Students with Disabilities in Life Science Undergraduate Research Experiences: Challenges and Opportunities

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ABSTRACT

Individuals with disabilities are underrepresented in postsecondary science education and in science careers, yet few studies have explored why this may be. A primary predictor of student persistence in science is participating in undergraduate research. However, it is unclear to what extent students with disabilities are participating in research and what the experiences of these students in research are. To address this gap in the literature, in study 1, we conducted a national survey of more than 1200 undergraduate researchers to determine the percent of students with disabilities participating in undergraduate research in the life sciences. We found that 12% of undergraduate researchers we surveyed self-identified as having a disability, which indicates that students with disabilities are likely underrepresented in undergraduate research. In study 2, we conducted semistructured interviews with 20 undergraduate researchers with disabilities. We identified unique challenges experienced by students with disabilities in undergraduate research, as well as some possible solutions to these challenges. Further, we found that students with disabilities perceived that they provide unique contributions to the research community. This work provides a foundation for creating undergraduate research experiences that are more accessible and inclusive for students with disabilities.

INTRODUCTION

Individuals with disabilities[1] are underrepresented in postsecondary science education; while they are estimated to make up about 26% of the U.S. population, individuals with disabilities comprise 18% of those who pursue an undergraduate degree in the life sciences and only about 10% of those who graduate college with a life sciences degree (National Science Foundation [NSF], 2016; Centers for Disease Control and Prevention [CDC], 2018). It is becoming increasingly clear that students with disabilities experience unique challenges in undergraduate science, including facing discrimination and enduring inaccessible classroom learning environments, which are thought to contribute to their attrition from science degree programs (Fayer *et al.*, 2017; Zablotsky *et al.*, 2017). However, there is a growing recognition that there are specific high-impact practices, often not part of the standard college science curriculum, that can greatly influence a student's persistence in science. It is not well known to what extent students with disabilities participate in and thrive in high-impact practices such as undergraduate research, which are known to increase student persistence

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[1]In this article, we primarily use person-first language when describing students with disabilities generally, which has been promoted as a way to indicate that the individual is a person first, who happens to have a disability (National Center on Disability and Journalism, 2018; American Psychological Association, 2020). However, there are specific communities that have advocated for identity-first language (e.g., autistic community, deaf community, blind community) (Vaughan, 2009; Lum, 2010; Kenny *et al.*, 2016). There is not widespread agreement on what type of language is most preferred among those in the disability community (Ferrigon and Tucker, 2019).

in undergraduate science programs (Nagda *et al.*, 1998; Hathaway *et al.*, 2002; Jones *et al.*, 2010; Hernandez *et al.*, 2018) and their chances of going to graduate school (Bauer and Bennett, 2003; Seymour *et al.*, 2004; Russell *et al.*, 2007; Carter *et al.*, 2009; Hernandez *et al.*, 2018). In this article, we examine the representation of students with disabilities in undergraduate research and explore the unique experiences of students with disabilities engaging in research to further understand how colleges and universities might leverage this high-impact practice to improve the persistence of students with disabilities in science.

Increasing the representation of individuals with disabilities in science has become a priority for national funding agencies (NSF, 2021). Having individuals from diverse backgrounds engaging in science is integral to national success, because it can lead to a stronger, more talented U.S. workforce that can meet the demands of a 21st-century economy (Olson and Riordan, 2012) and increase the objectivity of science by including individuals with unique perspectives that can influence scientific questioning and interpretation (Intemann, 2009). However, societal norms, attitudes, and ableist structures have contributed to the historic underrepresentation of individuals with disabilities in science (Oliver, 2013; Sins Invalid, 2019). Undergraduate courses are often taught in ways that are inaccessible to students with disabilities, and these ableist course design structures can discriminate against individuals with disabilities, often in ways that may not be apparent to an instructor (Hehir, 2002; Goodley, 2014). For example, teaching practices in science courses (e.g., asking students to work together or asking students to speak out in front of the whole class), content delivery (e.g., in-person vs. remote vs. hybrid), and course and university policies (e.g., required attendance in a course, required wet lab course for a science major) can create unique challenges for students with disabilities (Hutcheon and Wolbring, 2012; Gin *et al.*, 2020, 2021a). As such, students with disabilities often require accommodations, defined as auxiliary aids and services, to facilitate their participation in university courses (Meeks and Jain, 2015). Even though adequate accommodations for college course work are legally mandated, students with disabilities often need to self-advocate, or actively assert their needs and rights, to secure what they need (Martin and Marshall, 1995; Test *et al.*, 2005). The process of self-advocating has been shown to be a critical, yet challenging, part of navigating undergraduate education in general (Hadley, 2007), as well as in science-specific learning contexts (Pfeifer *et al.*, 2020, 2021; Gin *et al.*, 2021a). In fact, science disciplines have been reported to be particularly exclusionary for students with disabilities. For example, science majors with disabilities often receive fewer accommodations in their courses compared with non-science majors with disabilities (Lee, 2011). Additionally, one study found that college science instructors doubt the abilities of students with disabilities and also lack the knowledge and experience required to provide proper accommodations for science course work (Dunn *et al.*, 2012). As such, it may be particularly difficult for students to self-advocate in the context of college science courses (Pfeifer *et al.*, 2020, 2021).

