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Inequalities in Becoming a Scholar: Race, Gender and Student-Advisor Relationships in Doctoral Education

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Abstract

Background: Extensive research has documented the importance of faculty advisors for graduate students' experiences and outcomes. Recent research has begun to provide more nuanced accounts illuminating different dimensions of advisor support as well as attending to inequalities in students' experiences with advisors.

Purpose: We extend the research on graduate student advisor relationships in two important ways. First, building on the concept of social capital, and in particular the work on institutional agents, we illuminate specific benefits associated with student-advisor relationships. Second, we advance prior work on inequality in advisor relationships by examining students' experiences at the intersection of race and gender.

Research Design: To illuminate the nuances of graduate students' experiences with advisors, this study included interviews with 79 students pursuing PhD's in biological sciences. Thematic coding revealed several important dimensions of benefits associated with advisor relationships. Corresponding codes were grouped into three categories, describing three groups of students with notably different experiences with advisors.

Findings: The data revealed three distinct student-advisor relationship profiles which we term scholars, subordinates, and marginals. The three groups had vastly different experiences with access to knowledge and resources, access to networks, and cultivation of independence. Moreover, the distribution across these three groups was highly unequal with unique patterns observed at the intersection of race and gender. White men benefited from both racial and gender privilege and were

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notably overrepresented in the scholars group while White women and racial/ethnic minority (REM) students were more likely to be socialized as subordinates. REM men had the least favorable experiences with the majority of them being in the marginal category, along with a substantial proportion of White and REM women. Notably, even experiences of negative relationships with advisors were gendered and raced: REM men's negative relationships with advisors were characterized by "benign neglect" while women primarily experienced conflictual relationships.

Conclusion and Recommendations: The findings illuminate important consequences of student-advisor relationships and pronounced inequalities in who has access to benefits accrued through those relationships. Creating more equitable experiences will necessitate substantial attention to improving mentoring and eliminating gender and racial/ethnic inequalities in faculty support.

Keywords

doctoral education, inequality, intersectionality, social capital, advisor relationships

A recent National Academies report opens with "Talent is equally distributed across all sociocultural groups; access and opportunity are not (p. ix)." The report goes on to articulate the central role of mentoring in generating more equitable experiences and outcomes, especially in STEM fields, and describes mentoring as a "catalytic factor to unleash individuals' potential for discovery [and] curiosity" (National Academies of Sciences, Engineering, and Medicine, 2019, p. ix). Similarly, extensive literature on doctoral student socialization highlights the importance of faculty advisors (Austin & McDaniels, 2006; Barnes, Williams, & Strassen, 2012; Burt et al., 2019; Gardner, 2010; Millett & Nettles, 2006), who typically serve as students' mentors, especially in the STEM fields, wherein students' time, research opportunities, and funding are often tied to faculty advisor's lab (Maher et al., 2020). While the importance of faculty advisors is broadly appreciated, we know much less about the specific benefits associated with student-advisor relationships. What opportunities and resources are embedded in student-advisor relationships? And do they vary at the intersection of race and gender?

To address these questions, we draw on two theoretical frameworks: social capital and intersectionality. Social capital represents resources and key forms of social support embedded in relationships (Bourdieu, 1986; Lin, 2002; Small, 2009). Stanton-Salazaar's (1997; 2011) work on institutional agents is particularly illuminating as it explicates specific benefits of social capital, such as acess to knowledge, resources, and networks. Second, while a growing body of literature describes challenges experienced by graduate students from marginalized racial/ethnic groups as well as women (e.g., Griffin, 2020; McGee, Griffith, & Houston, 2019; Sallee, 2011, Wofford & Blaney, 2021), few studies compare experiences across groups at the intersection of those identities. As intersectionality scholars have argued, race and gender represent

interconnected dimensions of inequality that are mutually constitutive and thus need to be examined jointly (Chafetz, 1997; Collins, 2009). We begin with a brief overview of the socialization literature, followed by articulating how social capital and intersectionality frameworks can illuminate specific dimensions of inequality as reflected in student-advisor relationships.

Literature Review

Faculty Advisors And Inequitable Experiences In Doctoral Education

Extensive higher education literature has explored how doctoral students become socialized into their disciplines and future professional roles (e.g., Holley, 2009; Gardner, 2010; Weidman, 2010). Much of this work is underpinned by Merton's (1957) conceptualization of socialization as "The process through which [an individual] develops [a] professional self, with its characteristic values, attitudes, knowledge and skills . . . which govern [their] behavior in a wide variety of professional (and extraprofessional) situations" (p. 287; see also Merton, Reader & Kendell,1957). As applied to doctoral training, socialization is more specifically defined as "a process of internalizing the expectations, standards, and norms of a given society, which includes learning the relevant skills, knowledge, habits, attitudes, and values of the group that one is joining" (Austin & McDaniels, 2006: 400). The goal of the socialization process is the development of autonomous disciplinary researchers able to extend their discipline's knowledge base (Lovitts, 2005; Weidman, 2010).

