Identifying Inequities in Mentorship and Addressing Student Needs

Status Report from DEI Small Grants Program

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Summary of motivation and methods

Most graduate students view the relationship with their faculty advisor as the single most important factor in their graduate experience (1). Faculty support is instrumental in applying for funding, accessing departmental resources, planning research projects, and obtaining letters of recommendation. While the importance of this relationship is universal, students vary widely in their specific needs and expectations. **Mentorship is a key priority for efforts to improve diversity in science** both because poor or inequitable mentorship can exacerbate existing disparities (2-3) and because effective mentorship can help students overcome them (4-5).

Results of graduate student surveys in the Integrative Biology department implicate student-faculty relationships as a key area of need for building an inclusive community. In a 2020 department-wide survey, the majority of students (81.1%) had experienced discrimination or microaggressions perpetrated by faculty. Few indicated that they were willing to share experiences of discrimination with their advisor (5.9%), compared to sharing with their peers (86.9%), or keeping the experience to themselves (36.9%). These reports indicate the need for better mentoring in IB, yet past surveys have not identified mentoring practices that predict student outcomes, or asked how these needs vary across student backgrounds.

In response to a funding call for projects that would improve diversity and equity in the IB department, we conducted a research study on effective mentorship. In consultation with the UCB Division of Equity and Inclusion and the UCB Committee for the Protection of Human Subjects, we developed a 71-question survey that asked respondents to evaluate their advisors, research groups, and departments on a five-point scale and solicited quantitative and qualitative measures of their productivity and well-being. We administered the survey to current graduate students in the Integrative Biology, Plant and Microbial Biology, Molecular and Cell Biology, and Environmental Science, Policy, and Management departments. Our sample size of 129 respondents (~24% response rate) generally reflected the underlying gender and racial proportions of the graduate programs that we surveyed (Tables 1-3).

Experiences within and across departments

IB (and in some cases ESPM) students consistently rated their experiences lower than students in PMB and MCB. This was true for a range of aspects including the culture of research groups, inclusion and belonging in the department as a whole, and self-assessed career preparedness after graduate school (Figure 1). Within the IB department, students associated with museums had different experiences than students in unaffiliated labs. Museum-affiliated labs were smaller, yet students in museums reported a stronger sense of belonging and better peer support, potentially reflecting a sense of inter-lab community in museums. However, students in museum-affiliated labs also reported being more negatively impacted by lab and/or travel restrictions during COVID-19 (Figure 2). This might reflect the difficulty of social distancing in large, shared spaces or the possibility that museum-affiliated

researchers are more involved in fieldwork, live animal care, or other activities impacted by COVID-19 restrictions.

Experiences of students from varying backgrounds

Several groups of students were significant less likely than their counterparts to experience supportive relationships with their advisors or inclusive research environments: i) **Female students**, ii) **Students who started their graduate degree after the age of 30**, and iii) **Non-traditional students**, e.g. parents or caregivers, first-generation students, students with a disability, or veterans (these categories were all grouped together to protect anonymity of respondents) (Figures 3-5). These discrepancies may reflect direct effects (e.g. unconscious bias towards female students, social activities that conflict with childcare duties) and/or indirect effects (e.g. students that start their degree later in life are often from less privileged backgrounds and have faced other barriers to success). Indeed, the effects of multiple marginalized identities on student experiences were compounded (Figure 6).

It is important to mention that the three categories identified above were among the most statistically tractable demographic groups in our survey. For example, when selecting their gender identity, most respondents fell into one of two groups, and sample sizes for those groups were close to evenly distributed. In contrast, the racial identity question had many categories, students often selected multiple identities, and subgroups had uneven distributions, making it potentially difficult to analyze responses in ways that meaningfully reflected their lived experiences. Additionally, some students elected not to provide any specific identification factors in certain demographic questions (i.e., they elected “Prefer not to disclose” as a response). These students consistently reported less support from their advisors, labs, and departments than students who answered the questions, suggesting that the unhappiest graduate students did not even trust the survey (Figures 7-8). True effects of race, ethnicity, or sexual orientation may therefore be masked due to these data collection and analysis challenges.

Representation by advisors

The vast majority (86.5%) of respondents reported that they identified with a demographic that had been historically underrepresented in the biological sciences (such as gender, race, first-generation, etc.). We asked these respondents whether their advisor was also a member of that demographic group. **Students who felt represented by their advisors were happier and more productive by nearly every metric we measured:** they felt their advisors were more empathetic, that they understood what their advisors expected of them, that they belonged in their graduate program, and that they were prepared for an academic or non-academic career after graduate school. They published more frequently and presented at more conferences, felt that their research was more meaningful, and were more likely to report that they were on track to graduate within normative time (Figure 9).

While there is some interconnectedness that is difficult to untangle – for example, an unhappy student may have a detached relationship with their advisor and conclude that they do not share any marginalized identities with their advisor (because they do not know) – this set of results is largely unlikely to be explained by reverse causality or a hidden third variable. **This is by no means a call for the IB department to accept only students who reflect the faculty’s**

backgrounds, but rather, we view these results as an important tie-in to understanding community building needs in academic science.

Advising practices

The overall quality of the student-advisor relationship consistently ranked among the top predictors of research progress, self-assessed career preparedness, well-being, and sense of belonging in science. To identify specific aspects of effective advisors, we asked students to evaluate their advisor on a range of qualities, some relating to empathy and kindness and others relating to structure, feedback, and helpfulness. Students who rated their advisors highly on empathy and kindness felt their labs were more inclusive, more collaborative, and had better conflict resolution. They felt more satisfied overall with their mentorship than students who rated their advisors low on kindness. Students who rated their advisors highly on structure and feedback published more often, felt their research was more meaningful, and felt more prepared for academic and non-academic careers (Figure 10). Of note, while kindness and feedback had explanatory value for different outcome variables, there was no trade-off between the two. In fact, most students who thought their advisors were honest and helpful also found them to be kind, and vice versa.

In both the empathy/kindness and structure/feedback evaluations, a large proportion of variance was attributable to a single variable – the availability of advisors to their students. Students who frequently met with their advisors reported a better understanding of what was expected of them, a higher sense of inclusion and belonging, and better preparedness for their post-graduate career. Meeting frequency was closely related to how meetings were scheduled: students saw their advisors more often and were happier with their meeting schedule if they could drop into their advisor's office briefly or had regular standing meetings (Figures 11-12). This distinction was especially important for female graduate students, who reported the least satisfaction with as-needed meetings. Female students who could only see their advisors on an as-needed basis also rated their labs low on equity, perhaps suggesting that advisors with this system were not equally available to all lab members (Figure 13). Lastly, group size influenced meeting frequency, with graduate students in the largest and smallest labs seeing the least of their advisors (Figure 14). In large labs, faculty likely face constraints on their time and/or delegate supervision to postdocs and senior graduate students. At the other end of the spectrum, we hypothesized that labs headed by faculty who invest less in mentoring might face challenges with recruitment and/or retention, eventually resulting in fewer members. In support of this possibility, students who were dissatisfied with their advisors came on average from smaller labs.

Informal mentorship

We asked respondents about the quality and quantity of their connections outside of their formal advising relationship. In general, students reported high levels of support from peers or near-peers on issues pertaining to research practices, scientific careers, and personal issues such as discrimination or work-life balance. Far fewer reported that they had received such advice from faculty, especially on personal issues. Be it advice from faculty members, collaborations with other labs, or support from other graduate students in the program, **informal mentorship reduced or closed gaps in outcomes between students with good or poor**

relationships with their formal dissertation advisors (Figure 15). This suggests a path forward for community building, particularly for students who are dissatisfied with their advising experience.

Outlook

Generally, Integrative Biology students report worse experiences relative to UC Berkeley peer programs, specifically as compared to Plant and Microbial Biology, Molecular and Cellular Biology. We found that students from underrepresented backgrounds reported worse graduate experiences across many aspects surveyed including with their advisor, research group and community. Our results emphasize the importance of mentoring and mentoring traits to student satisfaction and graduate student outcomes.