Previous research has established that students with disabilities can experience challenges in navigating different science learning environments, because individuals involved in a student's education (e.g., instructors) are unfamiliar with available resources for students with disabilities (Baker *et al.*, 2012; Cole and Cawthon, 2015; Roth *et al.*, 2018). For example, students with disabilities are traditionally supported by a university's disability resource center (DRC).[2] DRCs are offices that provide services to students with disabilities and other diagnosed medical conditions to ensure compliance with both educational and civil rights laws that mandate that students with disabilities be reasonably accommodated (Section 504 of the Rehabilitation Act, 1973; Americans with Disabilities Act of 1990, 1990). While support services for students with disabilities are available on nearly every college and university campus (Madaus, 2011), some students are unaware of the existence of the DRC or are unsure of the types of accommodations that may be available to them through the DRC (Dowrick *et al.*, 2005; Marshak *et al.*, 2010; Gin *et al.*, 2021a). Most DRCs are well equipped to support students with disabilities in traditional learning environments (e.g., traditional lecture courses); however, emerging research suggests that DRCs are not as prepared to serve students in innovative learning environments, such as active-learning classrooms (Meeks and Jain, 2015; Gin *et al.*, 2020) or online courses (Gin *et al.*, 2021a). Further, it is unclear to what extent DRCs help students navigate challenges in college learning environments outside the formal classroom; for example, many students enroll in academic credit for research in a faculty member's research lab, thereby making it a course that appears on their transcript, but the involvement of the DRC in providing accommodations for students with disabilities in undergraduate research is not well established (Gehret *et al.*, 2017).

The primary approach to improving attrition among college students with disabilities in science has been to reduce barriers to success in undergraduate education broadly, often by providing accommodations in courses or offering replacement courses if students cannot fully participate in a particular course (e.g., taking a lecture course instead of a lab course if they have a physical disability; Dunn *et al.*, 2012). However, many of these accommodations are designed so that students can achieve equivalent knowledge or grades in a course; this approach takes a narrow view of what higher education entails and assumes that formal course work is the most important factor influencing a student's decision to engage in science. In contrast, many educators view higher education as a holistic experience and believe the engagement of students in high-impact practices, many of which may not take place in formal courses, is critical to one's persistence and success in college (Kuh, 2008). High-impact practices are defined as teaching practices that have been shown to be beneficial for college students by increasing student engagement and retention (Russell *et al.*, 2007; Kuh, 2008; Graham *et al.*, 2013). The Association for American Colleges and Universities defines 11 high-impact practices for undergraduates: first-year seminars and experiences, common intellectual experiences, learning communities, writing-intensive courses, collaborative assignments and projects, diversity/global learning, ePortfolios, service learning/community-based learning, internships, capstone courses and

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[2]We use the broad term "disability resource center" to describe offices on college campuses that are designed to support students with disabilities. Some institutions have other names to describe these offices, such as disability support services, accessibility services, student access centers, and accommodation resource offices.

projects, and undergraduate research (Kuh, 2008). Thus, we argue that the approach to retaining undergraduates with disabilities in science should be multifaceted and extend beyond merely providing the minimal accommodations appropriate for course work. Another strategy to help increase the persistence of students with disabilities could be to increase the participation of students with disabilities in high-impact practices.

Undergraduate research is a high-impact practice that national science agencies and science educators recommend all students engage in, owing to the wide array of skills and benefits that it can provide (Kuh, 2008; National Research Council, 2012; National Academies of Sciences and Medicine [NASEM], 2017). Specifically, engaging in undergraduate research experiences (UREs) can lead to increased perceived understanding of how to conduct scientific research (Russell *et al.*, 2007), as well as elevated student confidence in their ability to think critically (Bauer and Bennett, 2003; Brownell *et al.*, 2015). Further, participation in undergraduate research has been shown to enhance student learning (Rauckhorst *et al.*, 2001; Brownell *et al.*, 2015) and bolster student confidence in their ability to conduct research (Bauer and Bennett, 2003; Seymour *et al.*, 2004). Undergraduate research can prime students' career goals and aspirations to become scientists (Eagan *et al.*, 2013) and is a robust predictor of student persistence and completion of undergraduate science degrees (Graham *et al.*, 2013; Hernandez *et al.*, 2018). For example, a 10-year longitudinal study showed that students who completed at least 10 hours per week of faculty-mentored research across two academic terms were more likely to graduate with a science-related bachelor's degree and be accepted into a science-related graduate program compared with students who did not engage in research (Hernandez *et al.*, 2018). Further, undergraduate research has been shown to be a positive predictor of who excels in science-related graduate programs (Bauer and Bennett, 2003; Carter *et al.*, 2009; Jones *et al.*, 2010; Hernandez *et al.*, 2018). In sum, engaging in undergraduate research has tremendous potential to positively impact a student's persistence and experience in the sciences.

Participating in undergraduate research has been thought to be an especially important activity for individuals who are underrepresented in science (NASEM, 2017). Specifically, a study of students who participated in a minority training program that included undergraduate research found that participants had higher scientific-related career aspirations compared with students who did not participate in research (Schultz *et al.*, 2011). Another study of graduate students who identify as persons excluded based on their ethnicity or race (PEERs) found that students highlighted their experiences in undergraduate research as a key factor that influenced their decisions to pursue a PhD and stay in science (Villarejo *et al.*, 2008). Additionally, PEER students, particularly from Latinx backgrounds, seem to experience unique gains in knowledge and skills from participating in undergraduate research (Daniels *et al.*, 2016). Encouragingly, studies have shown that PEER undergraduates engage in research to the same extent as white students (Lopatto, 2004, 2007; Russell *et al.*, 2007). However, despite the evidence suggesting that research is beneficial to individuals who are underrepresented in science because of their ethnicity or race, there is much less known about the experiences of students with disabilities in research and how such students may uniquely benefit from these experiences.

The majority of extant literature on undergraduate research and individuals with disabilities probes the experiences of deaf and hard of hearing students in scientific research environments where they are surrounded by hearing peers and mentors (Pagano *et al.*, 2015; Gehret *et al.*, 2017; Braun *et al.*, 2018). There are concerns that deaf and hard of hearing students are not able to easily communicate and connect with others in the lab, so they end up working in more isolated situations, which can result in negative research experiences (Thiry and Laursen, 2011; Gehret *et al.*, 2017, 2021; Majocha *et al.*, 2018). Group discussions with multiple people talking over one another can be hard for these students to follow, and students acknowledged that, without an interpreter standing by at all times, they often missed learning opportunities in the research lab. Notably, support services for interpreters are costly and priority often goes to classrooms, not research labs; even when interpreters are present in the research lab, they often are unsure of their role and may not have signs for some of technical jargon, making them less effective than in other learning situations (Ott *et al.*, 2020). Additionally, research mentors can be unaware of how they may marginalize deaf students and make them feel as though they do not belong by both their explicit statements and implicit behaviors, often inadvertently promoting ableism (Braun *et al.*, 2018; Lynn *et al.*, 2020).