In the socialization process, faculty advisors play a central role in facilitating doctoral students' development as disciplinary researchers (Barnes, Williams, & Strassen, 2012; Nettles & Millett, 2006; Gardner, 2010). In disciplines where laboratory-based research teams are common, such as natural sciences, the socialization process largely occurs within PI's (principal investigator's) labs. In these environments, students' work is closely tied to faculty advisors' research agenda and funding sources (Parry, 2007; Cumming, 2009; Lee, 2012). In addition to demonstrating the importance of advisors in general, recent research has begun to describe different dimensions of advisor support, from instrumental and intellectual to affective (e.g., Barnes, 2010; Burt et al., 2021; Curtin, Malley, & Stewart, 2016; Griffin, Baker, & O'Meara, 2020; Noy & Ray 2012; Rose, 2005).

While faculty advisors are central to doctoral students' experiences, "little is known about the role that race and gender play in influencing how graduate students perceive and interpret their relationships with their advisors" (Noy & Ray, 2012: 876). Emerging literature comparing demographic groups presents troubling patterns. Millett and Nettles (2006) showed that African American graduate students in math and science fields are less likely to report having a mentor than White students. In addition, Noy and Ray (2012) noted that students of color report that their advisors are less respectful than White students. Women, on the other hand, report that their advisors are more supportive. However, women of color have less instrumentally supportive and less

respectful advisors than any other group (White women, White men, or men of color), reflecting their "double disadvantage" in academia (Malcom, Hall & Brown, 1976; Armstrong & Jovanovic, 2015).

Much of the research considering inequality in doctoral students' experiences tends to focus on a specific group historically excluded from academia (e.g., women or students of color). Surveys and interviews of students from marginalized racial/ethnic groups point to feelings of isolation and experiences with discrimination and stereotypes as well as limited access to mentoring and other opportunities (Johnson-Bailey et al., 2009; Gildersleeve, Croom, & Vasquez, 2011; González, 2006; Felder, Stevenson, & Gasman, 2014; Griffin, 2020; McGee, Griffith, & Houston, 2019; McCoy, Luedke, & Winkle-Wagner, 2017; Ramirez, 2017). A number of studies have also considered the role of gender in graduate education (e.g., Gardner, 2008; Sallee, 2011, Wofford & Blaney, 2021). Interviews with female graduate students reveal experiences of discrimination regardless of race, although minority women also report a lack of mentorship and fewer opportunities to coauthor with faculty than White women (Turner & Thompson, 1993). While these studies provide valuable insights into students' experiences, they less often explore the specific benefits that students receive from relationships with advisors or the extent to which those vary at the intersection of race and gender. Theoretical frameworks of social capital and intersectionality provide the conceptual tools for advancing this work.

Theoretical Framework

Social Capital and Intersectionality

Social capital encompasses both access to social ties and the ability to mobilize those ties to gain access to desirable resources (Bourdieu, 1986; Lin, 2002; Small, 2009). While the literature on social capital in education is extensive, we focus in particular on work by Stanton-Salazaar (1997; 2011) who argues that teachers and professors are especially important sources of social capital because of their capacity to act on behalf of students as *institutional agents*. Relationships with institutional agents are a particularly important form of social capital because of their power to transmit (or negotiate the transmission of) "highly valued institutional support," encompassing "resources, opportunities, privileges and services" (Stanton-Salazar 2011: 1075). Thus, institutional agents can provide several important benefits including a) information on how to successfully navigate the institution and facilitate access to valued resources within that institution and b) expansion of students' networks by facilitating introductions and inviting them to participate in different extracurricular activities and organizations. The social capital framework thus draws our attention to the question of whether and how advisors mobilize their own institutional position on graduate students' behalf and what specific benefits accrue as a result.

Most research on institutional agents as a source of social capital has focused on the role of high school teachers and counselors in the transition from high school to

college (e.g., Belasco, 2013; Roderick, Coca & Nagaoaka, 2011; Robinson & Roksa, 2016). Within this context, teachers and counselors provide access to an important resource: information and guidance on navigating the college application process. However, in extending to the PhD context, where students are being prepared to become scholars, and where the educational process is guided by moving from a novice to an independent researcher (Austin & McDaniels, 2006; Gardner, 2010; Weidman, 2010), we also consider the interplay between providing support and fostering independence. Thus, we examine not only what resources graduate students obtain through their relationship with advisors but also consider whether advisors prepare graduate students to access these resources on their own.

Research on institutional agents has demonstrated that while students from marginalized populations are more reliant on institutional agents for support, they are less likely to receive it (e.g., Hardie, 2018; Holland, 2019). This work, similar to that on doctoral education, has rarely attended to the extent to which students' experience with and benefits of interactions with institutional agents vary at the intersection of race and gender. The central position of intersectionality is that social identities "are not separate and additive, but interactive and multiplicative in their effects" (Chafetz, 1997: 115). Black feminist theorists developed intersectionality as a framework in opposition to theoretical approaches that conceptualized race and gender as disconnected systems of inequality (Collins, 1998, 2009; Crenshaw, 1989). From this perspective, experiences are shaped by the specificity of individual's intersecting social positions. Intersectional analyses identify the complex ways in which inequalities associated with multiple identities are mutually constitutive. This work combines social capital and intersectionality as conceptual frameworks to examine how the dynamics of advisor relationships - and the benefits they facilitate access to - vary at the intersection of multiple identities. Attention to intersectionality is especially valuable in the context under study. Although both women and racial/ethnic minority (REM) students are generally underrepresented in STEM fields, women are equitably represented in biological sciences (National Center for Science and Engineering Statistics, 2017). While numerical representation does not imply equity in experiences, it presents a compelling context of investigation.