The survey results highlight several potential opportunities for improving graduate experiences overall, but especially for those students that are reporting the lowest satisfaction and worst outcomes. Our study provides evidence of improved mentoring, research and career preparedness as well as improved sentiments of increased inclusion and equity associated with regularly scheduled meetings. Several findings from this study also point to the importance of community engagement and informal mentoring channels for graduate student experiences and outcomes. Facilitating connections for secondary mentors (both faculty and near-peer and especially in the smallest and largest lab groups), by improving collaborative environments, community inclusion and engagement may narrow the gap for those graduate students that are less satisfied with their primary mentoring experience. Finally, our results provide support for the importance of a continued emphasis on diversity hires. Graduate students represented by their primary advisor have improved outcomes and experiences in lab culture, inclusion, research progress and career preparedness.

References

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Table 1. Sample sizes and response rates by department. Enrollment is based on Spring 2022 data from the UC Berkeley Office of Planning and Analysis.

Department	Our study	UCB enrollment	Estimated response rate
Integrative Biology (IB)	42	114	36.8%
Molecular and Cell Biology (MCB)	41	215	19.1%
Plant and Microbial Biology (PMB)	24	92	26.1%
Environmental Science, Policy, and Management (ESPM)	22	117	18.8%

Table 2. Sample sizes and response rates by gender. Enrollment is based on Spring 2022 data from the UC Berkeley Office of Planning and Analysis.

Gender identity (this study)	Composition of this study	Gender identity (UCB categories)	Composition of participating departments
Female	56.6%	Female	58.0%
Male	27.1%	Male	41.6%
Non-binary	5.4%	Non-binary	0.4%
Female, Non-binary	3.1%		
Male, Non-binary	0.8%		
NA / prefer not to disclose	5.4%		

Table 3. Sample sizes and response rates by race. Enrollment is based on Spring 2022 data from the UC Berkeley Office of Planning and Analysis.

Racial identity (this study)	Composition of this study	Racial identity (UCB categories)	Composition of participating departments
White/Caucasian	50.4%	White/Other	54.0%
East Asian/South Asian/Pacific Islander	16.3%	Asian	16.3%
Black	4.7%	International	10.4%
Native/Indigenous	0.8%	Underrepresented Minority	20.0%
Multiracial	10.1%		
NA / prefer not to disclose	9.5%		

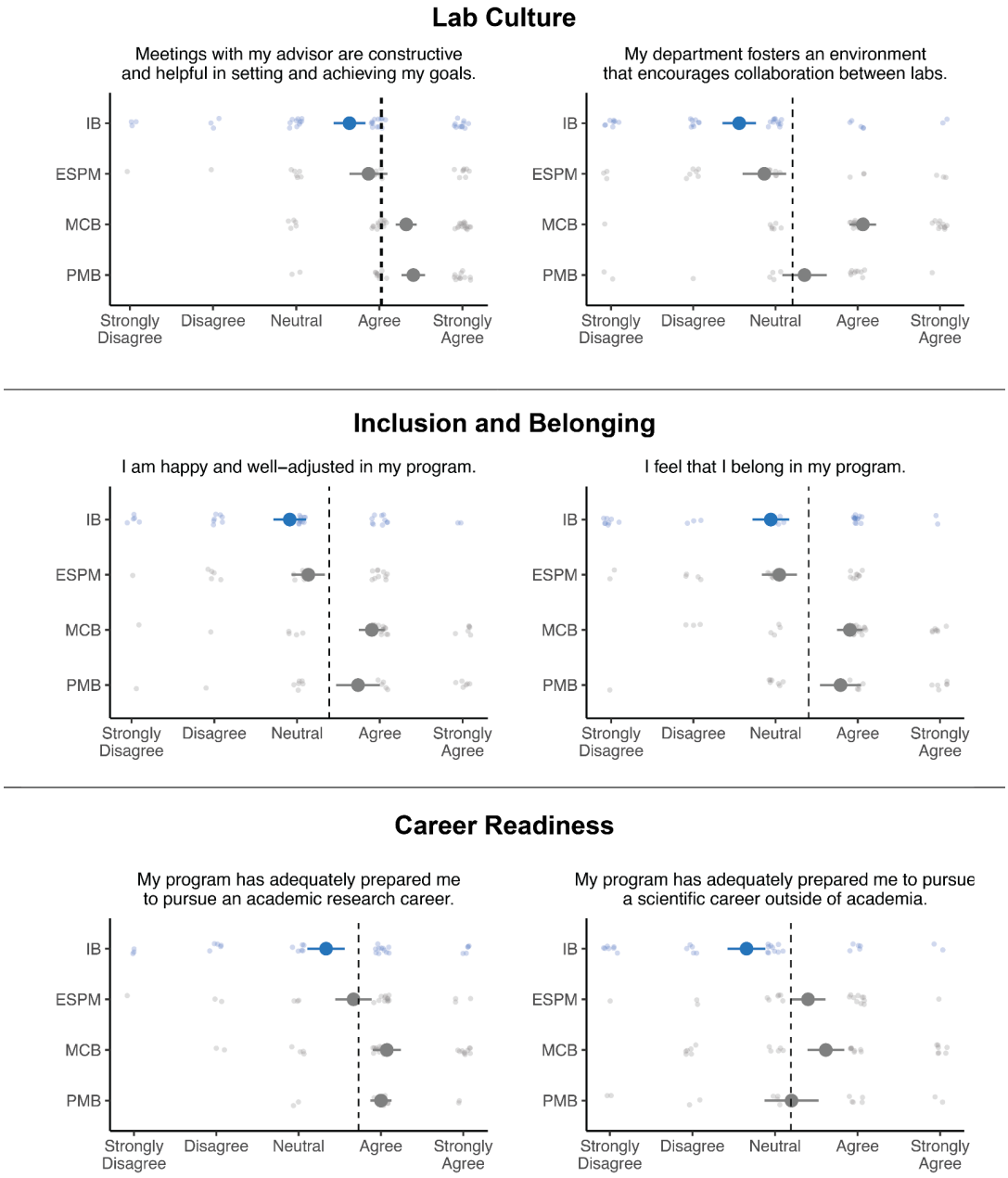

Figure 1. Variation in graduate experiences across departments. IB graduate students (blue) rated their graduate experiences lower than students in other departments (grey), including in the quality of meetings with their advisors (Tukey HSD post-hoc test, IB-PMB p = 0.019, IB-MCB p = 0.018), collaborations among labs (IB-MCB p<0.001), happiness (IB-PMB p = 0.032, IB-MCB p = 0.001), sense of belonging (IB-PMB p = 0.038, IB-MCB p = 0.003), readiness for an academic career (IB-MCB p = 0.031), and readiness for a non-academic career (IB-MCB p = 0.014). Summary bars represent means and standard errors by department, while dashed lines represent the mean response of all students in the study.