Other studies on students with disabilities in undergraduate research have explored the experiences of students with depression, some of whom consider their depression as a disability. These studies found that specific aspects of research, such as failing and lack of guidance, can exacerbate students' depressive symptoms (Cooper *et al.*, 2020a; Gin *et al.*, 2021b). Further, many students with depression are uncomfortable sharing this identity with their peers and mentors, which would limit their ability to get support and accommodations (Cooper *et al.*, 2020b). However, we know of no other literature on the experiences of students with other disabilities in research, which indicates a need for additional research.

Current Study

To address the current gaps in the literature, we conducted two studies to understand 1) how common it is for students with disabilities to do undergraduate research and 2) what their experiences are like once they are in undergraduate research. Our studies were guided by the following research questions:

Study 1:

1. To what extent are students with disabilities participating in undergraduate research experiences?

Study 2:

1. What are the unique challenges that students with disabilities experience in undergraduate research?
2. How do students with disabilities navigate challenges in undergraduate research?
3. What are the unique benefits that students with disabilities experience in undergraduate research?
4. Are there unique ways in which students with disabilities contribute to undergraduate research?

Theoretical Models Informing This Work

The *medical model of disability* was the predominant way of describing disability in the 20th century and considers disability to be a physical or mental impairment of the individual that has personal and social consequences (Oliver, 1996, 2013; Shakespeare, 2006). The medical model of disability suggests the limitations faced by people with disabilities primarily result from their impairments. In contrast, the *social model of disability*, which emerged during the disabilities rights movement of the 1970s and 1980s, argues that disability is a social construct; an individual may have a functional limitation, or physical, mental, or sensory impairment, but what makes that individual have a disability is that opportunities are taken away due to the attitudes and structures of society (Barnes and Mercer, 1997; Stone, 1997; Charlton, 1998). The social model of disability has become the prevailing model of the 21st century used by disability scholars. While each of these models has its limitations, neither, in its extremes, is truly sufficient to describe the experiences of individuals with disabilities (Shakespeare, 2006; Goering, 2010; Oliver, 2013). Practitioners have argued that these models of disability can be synergistically considered in a pragmatic sense to describe the disability experience from the perspective of individuals with disabilities (Toombs, 1995; Overboe, 1999). Thus, in this research, we have chosen to consider elements of both models when describing the experiences of undergraduate researchers with disabilities. Specifically, we consider students' experiences in research from the following perspectives:

- Medical model perspective: We use the students' experiences of living with different physical, sensory, cognitive, or affective functions than the majority of the population to understand how they perceive their disabilities interfere with or prevent them from engaging in undergraduate research.
- Social model perspective: We use the students' experiences of facing attitudes, structures, bias, stigma, and discrimination based on their different physical, sensory, cognitive, or affective functions to understand how the students perceive that societal structures or attitudes interfere with or prevent them from engaging in research.

In addition, we examine what unique perspectives students with disabilities perceive they bring to undergraduate research. Using an asset-based approach, we consider the ways in which students with disabilities may possess unique strengths and skill sets that they bring to their research experiences (López, 2017). This is in contrast to a deficit-based approach, which focuses on the perceived weaknesses or shortcomings of an individual (Dinishak, 2016). We also consider the unique benefits that students with disabilities may receive from participating in undergraduate research.

METHODS

This study was approved by Arizona State University's Institutional Review Board STUDY00007247.

Study 1 Methods

Survey Development. In Fall 2018 and Fall 2019, we conducted a national survey of undergraduate researchers in the life sciences at research-intensive (R1) public institutions, research-intensive (R1) private institutions, master's-granting institutions, and primarily undergraduate institutions (PUIs).

The survey generally asked students about their overall experiences in undergraduate research. In addition, students were asked specifics about their UREs, such as the position of their primary mentors (e.g., graduate student, faculty member) and how many hours they spent in research per week. Students also answered general demographic questions, including a question about their disability status. The question specifically asking about disability status was developed by reviewing the literature on different ways that disability status has been collected (e.g., Livermore *et al.*, 2011; Cappa *et al.*, 2015; Verbrugge, 2016) as well as how organizations and agencies (e.g., NSF, National Center for Science and Engineering Statistics, CDC) define disability. We drew from these existing surveys to create an inclusive question to determine disability status. Specifically, students were invited to select whether they identified as having a disability, which included a learning disability (e.g., dyslexia), a mental health/psychological disability (e.g., anxiety, depression, PTSD), a physical disability (e.g., cerebral palsy, spina bifida, dwarfism), a chronic health condition (e.g., cancer, diabetes, multiple sclerosis), visual loss (e.g., blind), hearing loss (e.g., deaf), or another disability, which they were asked to describe. Students were invited to select which type(s) of disability/disabilities applied to them and could select more than one that applied. Notably, this question did not require students to be diagnosed in order to identify as having a disability, because access to healthcare can vary based on student demographics such as gender, race/ethnicity, and socioeconomic status (Adler and Rehkopf, 2008; Thompson *et al.*, 2016; Sommers *et al.*, 2017; Baeten *et al.*, 2018), and we did not want to bias our sample in ways that privilege those who have access to mental healthcare. Cognitive think-aloud interviews were performed with two undergraduate researchers with disabilities to test the validity of the questions on the survey based on verbal reports of their thought processes (Trenor *et al.*, 2011). The survey was iteratively revised based on each think-aloud interview. The survey was then piloted with undergraduate researchers at a large public research-intensive (R1) institution in the Southwest. A copy of the questions analyzed in this study are provided in the Supplemental Material.