Data and Methods

This study is part of a larger research project that began by surveying 336 Ph.D. students who entered graduate programs in biology across 53 different institutions in the fall of 2014. More specifically, the study focused on "bench biology" – doctoral programs in fields including microbiology, cellular and molecular biology, genetics, and developmental biology. While focusing on one field inevitably limits generalizability of the study, biology is particularly suitable for examining racial and gender differences in relationships with advisors. Among STEM (science, technology, engineering, and mathematics) fields, biological sciences are most gender-equitable and racially/ethnically diverse in terms of Ph.D. attainment (approximately half female and one

third non-White) (National Center for Science and Engineering Statistics, 2017). At the same time, only approximately a third of tenure-line assistant professorships in the discipline are held by women (Nelson & Brammer, 2010), and racial/ethnic minorities continue to be underrepresented among faculty ranks (Meyers et al., 2018). Moreover, prior research indicates that doctoral students' relationships with faculty vary across fields (Millett & Nettles, 2006; Noy & Ray, 2012). Focusing on one field thus allows us to avoid conflating disciplinary differences in faculty-student relationships with other sources of variation, providing a more compelling analysis of inequalities by race and gender that is not affected by differences in more general disciplinary socialization practices.

The data for this study comes from annual interviews with a subsample of students from the larger survey (survey data is not used). Given the project's emphasis on social inequality, interviews were conducted at institutions that had at least one survey participant from a racial/ethnic minority (REM) group (i.e., those who identified as Black or African American, Latina/o/x, American Indian or Alaska Native, Native Hawaiian or other Pacific Islander). All survey participants who were from REM groups were invited to participate in a follow-up interview. In addition, a random sample of students from other racial/ethnic backgrounds at the same institutions were invited to participate. Analyses presented herein are based on interviews with 79 Ph.D. candidates in biology during the summer following their fourth year in the program.

In biology, graduate students spend the first year rotating across labs and begin their permanent lab placement at the start of the second year (Maher et al., 2019). Thus, by the time of the 4th year interview, students have spent three years working with their advisors, which presents adequate time to build relationships and for the nature of those relationships to be clearly apparent. 88 students were in the 4th year interview sample, and 84 completed the interview, for a 95% response rate. Among interviewees, five participants were dropped because they switched advisors in the third or fourth year of their program providing insufficient data on their relationship with new advisors. In one case, the switch was initiated by the student, in three cases advisors changed institutions without bringing the student along, and one advisor passed away unexpectedly. While the analyses focused on the 4th year, we also consulted 3rd year interviews to corroborate findings and gain greater depth. Thirty percent (N=24) of respondents in the analysis sample reported Black, Latinx or American Indian as a sole or one of their racial/ethnic identities (which we refer to as racial/ethnic minority (REM)), and 69 percent (N=54) as female. More specifically, our analysis is based on 16 REM women, 38 White women, 8 REM men, and 17 White men (see table 1). While we do not have an adequate number of cases to explore variation within the REM category, in the description of participant experiences, we refer to respondents' specific racial/ethnic identification.

Presented analysis includes interviews conducted primarily during the summer of 2018 and lasted approximately an hour. Interviews were semi-structured and wide-ranging, with interviewers asking questions covering the participants' overall

Table 1. Participant Demographics.

	Men	Women
White	17 (22%)	38 (49%)
Racial/ethnic minority (REM)	8 (9%)	16 (21%)

experience in their program and their future career goals. Particularly important to this study were a series of questions asked in year four about participants' relationship with their advisor. Relevant questions included "How would you describe the nature and quality of your relationship with your advisor?"; "In what ways, if any, has your advisor helped you prepare for your chosen career path?"; "If you could change something in your relationship, what would you change?".

Given geographic dispersion of respondents, all interviews were conducted by phone. Interviews were recorded, subsequently transcribed verbatim and entered into the qualitative analysis software Atlas.TI. In total, over 800 single-spaced pages of interviews were analyzed, with interviews averaging 10.5 single-spaced pages. The main limitation of phone interviews is the lack of visual data, which can provide additional insights into participants' tone and emotions. Interviews were transcribed verbatim to maximize data around tone (through indicators such as pauses or "ums") and interviewers wrote memos after each interview including additional context as appropriate.

Interviews were systematically analyzed by the first author using a "flexible coding" process (Deterding and Waters, 2018). In the first round of coding, index codes were applied to the sections of the transcripts related to the research question. For example, the code "q:new projects" was used to identify where the participant was asked whether they felt supported in pursuing new projects. A second reading of the indexed sections of the transcript was used to inductively produce a list of analytic codes. For example, the code "network support" was used when a participant described their advisor introducing them to faculty members outside their institution. After the second round of coding, the first author reviewed and finalized the codebook, writing definitions, omitting duplications, and combining codes as needed. In a third reading, the finalized set of analytic codes were applied to the full sample of interviews, with the focus of this round being the consistent application of codes. The categories of scholars, subordinates and marginals emerged during this third round of coding when the first author observed how particular forms of support (or the lack of support) appeared to be related to each other and to sets of relationship dynamics. After the codebook had been applied to the full set of interviews, the analysis tools of Atlas.TI were used to confirm how forms of support and relationship dynamics were patterned together. For example, the document-code table tool was used to identify how many forms of support each participant received from their advisor, as well as to identify how forms of support clustered together. In a fourth reading of the interviews, each participant was assigned deductively to one of the four groups. Atlas.TI was used to

compare within and across groups to validate the credibility of these assignments. Throughout the analysis process, the first and second author met to discuss analytic memos written by the first author that included both identified patterns and data supporting them. These meetings also allowed the second author to verify credibility of the findings.