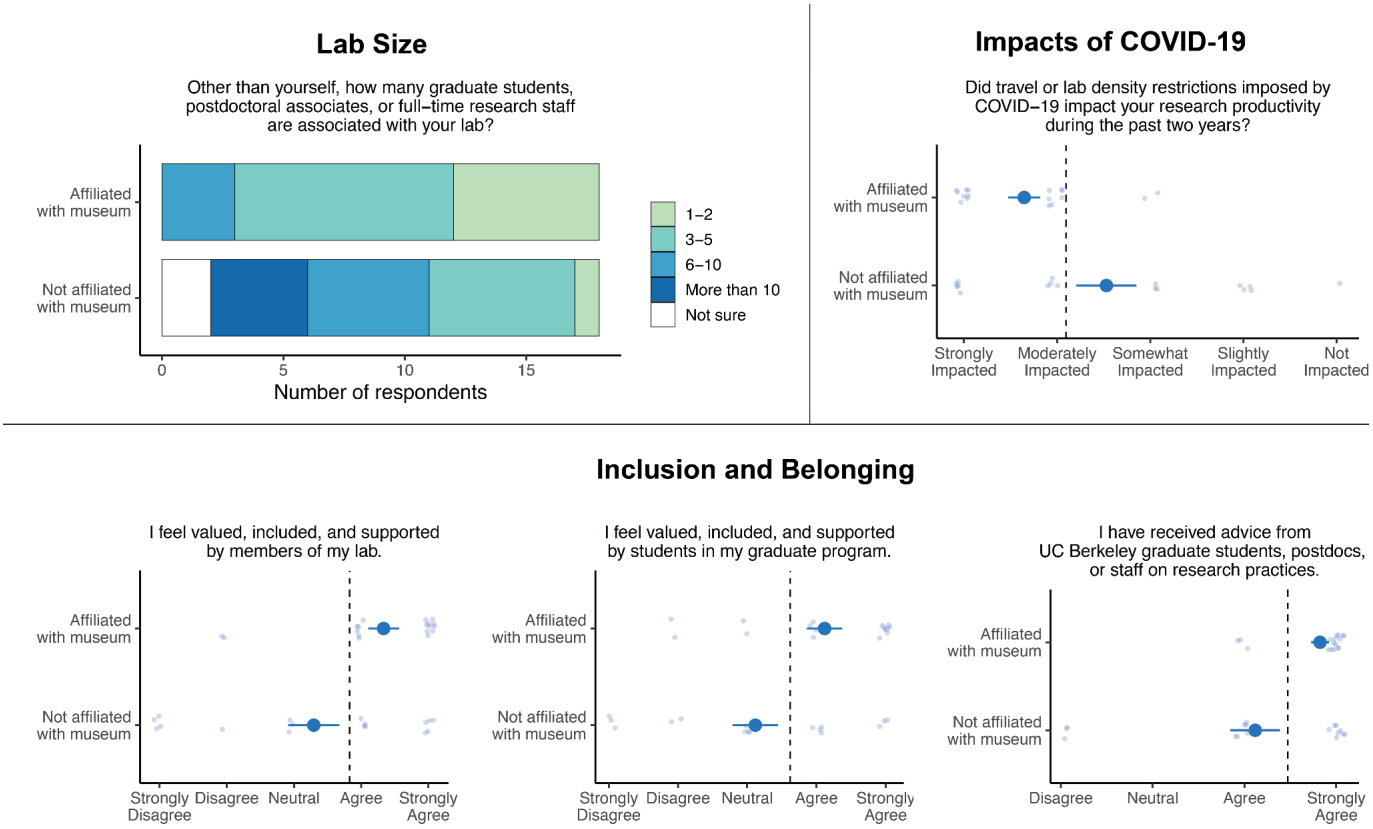

Figure 2. Variation in experiences of IB students by museum affiliation. IB labs affiliated with museums were smaller than labs not affiliated with museums (chi-squared test, X^2 = 10.671, p = 0.031). IB students affiliated with museums reported more inclusive and supportive experiences within their labs (generalized linear mixed model, ß = 1.194, p = 0.005) and graduate program (ß = 1.079, p = 0.005) and were more likely to report support from peers on research (ß = 0.712, p = 0.014). IB students affiliated with museums reported more hardship due to COVID-19 (ß = 1.002, p = 0.005).

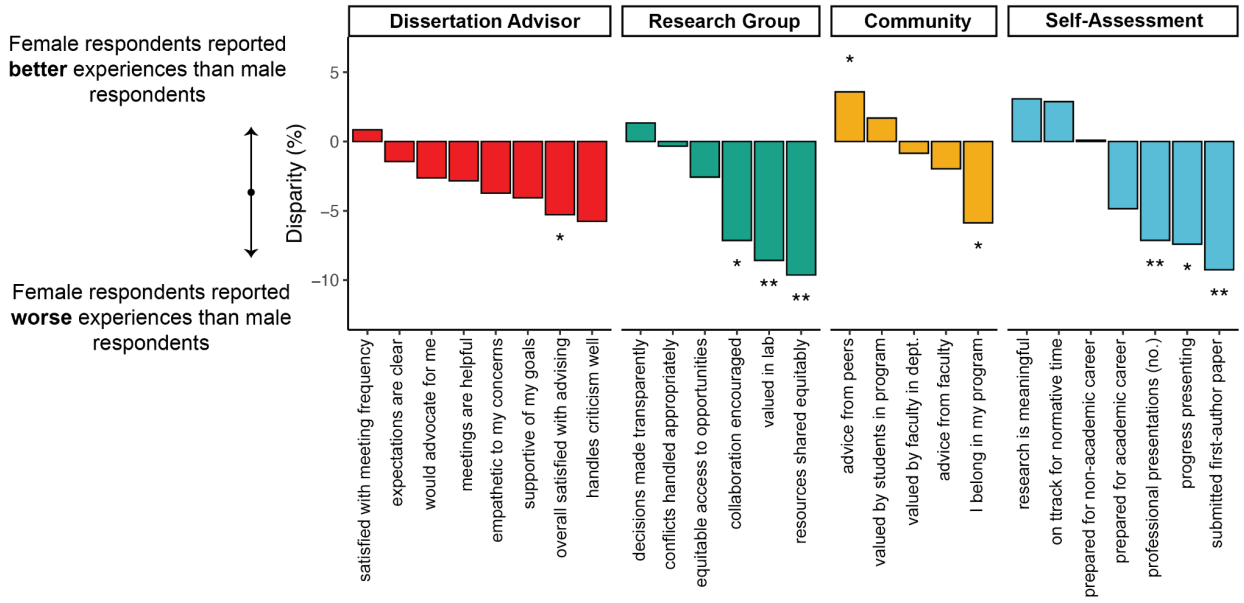

Figure 3. Disparities in experiences of male and female graduate students. We aimed to provide an overall view of differences among demographic groups. For each item with a quantitative response, the average difference between the response of each female graduate student and each male graduate student was computed. This distribution was compared to zero (the null hypothesis, that no differences exist across genders) using a one-sample t-test with degrees of freedom equal to the number of female graduate students minus one. The resulting plot shows areas of significant disparity between male and female graduate students, but also categories in which many differences are non-significant but trend in the same direction (e.g. experiences with dissertation advisor), patterns which may also be informative.

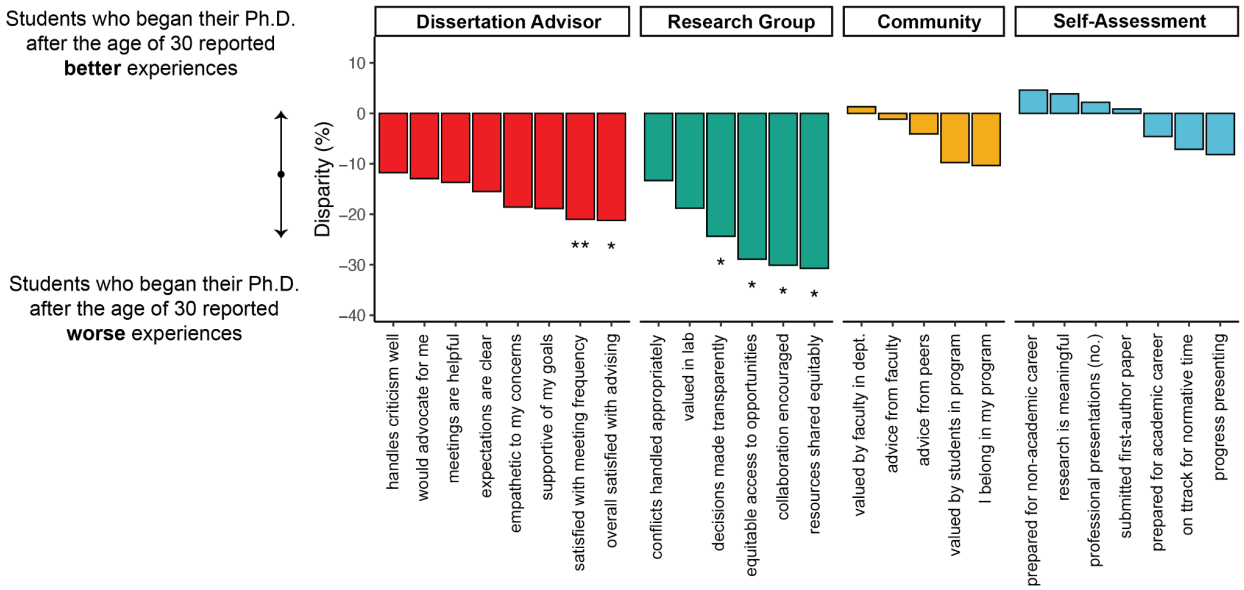

Figure 4. Disparities in experiences of younger and older graduate students. For each item with a quantitative response, the average difference between the response of each graduate student who started their Ph.D. after age 30 and each graduate student who started their Ph.D. before age 30 was computed. This distribution was compared to zero (the null hypothesis, that no differences exist) using a one-sample t-test with degrees of freedom equal to the number of older graduate students minus one.