Student Recruitment. In Fall 2018, we used the Carnegie classifications to identify all public R1 institutions in the United States. We used the university websites to identify individuals in life sciences departments who would be able to send an email to all undergraduate students via a Listserv or mailing list (e.g., undergraduate program manager). We then contacted all 81 public R1 institutions with a personalized email to request that they forward our survey announcement to their students. Twenty-five (31%) public R1 institutions agreed to send the survey out to students in their respective life sciences departments. In Fall 2019, we expanded our survey recruitment to other institution types. We repeated a similar process of using Carnegie classifications to identify private R1 institutions, master's-granting institutions, and PUIs as well as points of contact in life sciences departments to forward our survey. We contacted a total of 37 private R1 institutions, 12 of which agreed to send the same survey out to students in their department (32%), 350 master's-granting institutions, of which 30 (9%) agreed to send out the survey, and 241 PUIs, of which 20 (8%) agreed to send the survey out to students in their life sciences

department. In total, we recruited from 87 institutions. Students were incentivized to complete the survey by being entered into a drawing to win one of four $50 gift cards each term. Our recruitment method was intentionally not done through DRCs, because we wanted to be able to capture the experiences of students with disabilities who may not be registered with a DRC or who may not have had the health insurance or finances required to be formally diagnosed with their disabilities. Further, we intentionally did not recruit from a specific program (e.g., NSF REU program), because these programs often have greater levels of support and mentorship through a cohort model than traditional independent research experiences, and we wanted to be able to have representation from undergraduates who are not necessarily in these types of programs.

Survey Data Analysis. We used descriptive statistics to calculate and report the general demographics and research characteristics of the students who reported having a disability. To contextualize our findings, we compared them with results from national surveys assessing the representation of individuals with disabilities in the general U.S. population (CDC, 2018) and life sciences majors (NSF, 2016). To compare the representation of individuals with disabilities among different populations, it is important to distinguish how the term "disability" is defined and measured in each survey. We found that the definition and measurement of disability varied based on the organization that collected the data, which can affect conclusions that are drawn from these data. For example, the percent of the U.S. population with a disability is calculated by the CDC, which classifies disability as a condition that affects mobility, cognition, independent living, hearing loss, vision loss, and self-care; it is unclear, for instance, how or if mental health disabilities would be categorized within this organizational schema (CDC, 2018). The NSF collects data on disability status for undergraduate enrollment data; they consider disability as "blindness, deafness, severe vision or hearing impairment, substantial limitation of mobility, or any other physical, mental, or emotional condition," but restrict this to a time frame of having the condition within the last 6 months (NSF, 2016). By not explicitly including mental health disabilities and requiring a particular time frame that an individual has been affected by a disability, the CDC and the NSF may be underestimating the number of individuals with disabilities.

Study 2 Methods

Interview Recruitment. At the end of the survey described in study 1, we asked whether students would be interested in participating in follow-up interviews about their experiences in research. In Summer 2020, we contacted all students with disabilities who participated in the 2018/2019 surveys and asked them if they would be interested in participating in an interview about their UREs as an individual with a disability. A copy of the recruitment email can be found in the Supplemental Material. Students were offered a $15 gift card as an incentive to participate in the interview. Of the 152 students with disabilities who completed the study 1 survey, 20 undergraduate researchers with disabilities (13%) from eight institutions agreed to participate in the interviews.

Interview Protocol. The interview script was developed to explore the overall experiences of students with disabilities in undergraduate research and align with our research questions. Specifically, the interview questions asked students about 1) the extent to which they encountered challenges with conducting their undergraduate research; 2) what solutions or accommodations, if any, were helpful in navigating challenges in their UREs; 3) whether they perceived they uniquely benefited from conducting undergraduate research as a researcher with a disability; and 4) whether they perceived there were any unique contributions they brought to the undergraduate research context given their experiences as an individual with a disability. To ensure that each question would be interpreted correctly by our interviewees, we completed two think-aloud interviews with students with disabilities who had previously conducted undergraduate research (Trenor *et al.*, 2011). The interview protocol was revised upon conducting the two think-aloud interviews. These students in our study had engaged in undergraduate research before COVID-19, although the interviews were conducted during the COVID-19 pandemic. As such, we specifically asked students to consider their time in undergraduate research before the pandemic. A complete copy of the interview protocol can be found in the Supplemental Material.

Interviews and Post Survey. All interviews took place during Summer 2020. The interviews were semistructured, meaning that all students were asked the same set of questions, but additional follow-up questions were asked to allow students to elaborate on interesting ideas (McIntosh and Morse, 2015). It is also important to be attentive to the needs of individuals with disabilities who participate in research studies, particularly qualitative research (Kroll *et al.*, 2007). As such, our recruitment email and reminder asked students if they needed any accommodations for participating in the interview to maximize the accessibility of the interview process (e.g., live transcriptions or an interpreter). The interviews were conducted via Zoom, audio-recorded, and ranged from 45 to 60 minutes in length. The interview audio files were transcribed for qualitative analysis. To protect the identities of the participants, we assigned each person a pseudonym. The quotes from students were lightly edited for clarity, consistency, and anonymity. After the interviews were complete, students were given a brief follow-up survey asking about demographic information. The follow-up survey also included questions that were specific to a student's disability, such as whether they were formally diagnosed and whether they were registered with the university's DRC. A copy of the post survey can be found in the Supplemental Material.

Interview Analysis. We used inductive coding methods to identify themes from the interview data (Fereday and Muir-Cochrane, 2006). First, two authors (L.E.G. and D.P.) reviewed the same five randomly selected interviews independently and took detailed analytic notes to identify initial themes in the data. The researchers then came together to use their notes from these interviews to draft an initial codebook. Once the initial codebook was developed, the same two researchers reviewed a different subset of five interviews independently to determine whether the themes in the existing codebook were present and whether additional themes emerged. Afterward, the researchers met again to compare their notes from these additional interviews and revise the codebook accordingly. The revision of the codebook ensured that each code was distinct and independent

of other codes; that is, the researchers checked that each portion (or unit) of a student's thought would be captured by a single code. Any overlapping themes were revised to make sure that units remained independent and that themes were distinct enough to remain separate or similar enough to be combined. Additionally, the researchers used constant comparison methods to determine that quotes within the same theme were not too different from one another to merit creating an additional theme (Glaser, 1965; Glesne and Peshkin, 1992). Once the final codebook was agreed upon, the two researchers independently coded a new subset of five interviews (25%) to establish inter-rater reliability (Cohen's κ = 0.89, which is considered acceptable; Landis and Koch, 1977). After interrater reliability was established, one researcher (L.E.G.) coded the remaining 15 interviews. Because inferences about the importance of these themes cannot be drawn from counts, they are not included in the results of the paper (Maxwell, 2010), but are provided in the Supplemental Material along with the final coding rubric describing each theme. However, we caution readers against making generalizations based on the frequency of reported themes because of the nature of our qualitative methodology. Namely, because some types of disabilities are represented in our sample more than others, drawing conclusions about challenges, solutions, and benefits for students with different types of disabilities may be inappropriate.