Results

Our analysis revealed three student-advisor relationship profiles: scholars, subordinates, and marginals. Each profile is characterized by varying dynamics that shaped what forms of social capital students accessed and revealed pronounced inequalities at the intersection of race and gender (see Table 2). Scholars obtained the greatest advantage through relationships with advisors, accessing resources, information, and networks as well as the additional benefit of cultivated independence. In a relationship characterized by growing equality, scholars described their advisors as fostering their ability to independently solve problems and navigate institutions. The majority of White men fit into the scholar group (59%), while only a small minority of White women (16%) and none of the REM participants experienced this type of a relationship. Rather, about half of REM and White women (56% and 50% respectively) experienced a subordinate relationship with advisors. In these more hierarchical relationships, they accessed limited forms of support and did not receive the benefit of cultivated independence. Around a third of REM and White men (29% for both groups) experienced a subordinate relationship with their advisor as well. Participants in the marginals group had the most negative experience with advisors. They experienced very little access to resources, information, and networks through advisors and at times were actively blocked by advisors from accessing social capital. A majority (71%) of REM men fit into the marginal category, as well as 34% of White women and 44% of REM women. Only 12% of White men fit into this category.

Scholars

Scholars obtain the most valuable form of social capital through their advisors, encompassing extensive access to institutional resources, information, and networks, along with the benefit of what we term *cultivated independence*. Scholars felt their advisors valued their intellectual opinion and took it seriously. As Lana, a White woman, explained, "I have really good relationships with both of my PIs, I think. I think we can talk openly about science, and they both treat me like colleagues." Participants perceived this colleague relationship as developing over their four years with their advisors. When asked how his relationship with his advisor had changed, Brayden, a White man, answered

> At first. . .he was very much a mentor, very much guiding and kind of I would say making sure that I was going on the right path, and would help me when I stumbled and

Table 2. Summary of Key Analytical Categories and Demographic Distributions.

Dimensions of Social Capital	Scholars	Subordinates	Marginals
Knowledge and resources	Access to institutional knowledge and resources through regular interactions with advisor on an ongoing basis; knowledge is often not just about navigating the specific institution but also the next stage of the students' professional life	Access to some institutional knowledge and resources through less frequent interactions with advisor; knowledge is most often about navigating the specific institution	Little to no access to institutional knowledge or resources through relationship with advisor; at times advisor actively withdraws resources
Access to networks	Provides access to networks within and beyond the specific institution	Mostly provides access to networks within the same institution	Little to no access to professional networks; at times advisor actively discourages or impedes students building their professional networks
Cultivated independence	Advisor acts as a cultural guide and networking coach who develops students' ability to independently solve problems, navigate the institution, obtain institutional resources and develop professional networks	Students remain dependent on interactions with advisors to access knowledge, resources and networks	Students must find their own knowledge and networks apart from the advisor
Demographics	59% of White men 16% of White women 0% of REM men 0% of REM women	29% of White men 50% of White women 29% of REM men 56% of REM women	12% of White men 34% of White women 71% of REM men 44% of REM women

> stuff like that. And I would say, now recently, it feels almost like, it feels to me almost like we're peers. Like we're colleagues, and not so much he's a PI and I'm a graduate student.

In the scholars group, participants felt their relationships developed more equality as time went on.

Scholars felt their advisors gave them independence in intellectual decision-making while also providing guidance and advice. As Aaron, a White man, described

> My professor, he has an open-door policy. He's there six days a week. . .he gives you this ultimate freedom, but is totally accessible whenever you need to and it's just been phenomenal. He hasn't controlled the way I've done anything, meaning that he's given me ultimate freedom in the way that I want to tackle the problems, and then just gives advice on what things he thinks should be improved or whatever, and when things don't work, he points me to the places I need to go.

Participants in this group emphasized their freedom to direct their research trajectories, ability to choose what projects they worked on and shape the direction of those projects. Crucially, when they faced problems, they felt their advisor was readily available to provide support. These participants were more likely to describe their projects as self-generated rather than as part of their laboratory's ongoing work.

Participants in the scholars group described receiving a high level of professional development from their advisors. Advisors were likely to know their career aims, to support their pursuit of external opportunities such as conferences and internships, and to facilitate their development of professional networks. Scholars were the most likely to receive professional information on an ongoing basis and to be coached through particular aspects of the academic career trajectory. As Aaron, a White man described:

> He [his advisor] makes recommendations all the time of people that I should be looking at and tells me about their personalities and who they are and the students that come out of their labs and how to be successful. And now that I've had my first interview, he's trying to be more coaching in terms of the things to look out for, the things to watch for, more subtle stuff in terms of the path we take.

This ongoing mentoring also involved giving advisees a behind the scenes look into the advisor's own academic career. Participants described advisors discussing their own career decisions and practices on such topics as the reviewing process, departmental politics, and lab management. Advisors were prepared to share crucial information about the nature of scholarly endeavors and offer ongoing mentoring that provided students with backstage knowledge.