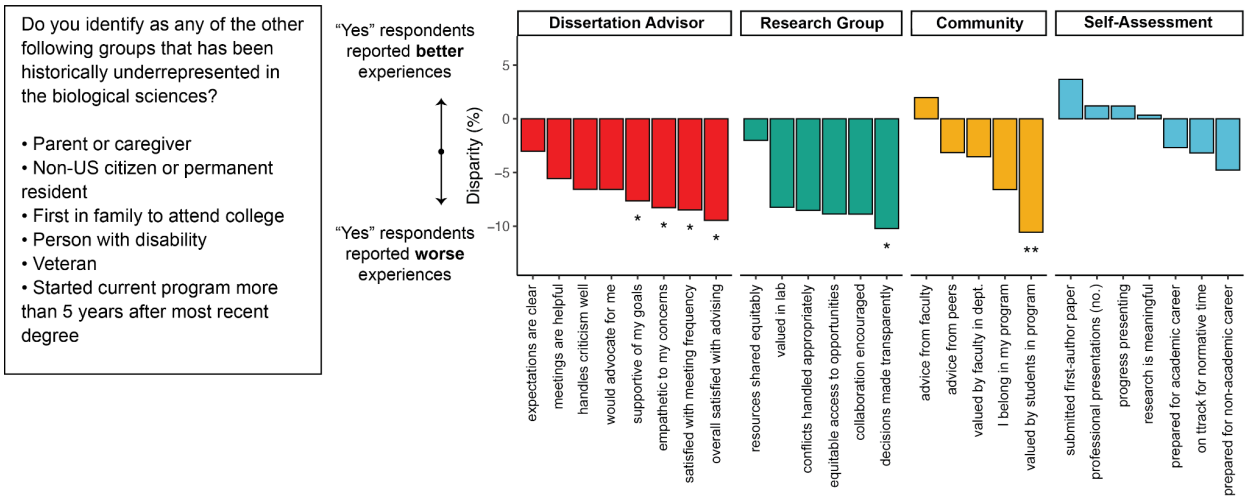

Figure 5. Disparities in experiences of traditional and non-traditional graduate students. For each item with a quantitative response, the average difference between the response of each non-traditional graduate student (i.e. those that answered "Yes" to the question in the left panel) and each traditional graduate student was computed. This distribution was compared to zero (the null hypothesis, that no differences exist) using a one-sample t-test with degrees of freedom equal to the number of non-traditional graduate students minus one.

1. **Gender** (female, non-binary, unlisted gender minority)
2. **Estimated age at start of program** (over 30)
3. **Representation by advisor** (no, not sure)
4. **Other underrepresented group** (parent or caregiver, non-US citizen, first-gen, disability, veteran, started program more than 5 years after most recent degree)
5. **Other identity not covered by survey** (elaborate in comments)

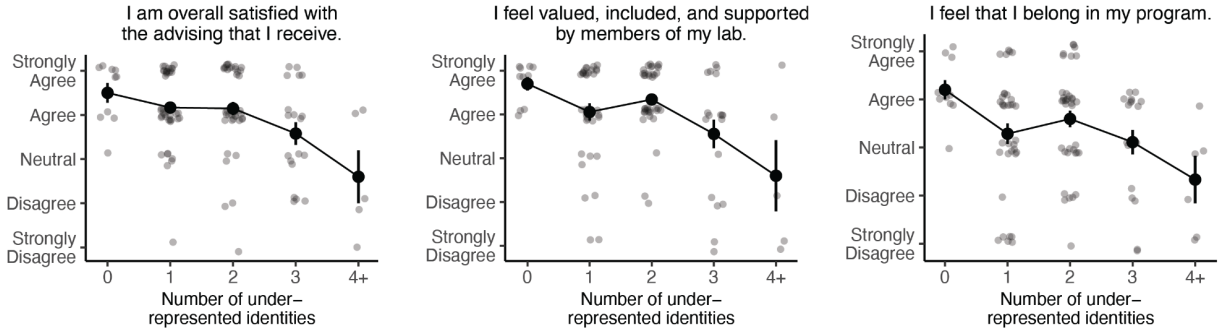

Figure 6. Interactions between underrepresented identities. Respondents who identified as multiple of the underrepresented identities listed in the top panel reported progressively lower satisfaction with their advisors (GLM, ß = -0.335, $p < 0.001$), inclusion and support within their labs (ß = -0.341, $p = 0.001$), and sense of belonging (ß = -0.221, $p = 0.037$) than respondents who identified as fewer underrepresented identities.