Student Demographics and Disability Information

All students in this study self-identified as having at least one disability. We used a previously developed organizational schema to categorize students' disabilities throughout the paper (Gin *et al.*, 2020). Students' disabilities were categorized as learning disabilities (e.g., autism, attention deficit/hyperactivity disorder [ADHD], dyslexia), physical disabilities (e.g., cerebral palsy, spina bifida), chronic health conditions (e.g., cancer, diabetes), vision loss, hearing loss, and mental health and psychological disabilities (e.g., anxiety, depression). There is some disagreement in terms of how to categorize certain types of disabilities (e.g., autism and ADHD as learning disabilities), as well as the overlapping nature of certain disabilities and categories (Mayes *et al.*, 2000; Budd *et al.*, 2016). Additionally, the personal experiences of individuals are unique; even if two people have the same type of disability, the severity of the condition may differ or their personal or environmental situations may be different (Brown, 2002; Shakespeare, 2006). However, we chose to categorize students' disabilities in this way to preserve the confidentiality of students' specific disabilities or combination of disabilities, which may make a particular student identifiable, especially in the context of UREs. We report each of the disabilities next to the student's pseudonym and respective quote but encourage readers not to make conclusions about any particular type of disability due to the small number of students with a given disability who were interviewed. A list of the types of disabilities reported by students and their pseudonyms can be found in the Supplemental Material.

Researcher Positionalities

The first author (L.E.G.) has a physical disability and conducted all of the interviews for this study. He disclosed his disability to all students who participated in interviews in an attempt to establish rapport and create a welcoming environment for the students to discuss their experiences (Kvale, 1996). This author also developed the rubric and coded the interviews. Another author (D.P.) who helped develop the coding rubric has a close family member with a developmental disability. These two researchers used their personal experiences with disability to inform the coding rubric and analysis while also attempting to counteract any potential biases that they may hold (Chenail, 2011). Additionally, members of the research team have personal experiences of struggling with depression and anxiety, either their own or that of close family members, which has influenced this work. The researchers used the interviews as an opportunity to learn from the lived experiences of those with a range of disabilities (Toombs, 1995). All members of the research team have currently or previously conducted either undergraduate or graduate research in life sciences as well as science education research, so there is an understanding of the dynamics of research experiences.

RESULTS AND DISCUSSION

For both studies, we chose to present our results and discussion together to contextualize the findings in the literature.

Study 1

Finding 1: Students with Disabilities Are Likely Underrepresented in Undergraduate Research. In our national survey of 1262 life sciences students engaged in undergraduate research across 25 public R1s, 12 private R1s, 30 master's-granting institutions, and 20 PUIs, 12.0% of respondents ($n = 152$) reported having a disability. This percentage indicates that individuals with disabilities are underrepresented in undergraduate research compared with the approximately 18% of students with disabilities who are pursuing undergraduate degrees in the life sciences (NSF, 2016) and the 26.0% of the U.S. population of individuals who identify with having disabilities (Centers for Disease Control and Prevention, 2018; Figure 1). Despite the differences in how each agency that collects data on individuals with disabilities defines having a disability (see *Survey Data Analysis* section for details), we feel confident in concluding that individuals with disabilities are underrepresented in undergraduate research in the life sciences given the data collected in this study. The primary difference between our definition of disability and those used by the CDC and NSF is that our definition explicitly included students with mental health disabilities to be as comprehensive as possible. If we were to remove individuals who report mental health disabilities from our data, we would have even greater underrepresentation of students with disabilities (5.0%, $n = 63$) in undergraduate research.

Who Are the Students with Disabilities Participating in Undergraduate Research? The undergraduate researchers who were surveyed reported a variety of different types of disabilities, with mental health (58.6%) and learning disabilities (24.3%) being the most prevalent. For students who participated in interviews, 55.0% of students reported a mental health condition and 50.0% of students reported a learning disability. The majority of students who were surveyed and who were interviewed were women (78.9% and 70.0%, respectively), white (67.1% and 55.0%, respectively), and continuing-generation college students (75.7% and 80.0%, respectively).
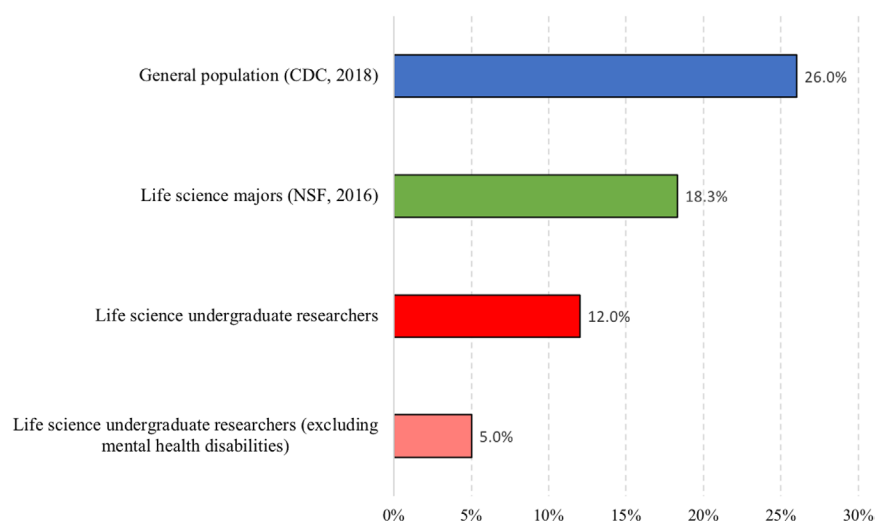
FIGURE 1. Representation of individuals with disabilities in the U.S. population, life sciences majors, and undergraduate research and classification of disability used in respective data collection. CDC (2018): mobility (serious difficulty walking or climbing stairs), cognition (serious difficulty concentrating, remembering, or making decisions), independent living (difficulty doing errands alone), hearing loss (deafness or serious hearing difficulty), vision loss (blindness or serious difficulty seeing), and self-care (difficult dressing or bathing). NSF (2016): Blindness, deafness, severe vision or hearing impairment, substantial limitation of mobility, or any other physical, mental, or emotional condition within the last 6 months. Data from study 1 on life sciences undergraduate researchers: learning disability (e.g., dyslexia), mental health/psychological disability (e.g., anxiety, depression, PTSD), physical disability (e.g., cerebral palsy, spina bifida, dwarfism), chronic health condition (e.g., cancer, diabetes, multiple sclerosis), visual loss (e.g., blind), hearing loss (e.g., deaf), and other (please describe).

