.

Science has a rich history of service to humanity. When scientists present their lectures with no allusion to this context, it may not because they are uninterested in it but only because such ties are so obvious to them already. A professor may think, for instance, that it goes without saying that an intimate knowledge of cellular processes is required for cancer research. Invoking the connections between science and service has profound potential for drawing students like those in this study into the pursuit of science. It even has the potential, I believe, to convert some dedicated premed students into research scientists.

If the obstacles presented by these cultural values are overcome, the institutional practices will be much easier to address. Although science professors may be stuck with large lecture sections, small changes in teaching can make these classes more equitable. I observed several strategies for doing this. One practice that is becoming common is to pose multiple-choice questions in lecture classes, asking students to indicate, by holding up a colored note card or pushing a button on an electronic device, which answer they feel is correct. I observed one physics professor using this approach, which let every student participate in class and see that other students also found the subject matter difficult. Another professor encouraged students to answer his questions in chorus, so that every student grew accustomed to speaking during class. Professors can make an effort to establish a rapport with students during office hours or in the context of research; this requires only a few moments to ask about the student's goals and interest in science. Clever scientists can then make explicit ties between students' own interests and the scientist's research. There is evidence that a change toward greater personal warmth in science contexts may already be taking place; as the numbers of women scientists increase, some are intentionally changing the culture of the research laboratories where they work (Ferreira, 2002; Scholer, 1998). If my informants are in any way typical of other women of color in science, then establishing a rapport with students, incorporating discussions of race, ethnicity, and gender into science as appropriate and acknowledging their impact on students' lives, and expressing support for students' altruistic career goals, as well as showing them how the practice of science can explicitly address those goals, all would encourage well-prepared Black, Latina, and American Indian women to persist in science. For these changes to happen, however, scientists must think about their teaching through the eyes of students like the participants in this study, and, perhaps, must let go of long-held assumptions and practices. I hope that some are willing to do so.

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