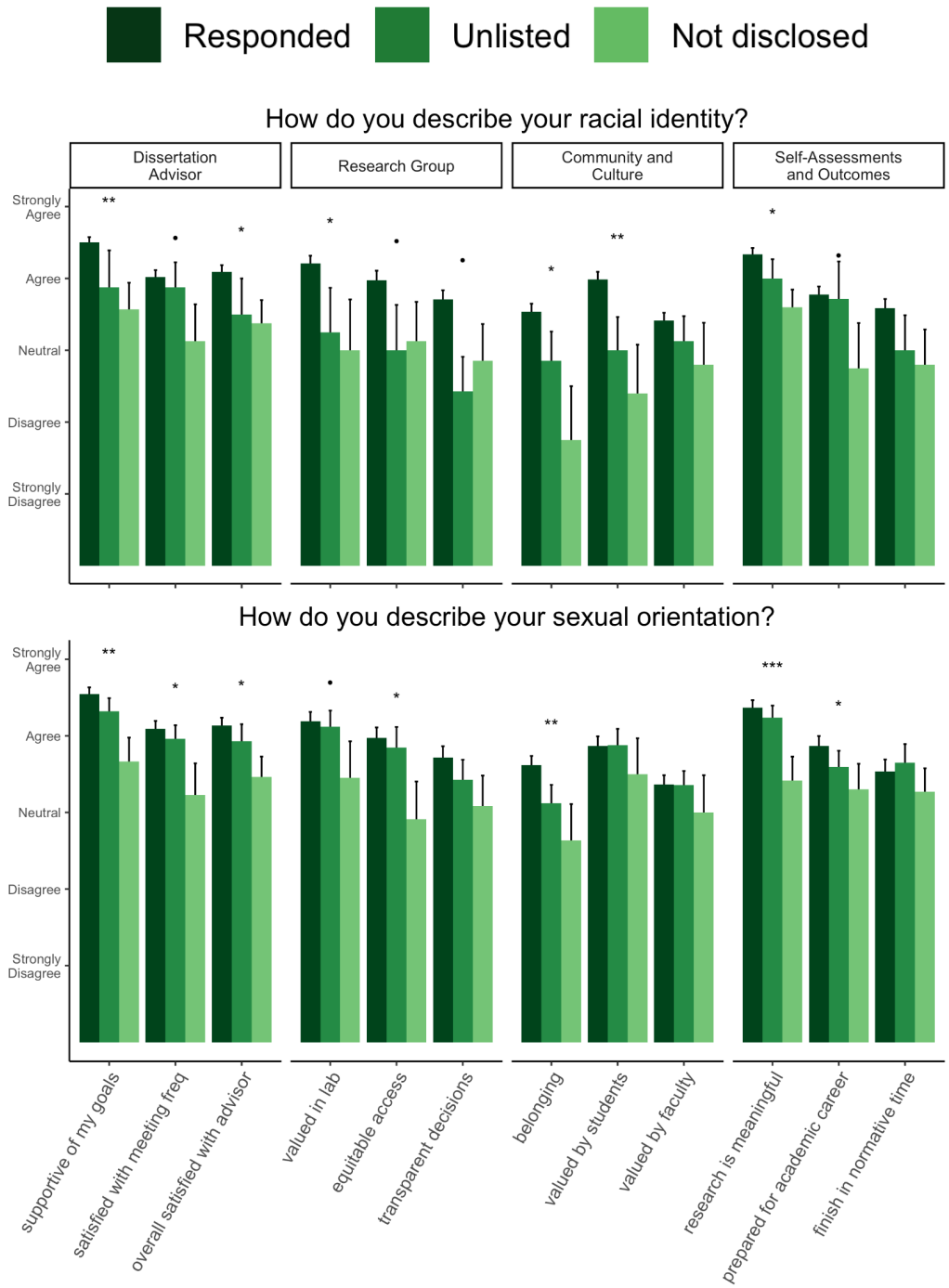

Figure 7. Response type effects from race and sexual orientation demographic questions. Respondents who chose either '*Unlisted*' or '*Prefer not to disclose*' in response to questions about their race (top) and sexual orientation (bottom) generally reported worse experiences with their dissertation advisor, their research group, the larger community, rated their research as less meaningful and rated themselves as less prepared for an academic career and less likely to finish in normative time. Statistical significance (cumulative link mixed models) are based on comparisons of "*Responded*" vs. "*Not disclosed*" groups.

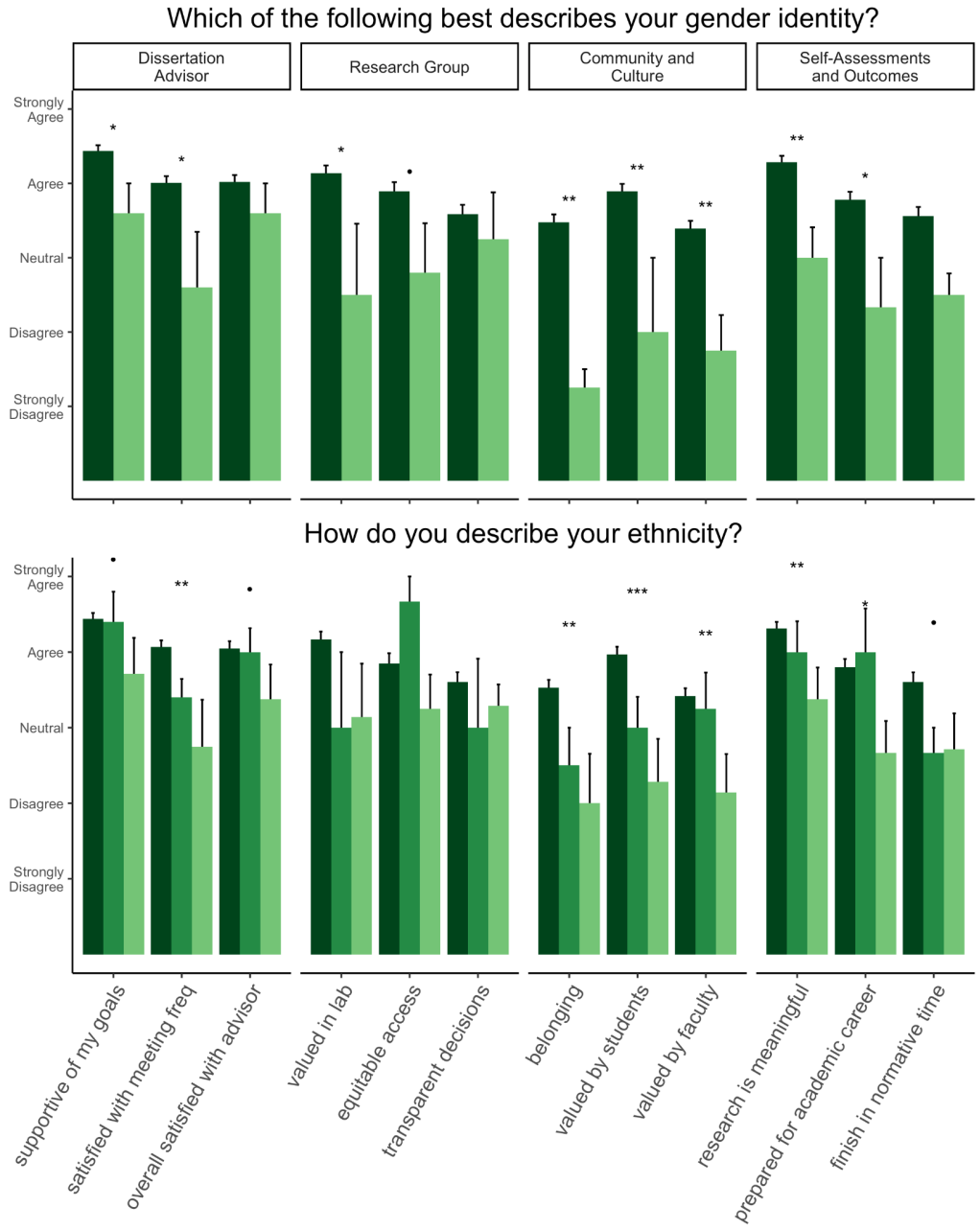

Figure 8. Response type effects from gender and ethnicity demographic questions. Respondents who chose either '*Unlisted*' or '*Prefer not to disclose*' in response to questions about their gender (top) and ethnicity (bottom) generally reported worse experiences with their dissertation advisor, their research group, the larger community, and additionally rated themselves as less prepared for an academic career, less likely to finish in normative time and rated their research as less meaningful. For gender identity, '*Unlisted gender minority*' and '*Prefer not to disclose*' responses are pooled (light green) because only one respondent chose '*Prefer not to disclose*'. Statistical significance (cumulative link mixed models) are based on comparisons of "*Responded*" vs. "*Not disclosed*" groups.