Students varied in their year in school, with fourth-year students being most represented for both the survey respondents and interviewees (44.1% and 45.0%, respectively). The average grade point average (GPA) was 3.54 for students who completed the survey compared with 3.37 for students who agreed to participate in the interviews. Additional demographic information can be found in the Supplemental Material.

Regarding students' research experiences, the most common response for time spent doing research was 6–10 hours per week (47.4% of the survey respondents; 40.0% of the interviewees); 41.4% of students in the survey had engaged in research for 1–2 years, while 35% of students who were interviewed had engaged in research for 2–3 years. Students in both samples were primarily mentored by a principal investigator (PI) (44.1% and 30.0%, respectively) or a graduate student (28.9% and 25.0%, respectively) and had received course credit (69.7% and 65.0%, respectively) for participating in research. Most students who completed either the survey or interview were attending research-intensive public institutions (53.9% and 55.0%, respectively). Table 1 summarizes the student demographics, research demographics, and disability-specific demographics for the national sample of student researchers with disabilities.

Study 2
Finding 1: Students with Disabilities Experienced Unique Challenges in Undergraduate Research
Students Reported Challenges Related to Their Disabilities That Can Make It Difficult for Them to Carry Out Specific

Research-Related Tasks. Nearly all students in this study referenced personal challenges related to their disabilities that prevented them from fully participating in their UREs. Specifically, students described that the symptoms or effects of their disabilities impeded their ability to do research-related tasks. For instance, Michael and Albert described how their disabilities may make it difficult to complete tasks that require reacting quickly or are tedious.

Michael (mental health disability): "It's harder to think quickly on your feet when you're battling an anxiety disorder plus trying to make the quickest informed decision."

Albert (learning disability): "Tedious [tasks] as in counting the [model organism] I guess would be the only place where my ADHD affected me. It's a pretty tedious task and requires a lot of focus, and in that case, I'd say ADHD might have affected me in my ability to do that."

Further, Amy and Judith described how their disabilities can impact their overall productivity in research.

Amy (chronic health condition, mental health disability): "During a flare up [an instance where symptoms related to the disability/disabilities are exacerbated], I have zero productivity. But when I don't have a flare up, then I can be at like 100% productivity. I wouldn't say it's like this overwhelming negative effect, but there still is that disadvantage."

Judith (mental health disability): "Some days [in research] were just way less productive than others because I was depressed or because I was anxious or because I couldn't sit still. There's been a couple of times where I've been doing an [animal behavior] observation session, and I'll just completely space out because my heart rate is so high, for literally no apparent reason."

Students with disabilities also highlighted that when their disabilities negatively affected their ability to do research, they needed to repeat or make up missed work, which often increased the total amount of time that they had to spend on research. For example, Judith explained how she had to repeat observations when her disability interfered with her attention span.

Judith (mental health disability): "I'd have to restart the observation session. I was there doing the observation longer."

Amy highlighted that when her disability negatively affects her productivity in research, she often feels pressure to catch up by working without breaks, which can lead to additional stress that affects her disability.

TABLE 1. Student demographics, research demographics, and disability-specific demographics for the national sample of student researchers with disabilities and interview participants

Student-level demographics

	Survey participants with disabilities n = 152 % (n)	Interview participants n = 20 % (n)
Gender		
Woman	78.9% (120)	70.0% (14)
Man	15.1% (23)	20.0% (4)
Nonbinary/gender fluid	3.9% (6)	5.0% (1)
Decline to state	2.0% (3)	5.0% (1)
Race/ethnicity		
Asian/Pacific Islander	15.8% (24)	20.0% (4)
Black/African American	2.0% (3)	0.0% (0)
Hispanic/Latinx	9.2% (14)	15.0% (3)
White/Caucasian	67.1% (102)	55.0% (11)
Other	3.9% (6)	0.0% (0)
Decline to state	2.0% (3)	10.0% (2)
Year in college		
First year	3.9% (6)	5.0% (1)
Second year	17.1% (26)	15.0% (3)
Third year	22.4% (34)	25.0% (5)
Fourth year	44.1% (67)	45.0% (9)
Fifth year or greater	11.8% (18)	5.0% (1)
Decline to state	0.7% (1)	5.0% (1)
College generation status		
First generation	23.7% (36)	15.0% (3)
Continuing generation	75.7% (115)	80.0% (16)
Decline to state	0.7% (1)	5.0% (1)
GPA		
Mean (SD)	3.54% (0.38)	3.37% (0.54)
Range	2.00–4.00	2.00–3.90