Lastly, scholars were most likely to describe their advisors facilitating collaborations with faculty outside their own institutions and departments. While participants in other groups also described their advisor providing introductions to other scholars, participants in this group were unique in their description of those introductions as

being specifically for the purpose of facilitating collaborations. Samuel, a White man, described his co-advisors: "They have both always been ready to connect me with a collaborator." Being introduced as a potential collaborator both validated participant's sense of themselves as future colleagues with their advisors and other scholars and led to professional collaborations in which participants played a major role. 36% of participants in the scholar category were involved in outside collaborations with senior scholars as compared to 25% of subordinates and only 11% of marginals. Moreover, participants in the scholar category were more likely to describe themselves as intellectual drivers of their collaborations, as opposed to facilitating collaborations for their advisor. Asked what her role was on her outside collaborations, Naomi, a White woman, answered, "I think the role was that I came up with the ideas, it was jointly done, but I largely inspired getting the projects rolling."

Subordinates

Participants in the subordinate group gained access to a more limited form of social capital through their advisors, accessing resources, information, and networks but not receiving the same support in developing an independent intellectual identity, research trajectory, and professional network as those in the scholar group. Subordinates most often described their dissertation projects as an extension of the larger intellectual project of the lab. Judy, a White woman, described the three major parts of her dissertation project:

> After the graduate student who was in charge of the project left, it was pretty much my project to finish up. I had helped out a little bit when I was around. . .the second project, that was related. It was like the project that I got when I started in the lab. It was like my principal project. It had changed hands a few times, but I did the majority of the work on it. . . For the last one that I'm writing now, it was started by a previous graduate student.

Subordinates spoke like workers on a team, emphasizing collaboration.

Participants in the subordinate group experienced intellectual decision-making as negotiated between themselves and their advisors. As Isabella, a White woman explained

> I think that scientifically, in terms of how we approach science and how we conduct things and do projects, we differ a little bit. . . .Personally, I want to try a lot of new things and try some crazy ideas. And he's very much more like, "No, let's just do what we know and what's established in lab." We've been able to compromise in a lot of ways, on those areas, which is nice and I appreciate that he still lets me have a little bit of creative freedom.

Whereas participants in the scholar category felt they had freedom to pursue their own path, for participants in the subordinate group freedom had to be negotiated. As Mila,

a Latina woman, explained about her advisor, "I wasn't comfortable with some of her interpretations with my work and suggestions of how to statistically analyze my work, so I had to be like, well I don't agree with this and I'd like to do it a different way." Subordinate participants often had to advocate for adopting their own approach to experiments and analysis rather than their advisor's. For these participants, new ideas were something they had to advocate for on a continuous basis.

While subordinates perceived professional development from their advisors, this support was often one-time and generalized. Lily, a White woman, describes her advisor's support of her career goals:

> We had a meeting for an individual development plan that she heard from NIH or whatever that they were a good idea and we did something very casual. Like, she didn't have us submit anything. . .we just talked about what I wanted to do and how she could help me do it. . . .I just said, I'm thinking about being a lecturer and she was like okay, how can I help you do that?. . . She kind of gave me specific information where she had contacts where she knew people who had become lecturers for colleges. . .that was the middle of my third year, maybe.

Subordinates often described professional development as delivered in yearly individual development meetings as opposed to on an ongoing basis. They were more likely to be referred to information rather than to receive coaching on specific topics. Subordinates were also more likely to mention and emphasize the technical training they had received as an important part of career development. When asked how her advisor had prepared her for her career path, Violeta, a Latina woman, answered, "She will make sure that you have the experience you need, the techniques that you need, the skills that you need to be successful."

Some subordinates were introduced to outside faculty and involved in collaborations by advisors. However, subordinates were rarely introduced to outside faculty specifically for the purpose of facilitating collaboration. In many cases, introductions took place when outside faculty came to the institution to give a talk. In some cases, introductions were specifically made to assist participants in their work on their advisor's behalf. Harper, a White woman, describes her contact with outside faculty, "There are other PIs that I could email that my boss has introduced me to, so I could email them if I needed help with a protocol that they have down really good." When subordinates were involved in collaborations with outside faculty, they were most often included by their advisor in a supporting role focused on technical aspects of the project. Aiden, a White man, describes an outside collaboration he was involved in:

> It was another project that was conceived by my PI that I'm working with in collaboration with some people in another lab. They developed this technology, so I'm trying to optimize this technology and use it for an application in our lab.

Subordinates were rarely the originators of a collaboration, most often working to support collaborations their advisor had conceived.

While participants in this group were supported in making progress through their program, their development differed significantly from participants in the scholar group. They did not receive the same support in developing an identity as an independent scholar with a self-driven research trajectory. Subordinates did not perceive themselves to be treated as equals or colleagues by their advisors; rather they experienced their relationship with their advisor as hierarchical. Significantly, their professional development was shaped by this relationship; the support they received was less likely to be ongoing and more likely to be focused on skills and training. Thus, their experience was akin more to being a postdoc or a laboratory technician than a principal investigator.

Marginals

While marginals made progress through their program, they did so with a consistent lack of everyday support and professional development from their advisors, who did not act as a source of social capital. Like the subordinate group, these participants often had a hierarchical relationship with their advisor, in which their advisor had expectations for their productivity and in which decision-making was negotiated. However, unlike the previous group, these participants were unlikely to have had conversations with their advisors about their future goals or to have received advice, support in attending conferences or introductions to other faculty. Beyond professional development, these participants often expressed a lack of day-to-day support and guidance and were the most likely to express dissatisfaction with their relationship with their advisor and to have explored switching advisors. While marginals found a way to progress through their programs, the lack of professional development they received often left them less prepared for obtaining positions post-graduation.