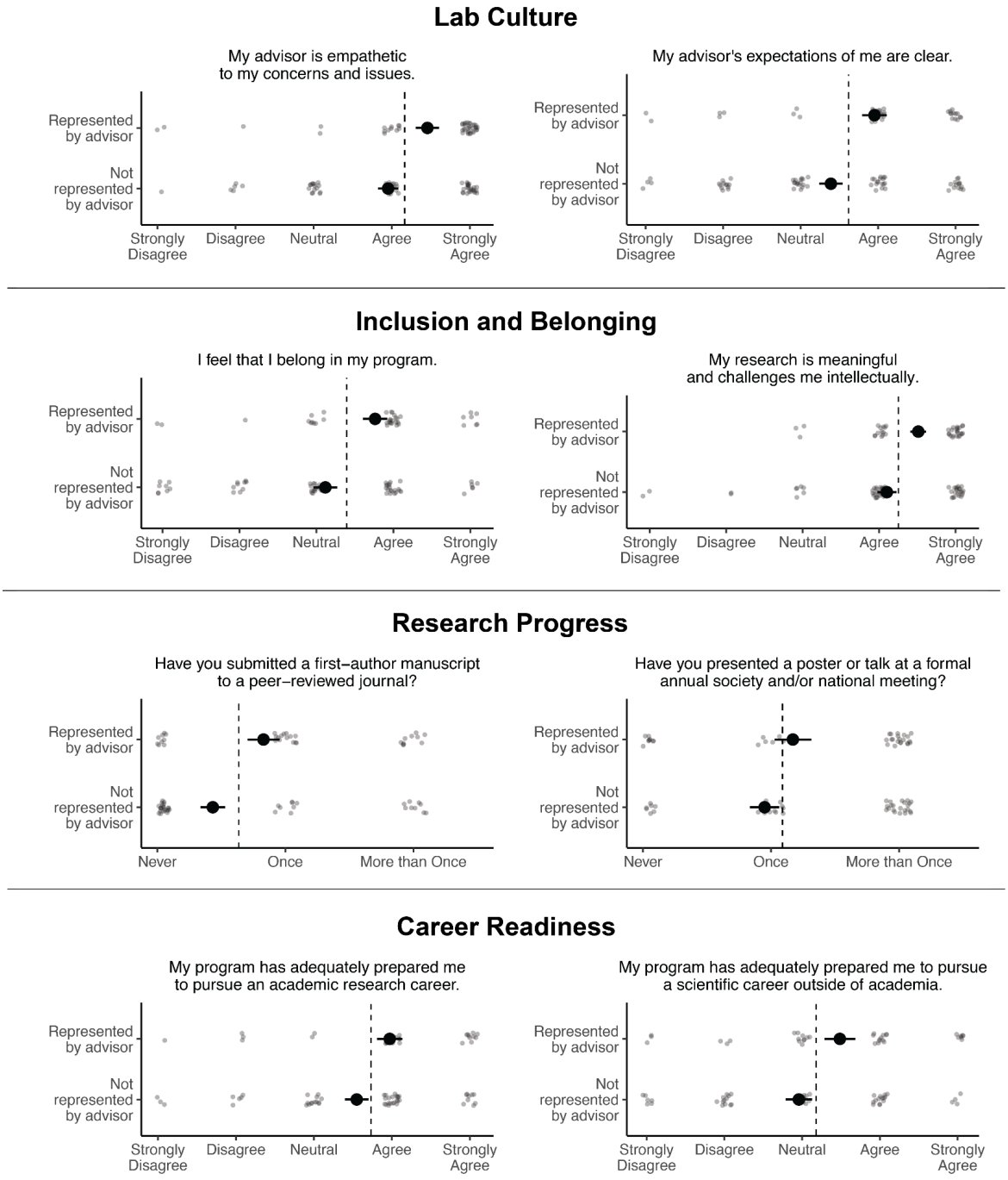

Figure 9. Effects of demographic representation by advisor. Respondents from historically underrepresented groups who felt their advisor shared one or more marginalized identities with them rated their advisors as more empathetic (GLM, ß = 0.503, p = 0.011) and felt they better understood what was expected of them (ß = 0.548, p = 0.015). They had a stronger sense of belonging (ß = 0.538, p = 0.017) and a stronger sense that their research was meaningful (ß = 0.410, p = 0.019). Controlling for their stage in the Ph.D. program, students who felt represented by their advisor were more likely to have submitted a first-author manuscript on their dissertation research (ß = 0.424, p = 0.006) and presented at a conference (ß = 0.324, p = 0.040) and felt more prepared for academic (ß = 0.475, p = 0.038) and non-academic (ß = 0.667, p = 0.007) careers.

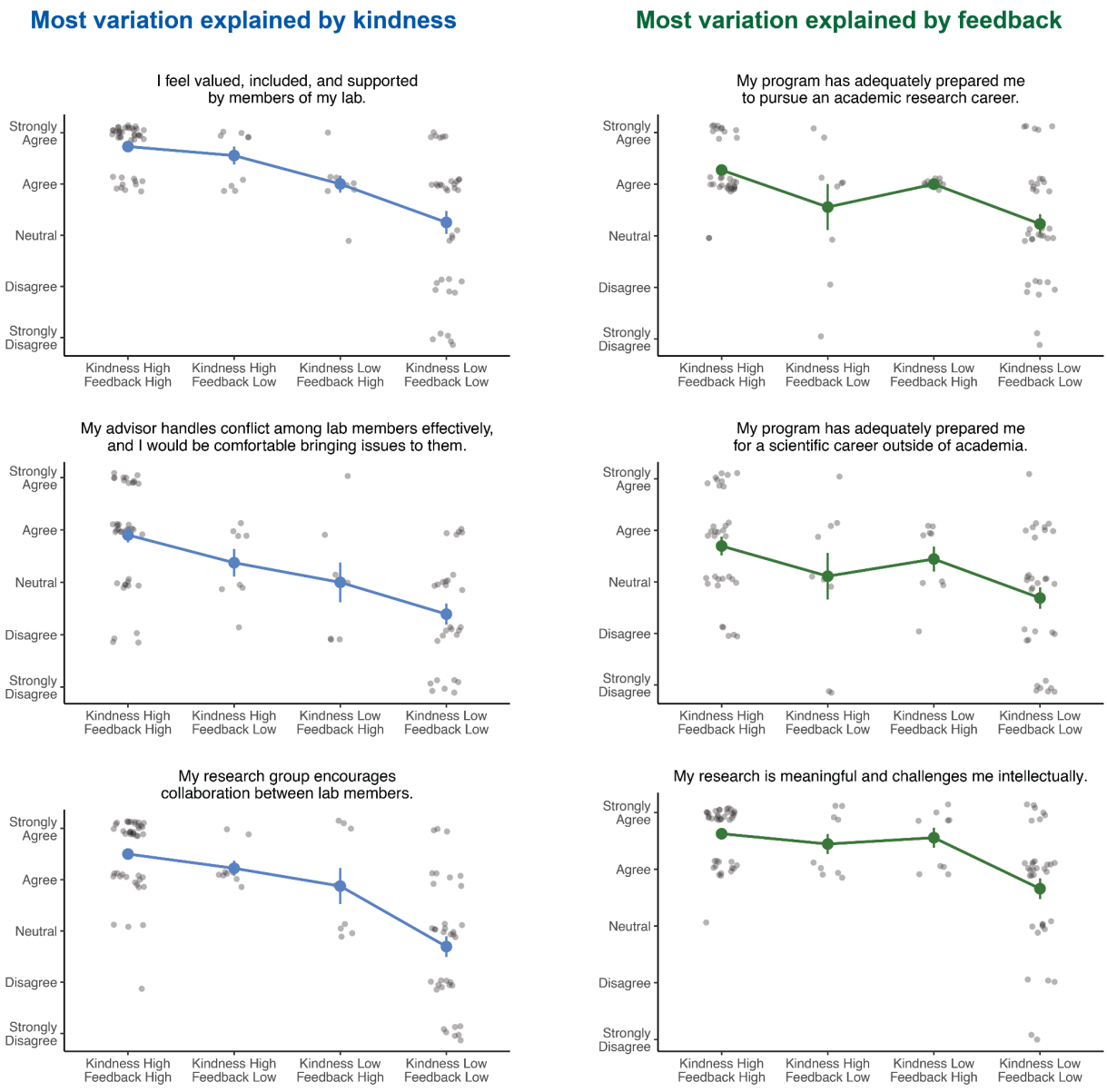

Figure 10. Contributions of kindness and structure in advising styles to graduate student success and belonging. An overall measure of advisor kindness was calculated based on total scores on the following items: "*My advisor is supportive of my goals and ambitions*"; "*My advisor is empathetic to my concerns and issues*"; "*My advisor would advocate for me if needed*". Similarly, an overall measure of structure and feedback was calculated based on total scores on the following items: "*My advisor's expectations of me are clear*"; "*My advisor is transparent with our lab*"; "*My meetings are constructive and helpful in setting and achieving my goals*". Both variables often contributed to explain student outcomes, but those relating to interpersonal dynamics tended to relate more strongly to advisor kindness, such as inclusion and support within the lab (GLM, kindness ß = 1.015 and $p < 0.001$, feedback n.s.), conflict resolution in the lab (kindness ß = 1.113 and $p < 0.001$, feedback ß = 0.653 and $p = 0.010$), and collaboration among lab members (kindness ß = 0.968 and $p < 0.001$, feedback ß = 0.601 and $p = 0.024$). Outcomes related to research progress and preparation tended to relate more to advisor structure and feedback, such as readiness for an academic career (kindness n.s., feedback ß = 0.668 and $p = 0.004$), readiness for a non-academic career (kindness n.s., feedback ß = 0.579 and $p = 0.040$), and feeling that their research is meaningful (kindness ß = 0.432 and $p = 0.039$, feedback ß = 0.521 and $p = 0.013$).