Research-level demographics

	Survey participants with disabilities n = 152 % (n)	Interview participants n = 20 % (n)
Duration of time in research		
6 months or fewer	40.8% (62)	30.0% (6)
1–2 years	41.4% (63)	30.0% (6)
2–3 years	15.8% (24)	35.0% (7)
4 years or more	2.0% (3)	5.0% (1)
Hours per week in research		
1–5	21.1% (32)	15.0% (3)
6–10	47.4% (72)	40.0% (8)
11–15	14.5% (22)	15.0% (3)
≥16	16.4% (25)	30.0% (6)
Decline to state	0.7% (1)	0.0% (0)
Compensation[b]		
Course credit	69.7% (106)	65.0% (13)
Volunteer	38.2% (58)	55.0% (11)
Paid	27.6% (42)	50.0% (10)
Primary mentor		
Graduate student	28.9% (44)	25.0% (5)
Postdoc	8.6% (13)	15.0% (3)
Staff member (e.g., lab coordinator, lab manager)	14.5% (22)	20.0% (4)
PI/faculty member	44.1% (67)	30.0% (6)
Other	3.9% (6)	10.0% (2)
Institution type		
R1 public	53.9% (82)	55.0% (11)
R1 private	19.7% (30)	20.0% (4)
Master's-granting institution	14.5% (22)	15.0% (3)
PUI	11.8% (18)	10.0% (2)

Disability-specific demographics

	Survey participants with disabilities n = 152 % (n)	Interview participants n = 20 % (n)
Disability type[a]		
Mental health disability (e.g., anxiety, depression, PTSD)	58.6% (89)	55.0% (11)
Hearing loss (e.g., deafness)	2.6% (4)	20.0% (4)
Learning and/or psychological disability (e.g., autism, ADHD, dyslexia)	24.3% (37)	50.0% (10)
Chronic health condition (e.g., cancer, diabetes, multiple sclerosis)	15.8% (24)	25.0% (5)
Physical disability (e.g., cerebral palsy, spina bifida)	5.9% (9)	10.0% (2)
Vision loss (e.g., blind)	1.3% (2)	0.0% (0)
Decline to state	9.2% (14)	0.0% (0)
Diagnosis		
Yes	No data	90.0% (18)
No	No data	10.0% (2)
Registered at DRC		
Yes	No data	65.0% (13)
No	No data	35.0% (7)

[a]Students had the option to report more than one disability, so percentages add up to >100%.
[b]Students had the option to report multiple forms of compensation, so percentages add up to >100%.

Amy (chronic health condition, mental health disability): "If I have like a day or two where I have a flare up and I can't physically work, then it's like the next day I have to compensate and sit there for six hours instead of taking a break. (…) I think just stress in general, like if you have a research deadline, you're stressed. And then stress is one of my triggers for a flare up."

Michael described how his disability causes him to spend more time doing research than his peers.

Michael (mental health disability): "I think I spend a lot more time than my colleagues [in research], double, triple checking and whether that's just because I'm trying to conduct very proper research versus anxiety, that line gets blurred every once in a while. But I definitely noticed myself doing things more often and just a lot more double and triple checking, a lot of worrying."

Several students with disabilities indicated a need to compensate for their disabilities by working for extended times or feeling the pressure to make sure their disabilities have not affected their research productivity. The need to work for extended time periods and working without breaks can lead to burnout, defined as a work-related chronic stress syndrome involving feelings of cynicism, emotional exhaustion, and reduced personal accomplishment (Maslach *et al.*, 2001; Bianchi *et al.*, 2014; Koutsimani *et al.*, 2019). In fact, studies have shown that individuals who experience burnout are likely to later report a disability (Ahola *et al.*, 2009), and burnout has been shown to be significantly associated with some mental health disabilities, namely anxiety and depression (Koutsimani *et al.*, 2019). However, the students' experiences in our study indicate that undergraduate researchers with disabilities could be at risk for experiencing burnout if they feel they need to compensate for delayed or disrupted research related to their disabilities (Toppinen-Tanner *et al.*, 2005), which could lead to a recurring cycle of nonproductivity and heightened mental stress (Abramson *et al.*, 1989; Murphy *et al.*, 2007).

Based on our interviews, it is evident that students often resort to adopting the medical model of disability perspective when conceptualizing the relationship between their disabilities and research productivity. Specifically, they often describe their disabilities as functional limitations resulting in impairment, preventing them from completing a certain task (Brisenden, 1986). For example, Caroline, Judith, Amy, Michael, and Albert all described how their disabilities prevented them from engaging in research. During the interviews, students rarely described their challenges from the social model perspective. Considering the social model would identify societal norms, attitudes, or structures that are barriers for students given their disabilities (Siebers, 2008; Oliver, 2013; Sins Invalid, 2019). However, some students did recognize how the societal norms of science, such as expecting everyone to read dense research papers quickly, may exclude individuals with disabilities from fully engaging in science. For example, Rebecca highlights that providing her with a summary of a paper would significantly shorten the time she needs to spend reading.

Rebecca (learning disability): "Well, the sad part for me about science research is that everything you do, you have to read. (…) For me that's probably the toughest part about research. It has taken me so long to get caught up to where I need to for a level of understanding that it's been a disadvantage. [People] you work with get angry, but they get frustrated because they're like, 'Why haven't you read this paper? You need to understand this going forward.' I'm like, 'If you could literally just summarize it for me, we would be so good.' I read slower. Something that would take the average person 20 minutes to read—I'm there an hour and a half later being like, 'I'm still halfway through.'"

Encouraging both students with disabilities and members of research labs, including PIs, to view the experiences of students with disabilities through a social model perspective is an important step toward creating a more accessible scientific community. For example, had Rebecca's research mentor known about her disability, they could have showed her text-to-speech technologies and programs that would allow her to listen to a scientific paper read aloud (e.g., Inclusive Docs or Natural-Reader) or to first try to interpret the figures, which may have created a more positive experience for her. Identifying ways that the traditional process of doing science can change, as opposed to how students with disabilities should mold into the traditional process of science, would be important moving forward (Brown and Leigh, 2018; Peterson, 2021).