Among marginals, there were gendered and raced patterns in why participants were not receiving support from their advisors. The two White men in this category lacked support from their advisors for reasons that diverged from the remaining participants. Both had taken on ambitious, independently conceived projects that had been initially supported by their advisors. When the students were unable to execute their projects as planned, they felt their advisors had withdrawn their support and were now infrequently communicating with them. The REM men, REM women, and White women in this category had not experienced this same level of intellectual independence. Rather, REM men fit into a distant relationship pattern, lacking career support because their communication with advisors was infrequent and impersonalized. The majority of both White and REM women who were not receiving professional development fit into a conflicting relationship pattern. Facing high service responsibilities, these women felt their advisors had withdrawn support for their progress through the program when they failed to meet expectations and challenged the division of labor in their laboratories.

The "Benign Neglect" of Distant Relationships. REM men in the marginal group typically had distant relationships with their advisors, characterized by infrequent and impersonal communication. These participants reported meeting with their advisors

infrequently and inconsistently, often noting that they wished communication with their advisor was better. Nigel, a Black man, felt that his advisor had not taken either a personal or professional interest in him. He only met with his advisor once a month and shared that in his second year, he had been taken off a lab project due to "miscommunication between me and my PI." Currently in his fourth year, he had not been assigned to any more collaborative projects and was only working on his dissertation. REM men in this category often struggled to make and keep appointments with their advisors. Josiah, a Black man, expressed,

> She's been saying for the last three years, like, 'Okay we need to meet every week.' The first week we'll meet at the time. Then the next week, she's like, 'Oh, actually I can't meet this week.' It's week three, I'm ready to see if like, "Okay, are you going to say anything?" Then she doesn't say anything and so we don't meet the third week. Then we just don't ever meet. . . It falls apart. It doesn't necessarily seem like it's a priority.

Experiencing infrequent communication, REM men felt that their advisors were not invested in them.

While they had made progress through their programs, the REM men in this group were underprepared for pursuing a career post-graduation. Asked how his advisor had helped him to prepare for his career path, Connor, a Black, American Indian and White man expressed,

> Looking back on it now, saying it out loud, I'm not sure if it's him [who's helped] or just grad school in general. Like I said, because he's very hands off and aloof sometimes. . .I've been operating on my own, which is kind of why I've been unsuccessful in some avenues of my grad school.

As a consequence of operating on their own, this group had the least defined career pathways and most limited external networks. Two REM participants in this group were graduating within two months of their interview but did not yet have a plan for what they would be doing when they graduated. While they made progress through their programs, REM men's infrequent communications with advisors led them to have little support in finding careers post-graduate school.

The Continuous Struggle of Conflicting Relationships. Women's lack of support took a different form. Women in the marginal group most often failed to receive professional support within deteriorating relationships characterized by a high degree of conflict. For most White and REM women in this category, the origin of the conflict was the high service responsibilities they assumed in their labs. Women frequently took on the role of lab managers, supervised undergraduates and/or spent significant amounts of time on research projects that were not a part of their dissertation work (Miller & Roksa, 2020). Conflict often arose when women challenged the responsibilities they had been assigned and what they saw as their advisor's unrealistic expectations for

progress through the program in light of those obligations. As women challenged their advisor's expectations, their relationships deteriorated, and advisors withdrew their support and denied women opportunities.

All REM women and most White women marginals reported high levels of responsibility in the lab that often slowed down progress on their dissertation. Asked about her progress on her dissertation, Joan, a White woman, explained, "I'm the one who's usually training people so sometimes the progress was slower. . .I've had four undergrads now that I've trained to do different projects in the lab." In addition to high service responsibilities, women often expressed that they were assigned by their advisor to take on projects that were not a part of their dissertation. Reflecting back on her time in the program, Candace, an Asian and Latina woman, explained,

> I would say, like, 75 to 80 percent of my time was spent on finishing this paper for which I was not first author on. And that is what I'd been working on for the past three, four years now. So that was a very frustrating point that I had to talk to my committee members about. That I just felt like I wasn't getting anything for my dissertation done.

Similar to Candace, women often perceived that their advisors failed to acknowledge their contributions to these non-dissertation research projects with authorship positions or otherwise.

A consistent trajectory to conflict arose for REM and White women. Facing high levels of responsibility in their labs, women struggled to prioritize their own dissertation work. When their advisors expressed concerns about their lack of productivity, women advocated for themselves, which led to their continued progress but also a deteriorating relationship. Reflecting on her time in the program, Antonia, a Latina and White woman, described continually being asked to take on new responsibilities by her advisor, with the consequence of spending most of her time on non-dissertation work. When her advisor attempted to add yet another new project to her plate, Antonia pushed back, explaining,

> I said, no, I'm going to work on my thesis project. I really think I should focus on that. I'll spend a little time on this other project you want me to do, but I'm not going to spend 90 percent of my effort on it. He was kind of annoyed - visibly annoyed by that.

However, refusing to take on additional tasks had consequences. As Antonia described, "I think our relationship has soured." Similarly, since her second year, Ava, an American Indian and White woman, had spent over half of her time as lab manager for her advisor's collaboration with an outside company. When her advisor postponed her dissertation defense, expressing a lack of confidence in her progress, Ava took steps to switch advisors. After a lengthy conversation with her initial advisor, she agreed to stay in the lab but expressed their personal relationship had not improved. Ava explained, "I wish I could trust him, and feel like he had my best interests at heart.