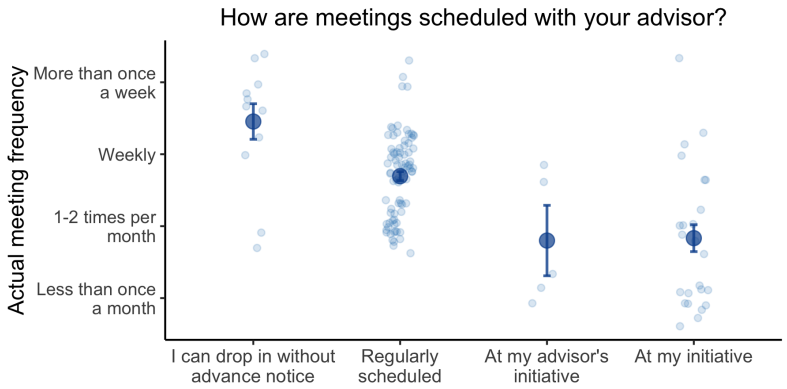

Figure 11. Effect of how meetings are scheduled on meeting frequency. The way meetings are scheduled between graduate students and their advisors significantly affects meeting frequency (ANOVA, *F*-value = 18.09, p < 0.0001). Here, regularly scheduled meetings are the combined values of the responses of "*Regularly scheduled, biweekly or less*" and "*Regularly scheduled, weekly or more.*" Graduate students that can drop-in without advance notice or that have regularly scheduled meetings meet, on average, more than two times per month. Students that meet at either their own or their advisor's initiative meet, on average, 1-2 times per month.

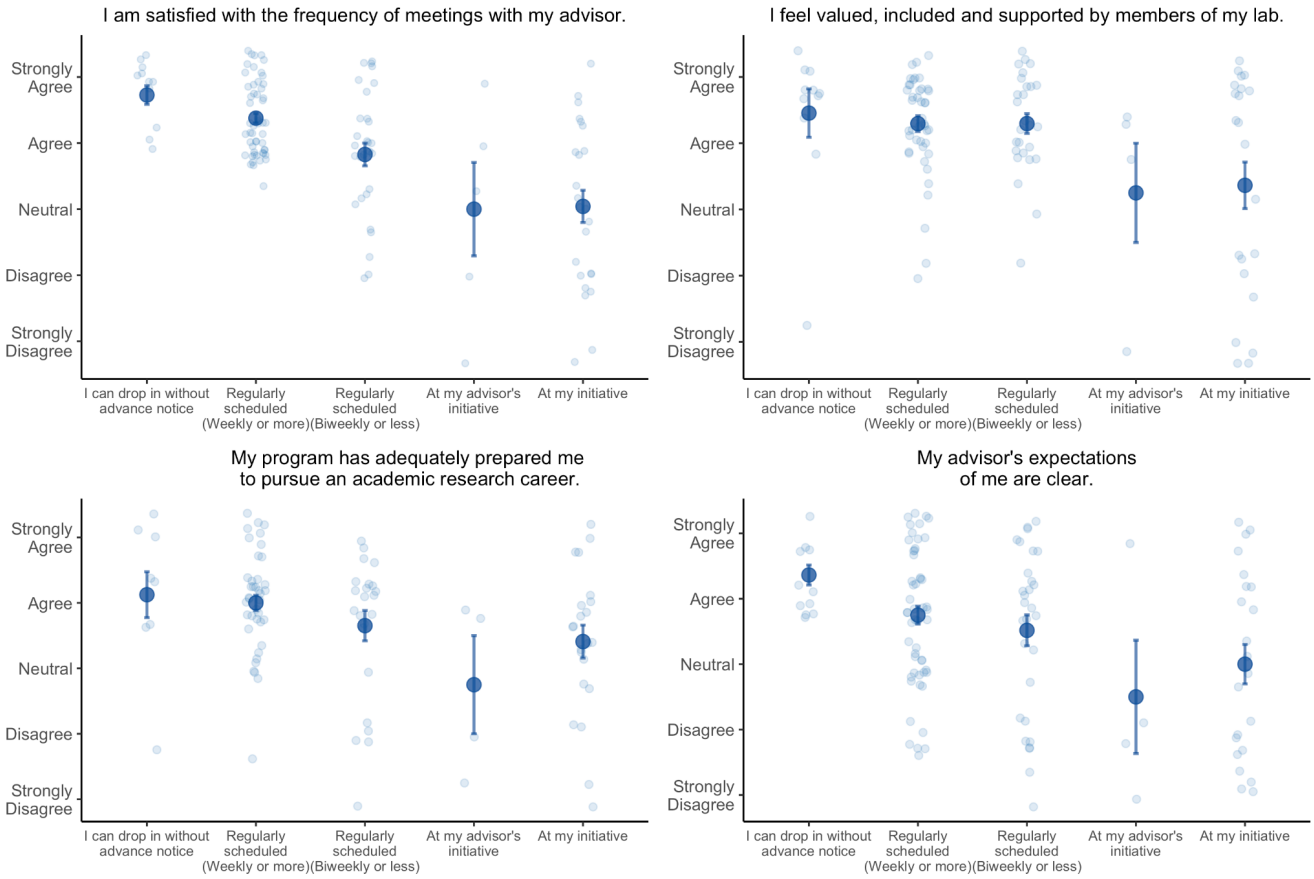

Figure 12. Effect of how meetings are scheduled on advisor meeting satisfaction, value in lab, career preparedness and meaningful research. Graduate students report higher levels of satisfaction with meetings (ANOVA, *F*-value = 14.35, p < 0.0001) as well as increased sense of value in their labs (*F*-value = 4.00, p = 0.005), preparedness for an academic career (*F*-value = 2.60, p = 0.04) and understanding of their advisor's expectations (*F*-value = 3.88, p = 0.005) when meetings are either available as drop-in or regularly scheduled.

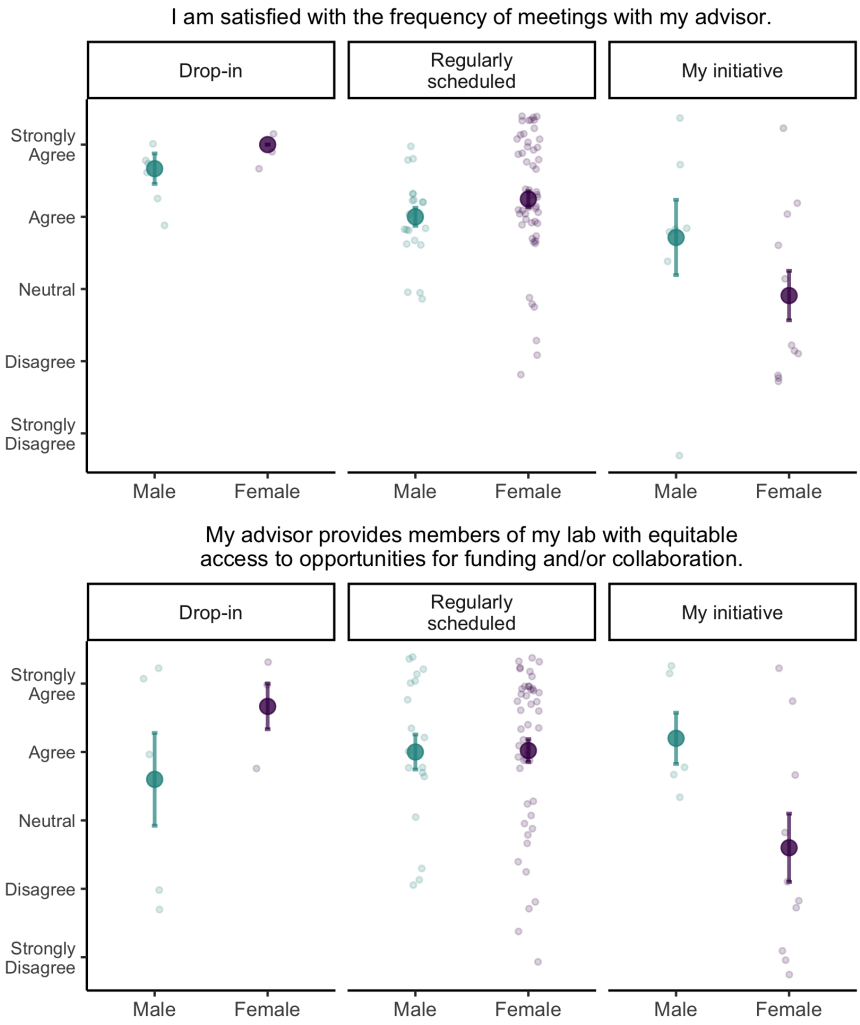

Figure 13. Effect of how meetings are scheduled on advisor meeting satisfaction and lab equity by gender. Female identifying respondents report differential overall meeting satisfaction (GLM, meeting satisfaction: gender overall, ß = 0.79, p = 0.052; *Regularly scheduled* vs. *At my initiative*, ß = 1.33, p < 0.0001; *Drop-in* vs. *At my initiative*, ß = 2.06, p = 0.0002; *At my initiative* vs. *Regularly scheduled* * gender, ß = -1.05, p = 0.023) and lab equity (GLM, *Drop-in* vs. *At my initiative*, ß = 2.06, p = 0.01; *Regularly scheduled* vs. *At my initiative*, ß = -1.42, p = 0.00096; *Drop-in* vs. *At my initiative* * gender, ß = -2.46, p = 0.016; *Regularly scheduled* vs. *At my initiative* * gender, ß = 1.62, p = 0.0292) when meetings are scheduled by their initiative, relative to male respondents. Regularly scheduled meetings refer to respondents that answered either "*Regularly scheduled, biweekly or less*" or "*Regularly scheduled, weekly or more.*" Respondents that identified as non-binary were excluded from this analysis due to anonymity issues.

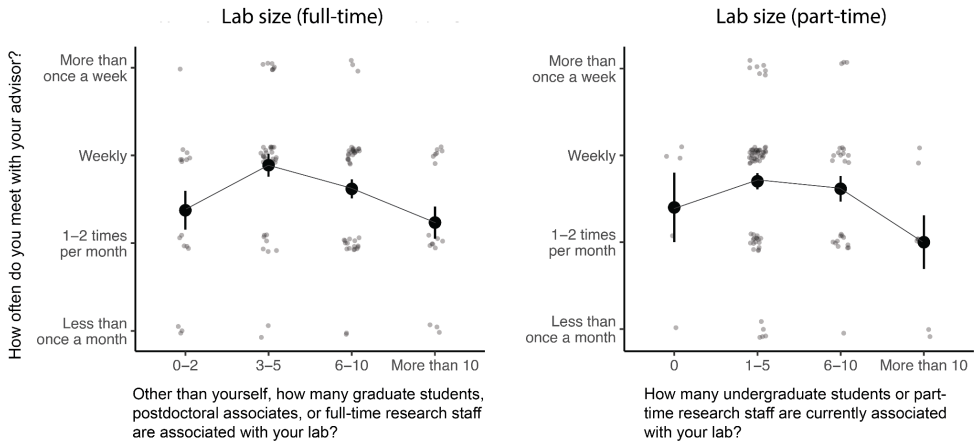

Figure 14. Group size influences meeting frequency. There was a significant inverse U-shaped relationship between full-time lab size and meeting frequency (quadratic regression, ß = -2.12, p = 0.007) and a significant relationship between part-time lab size and meeting frequency (quadratic regression, ß = 1.45, p = 0.059).

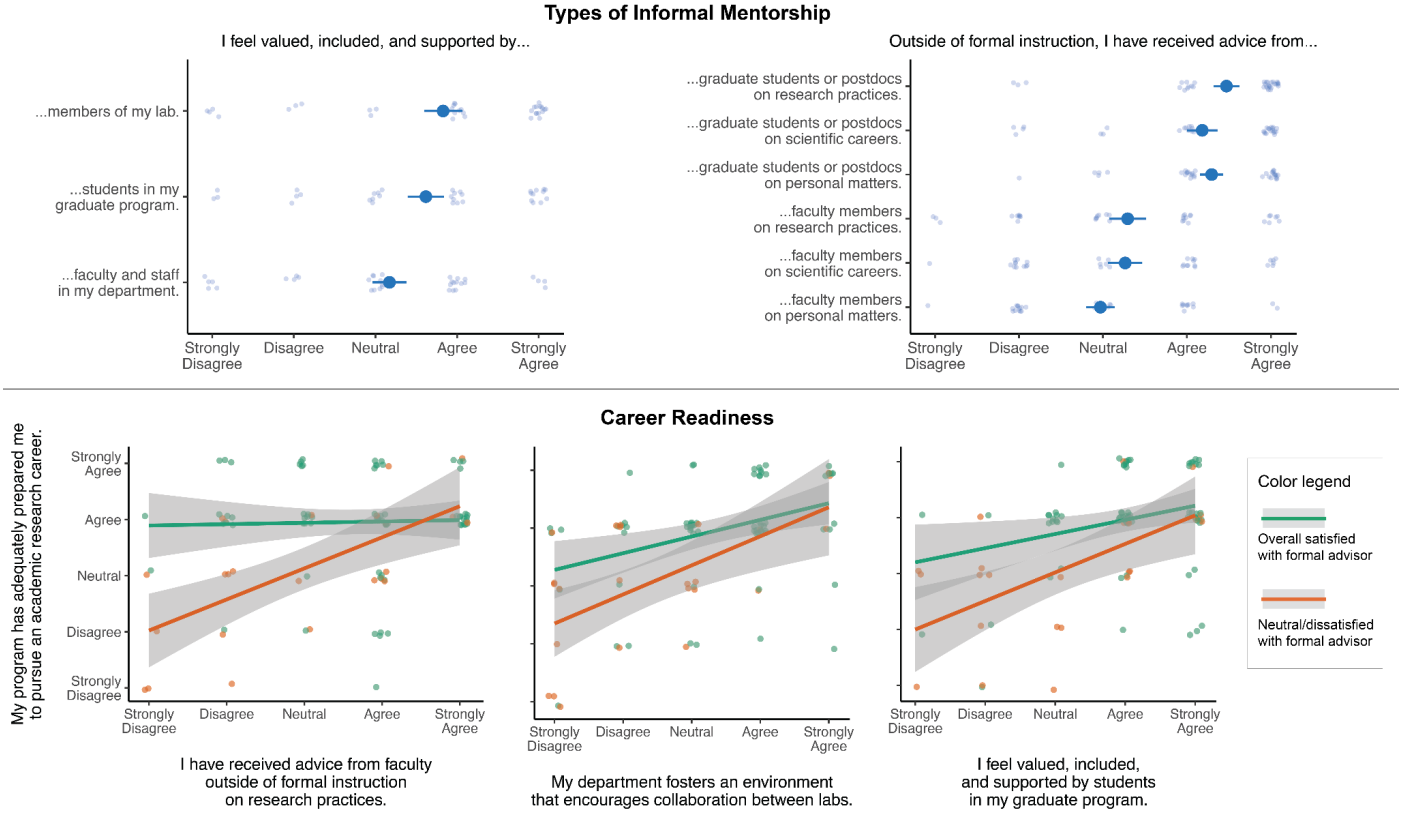

Figure 15. Interactive effects of formal and informal mentorship. IB graduate students generally reported high levels of support from their peers or near-peers, but less support from faculty (whether measured by feelings of inclusion or advice on research, scientific careers, or personal matters such as bias, discrimination, or work-life balance). For students dissatisfied with their formal advisors, several forms of informal mentorship such as research advice from other faculty (GLM, ß = 1.104, p = 0.006), collaboration with other labs (ß = 0.489, p = 0.034), and an inclusive departmental culture (ß = 0.804, p < 0.001) improved their self-assessed career preparedness similar to students with satisfactory advising experiences.