Because it makes it very difficult to work together and be completely candid and feel safe when you know that's not the case."

Within deteriorating relationships, women described their advisors pulling back from supporting their progress through the program, being unhelpful in their pursuit of external opportunities, and even withdrawing funding. Cassandra, a Latina woman, had a relationship trajectory with her advisor that exemplified this pattern. Since her first year, Cassandra had served as lab manager, carrying out the majority of service tasks in the lab, including ordering supplies, cleaning, and managing a team of undergraduates. Beginning in her second year, Cassandra's advisor began expressing concerns about her productivity, which Cassandra attributed to her high level of service. Cassandra's advisor responded by withdrawing a portion of her summer funding due to her taking time off for a pre-planned vacation and a family funeral. Cassandra explained,

> I had asked her about vacations. I had planned for a year in advance and she was fine with it. . . Then recently, she came to me and she said she thinks I had too much time off, and she basically docked my pay for the summer.

Cassandra explained that the summer pay in question was from a diversity supplemental grant that she had applied for and that specifically covered four years of Cassandra's pay, including summers. After this event early in her third year, Cassandra described her relationship with her advisor as "pretty much non-existent," explaining, "this all came to a head a couple of weeks ago and she kind of tried to persuade me to just get a Master's Degree and I held my ground and told her that, you know, I know that I can do it if given the chance." Cassandra remained in the program due to the strong support of her other committee members. However, the ongoing conflict with her advisor had hurt her professional development. As their relationship deteriorated, Cassandra's advisor threatened to not write Cassandra letters of recommendation and stopped Cassandra from pursuing a collaboration with an outside faculty member.

Within these deteriorating relationships, women received little to no support in developing an identity as an independent scholar and in developing their professional prospects. Their advisors rarely discussed their post-graduate school trajectories. Antonia had gone to her committee after her advisor's repeated attempts to change her dissertation to pursue a paper project she and her committee felt was too risky. Asked if her advisor was helping her prepare for her future career, she answered

> No. We're supposed to have an annual discussion about what career path but he's never available to meet for that. There's a form we have to fill out and he has to sign, so I email it to him and ask him to review it, give me any comments if he has any but he never does, so he usually just signs it without reading it.

This lack of career support was typical for the women in this category. In their fourth year, none of the women in this category reported their advisor introducing them to other scholars in their networks and only one woman reported her advisor financially

supporting her in attending a conference. Within conflictual relationships, women's resilience and self-advocacy enabled them to persist in their programs. However, they struggled to access consistent and ongoing support for their professional development and preparation for life beyond the PhD.

Discussion

While it is known that advisors play a central role in graduate education (e.g., Austin & McDaniels, 2006; Barnes, Williams, & Strassen, 2012; Burt et al., 2019; Gardner, 2010), we leverage social capital and intersectionality frameworks to illuminate specific benefits of student-advisor relationships and how they vary by race/ethnicity and gender. Building on work by Stanton-Salazar (1997; 2011) on institutional agents, we show that advisors can provide access to knowledge, resources, and networks. Moreover, we illuminate a new dimension of social capital – cultivated independence – which captures how advisors can foster students' ability to independently navigate institutions to gain access to resources and develop professional networks. Crucially, the findings also reveal that students' access to social capital through relationships with advisors varies at the intersection of race/ethnicity and gender, providing novel insights into inequalities in student-advisor relationships.

More specifically, the results indicate that White men, who were overrepresented in the scholar category, accessed institutional knowledge and resources on an ongoing basis through relationships with advisors, as well as receiving assistance from advisors in building professional networks that facilitated collaborations. They also received the benefit of cultivated independence: their advisors acted as a cultural guide and networking coach who developed students' ability to independently solve problems, obtain resources and build professional relationships. The second group – subordinates – experienced an employer-employee dynamic that led to a more limited form of social capital where students accessed some forms of information, resources, and networks but remained dependent on their advisors. Approximately half of White and REM women and some REM men were in the subordinates category. Lastly, a majority of REM men and a substantial proportion of REM and White women were found in the marginals category. They accessed little to no social capital through relationships with advisors; rather these relationships were at times active barriers to gaining institutional resources and building professional networks.

In addition to explicating specific benefits associated with student-advisor relationships, and their variation at the intersection of race/ethnicity and gender, we contribute to the prior literature by illumining how relationships with advisors can act as obstacles to success (see also Burt et al., 2019; Felder & Barker, 2013; Gildersleeve et al., 2011). Students in the marginal category were more likely to have advisors who blocked access to resources, by for example, denying attendance at conferences or trainings and withdrawing funding. Consequently, relationships with advisors reproduced race and gender inequality not just because White men (who were more likely

to be in the scholar category) gained an advantage through relationships, but also because students in the marginal category, who were disproportionately from groups underrepresented in STEM, were actively disadvantaged through their relationships with advisors. Student-advisor relationships are not only sources of social capital, with students accessing more or fewer benefits; advisors can also act as barriers to success. Instead of being institutional agents, they can become institutional inhibitors.

Our findings also illuminate the crucial role of attending to the intersectionality of race/ethnicity and gender when studying relationships with advisors. Both the research on advisor relationships and the social capital framework have rarely attended to the intersection of race and gender when studying relationships with institutional agents (but see Mangino 2009; Hardie 2015). Our findings reveal that different racial/ethnic and gender groups were not only distributed differentially across the three categories, but even the experience of an unsupportive relationship by students in the marginal category was raced and gendered. While White men benefited from the combination of gender and racial privilege, the experiences of the other groups were more complicated. Female graduate students were more heavily burdened by service tasks (Miller & Roksa, 2020), which in some instances led to a highly conflictual relationship with advisors. The highest percentage of both White and REM women were found in the subordinate category, suggesting they found a way to manage high responsibilities and prevent conflict. However, White women were advantaged relative to REM women in one notable respect: almost a quarter of White women were cultivated as scholars by advisors while no REM women experienced this type of a relationship. REM men, on the other hand, did not experience conflict, but also did not receive much support from advisors, experiencing 'benign neglect.' Although prior research described the "double disadvantage" of racial/ethnic minority (REM) women in academia (Malcom, Hall & Brown, 1976; Armstrong & Jovanovic, 2015), our findings indicate that REM men had the least favorable relationships with advisors (i.e., were most likely to be in the marginal category). These findings have notable implications for understanding inequalities in graduate students' experiences as they show that relationships with advisors and access to different forms of social capital do not conform to either gendered-only or raced-only accounts.

Recommendations for Future Research and Practice

While this study offers novel insights into the role of social capital in reproducing race and gender inequality during graduate education, future research is needed to extend the findings and address some of the limitations. This study is based on interviews with students in biological sciences. Focusing on one field is advantageous as it precludes us from confounding disciplinary differences with gender/racial inequalities. However, advisor roles are heightened in the natural sciences since students' time, research opportunities, and funding are often tied to faculty advisor's lab (Maher et al., 2020). Relationships with advisors may be less consequential in other fields, but advisors still play an important role in supporting graduate students across disciplines, so

access to different types of social capital may be generalizable. The extent to which the patterns observed in this study replicate across other fields remains to be examined in future research. In addition, future research would benefit from employing longitudinal methods to study the development of student-advisor relationships over time. Longitudinal data could help to illuminate how the patterns described in this study evolve over time and thus what specific elements may be particularly conducive to producing more positive relationships.

Moreover, relationships with advisors may vary not only based on race/gender of the students but also those of the advisors. Prior literature on this question is mixed (Blake-Beard et al., 2011; National Academics of Sciences, Engineering and Medicine, 2019; Newman 2015). Although we do not have data on racial/ethnic identity of advisors, consideration of advisor's gender does not explain the disparities in advisor relationships between men and women in our study. Similar proportions of women with female and male PI's were in the marginal category (35% vs. 38%, respectively) as well as in the subordinate category (50% and 53%, respectively). The numbers for the scholar category are rather small: only 6 women in the whole sample were in the scholar category and 3 of them had a female PI and 3 had a male PI. To the extent that gender matching is beneficial, it would be expected to be particularly important in the sciences, which have a more limited representation of women. In this sample, only approximately a third of the students had a female faculty advisor. Future research would benefit from exploring how these patterns may vary across fields with different representation of women among faculty.

Future research could further illuminate the dynamics of advisor-student relationships by interviewing advisors. Our study illuminates how advisees perceive their advisors' distribution of resources but leave uncovered advisors' perceptions and decision-making processes when it comes to providing access to information, networks, and opportunities. Incorporating the perspective of advisors could enhance our understanding of the role played by institutional policies and dynamics. Advisors may face various constrains related to funding, their own research area, and departmental cultures that may influence their relationships with students. Moreover, advisors may have differential access to training, especially ones emphasizing equitable practices in mentoring across race/ethnicity and gender. Prior research indicates that faculty may benefit from general training to improve the quality of mentoring (e.g., Pfund et al., 2014) as well as targeted professional development that can heighten their awareness of potential inequities that can manifest through benign neglect or a 'colorblind' approach to mentoring; they should learn strategies to proactively support students from historically excluded groups (Butz et al., 2021; Byars-Winston, et al., 2020).

While faculty training is important, the social capital framework illuminates the importance of context in which institutional agents are embedded (Stanton-Salazar 2011; Holland 2019). Consequently, academic departments and graduate schools could consider concrete steps to enhance working environments for both faculty and graduate students. For instance, they could incentivize the development of graduate students by including mentoring in tenure evaluations or by making additional research

funding available that is tied to developing advisees' independent research ideas. Our findings on the negative impact of advisor-advisee relationships also suggest that departments and graduate schools should consider reducing the stakes of this relationship for their graduate students. Students in the marginal category would have benefited from professional development opportunities that are broadly available and thus not so dependent on advisors. Departments could consider making more funding available to graduate students outside of the lab structure and encouraging the development of mentoring relationships with multiple faculty members – not just primary advisors (National Academies of Sciences, Engineering, and Medicine, 2019).

Over the past three years, the Covid19 pandemic has resulted in additional uncertainty and precarity for graduate students as well as faculty. If our study had been conducted during the pandemic, the inequalities in students' experiences may have been even wider. Students in the scholars category would likely be in the best position to weather the crisis due to their cultivated independence while students in the marginal category may have experienced even greater distance and conflict in relationships with advisors due to the personal and professional challenges experienced during the pandemic. In this moment, improving mentoring and eliminating gender and racial/ethnic inequalities in faculty support is more crucial than ever for creating a more just and equitable experience for graduate students.

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