Undergraduate Researchers with Concealable Disabilities Experienced Unique Challenges Related to Whether They Revealed Their Disabilities in Undergraduate Research. Some disabilities are apparent or visible, while others are not apparent or invisible (Kranke *et al.*, 2013). There is general stigma around having a disability (Fine and Asch, 1988), and as such, students who have nonapparent or invisible disabilities have what could be considered concealable stigmatized identities, or CSIs (Joachim and Acorn, 2000; Quinn and Earnshaw, 2011; Quinn *et al.*, 2014). CSIs are identities that can be kept hidden from others and that have negative stereotypes attached to them that can result in a loss of status and/or discrimination in society (Link and Phelan, 2001; Quinn and Earnshaw, 2011). Students who had disabilities that they described as nonapparent reported experiencing unique challenges related to their disabilities and whether they choose to reveal them in the context of undergraduate research.

Students discussed how they often chose not to disclose or discuss their disabilities with members of their research groups. Some students, such as Wanda, experienced instances where a stigma about disability was mentioned in conversations with other members of their research groups, which discouraged them from revealing their disabilities.

Wanda (learning disability, mental health disability): "I was working on the countertop and my mentor was talking with somebody else. They were talking about people with ADHD and how [people with ADHD] have to rely on their parents and [people with ADHD] don't know how to do anything and [people with ADHD] can't work. I'm thinking like, 'I can work, I'm working for you.' I didn't say anything, but I was shocked that he said that about the whole population and he didn't know what I had."

In addition to students feeling that disclosing a disability could result in others doubting their abilities, some students, such as Cornelius, mentioned that they did not disclose or discuss their disabilities because they did not want the disclosure to result in any questioning about their abilities to perform specific research-related tasks, such as writing, analyzing data, or problem solving.

> Cornelius (chronic health condition, learning disability, mental health disability): "If people talk about disabilities [in the lab], I don't usually say that I ever had an IEP [Individualized Education Plan, a document that lays out education instruction, supports, and services for K–12 students with disabilities; Pretti-Frontczak and Bricker, 2000] or anything. And I probably don't feel comfortable telling my PI because she's a little scary. (…) I know a lot of research involves writing and they always say strong writing is highly required. And I'm like, 'Oh [expletive].' The ability to communicate is really important because I know those are the parts more affected by my disability."

The experiences of Wanda and Cornelius echo studies suggesting that individuals with CSIs often assess the beliefs of those around them before revealing their identities (Jones and King, 2014). If there is an indication that someone in one's research group may not be accepting of one's identity, then individuals are unlikely to reveal their own identities (Barnes *et al.*, 2020, 2021; Cooper *et al.*, 2020b). Additionally, Cornelius's experience is further supported by studies that have shown that both undergraduate and graduate students with depression often choose to conceal their depression from their PIs, because they fear that revealing this aspect of themselves would result in research responsibilities being restricted, even though students who do reveal their depression to their PIs do not report any loss of responsibilities (Cooper *et al.*, 2020b). However, one student in the current study, Michele, did reveal her CSI and highlighted how she perceived that she was left out of experiments and collaborations once others knew of her disability and that others would make negative remarks about how she was unable to do something.

> Michele (chronic health condition, mental health disability): "Even when I'm getting [doctor's excuses] from my neurologist, [people in my lab] just treat me like, 'Well everybody has headaches. Why can't you do this?' I would just say that I feel like sometimes I'm treated like I can't do things as well as other people or like I'm just not reliable instead of actually having problems. I'm not being picked for certain experiments and certain people don't want to collaborate and work with me because [they know about my disability]."

Some students who had self-described more apparent disabilities discussed how they sometimes downplayed their disabilities. They explained that if they concealed their disabilities, at least at first, others would be more likely to believe it did not affect their research performance. For example, Gabriella describes hiding her hearing aids and monitoring her speech so that others in her lab did not notice her disability.

> Gabriella (hearing loss): "I wear my hair down [to hide my hearing aid]. [I also try to be mindful of] my voice. My mom says I talk like a deaf person. I think it does give it away a little bit, but only to people who know, like doctors."

Feeling the need to conceal one's disability in research can be detrimental to students for multiple reasons. First, concealing an identity can lead to psychological distress and take an emotional toll on students (Mak *et al.*, 2007; Goffman, 2009; Quinn and Chaudoir, 2009; Quinn *et al.*, 2014). Specifically, individuals who conceal an identity may worry about 1) someone revealing their identity when they do not want it to be revealed, 2) when they may need to reveal that identity, and 3) what may happen when others learn about the given identity, all of which can lead to further internalized distress (Link and Phelan, 2001; Quinn and Chaudoir, 2009; Quinn and Earnshaw, 2011). Additionally, experts on mentorship assert that effective mentorship requires an understanding of identity-related challenges students face, so that mentors can help meet the needs of their mentees (NASEM, 2019). As such, we encourage lab mentors to be mindful about what they say about student identities, including disabilities, and to work to create an inclusive environment where students can feel comfortable revealing their disabilities if they choose (Cooper *et al.*, 2020b). Students feeling comfortable discussing their disabilities with lab members is likely necessary to make the research environment more inclusive (Chaudoir and Fisher, 2010).

Finding 2: Students with Disabilities Navigate Undergraduate Research Experiences by Finding Unique Solutions to the Challenges They Experience

Few Students Reported That They Have Received Formal Accommodations in Undergraduate Research through the University's DRC. Traditionally, when students with disabilities are enrolled in university courses, they work with DRCs to receive accommodations to make learning environments more accessible (Feldblum, 1996; Madaus, 2011). If a student is enrolled in undergraduate research for course credit, as is the case for 65.0% of the students who were interviewed in this study, then technically the student should have the same access to the DRC and accommodations as for any other course at the university. However, most students who were interviewed, like Skylar and Anita, did not think that they could ask about accommodations for their UREs through their universities' DRCs.

> Interviewer: "Are you aware that if you are enrolled in research for credit, you may be eligible for accommodations through the Disability Resource Center?"
>
> Skylar (learning disability): "No, I didn't know that. And I didn't even think about it."
>
> Anita (learning disability, mental health disability): "I haven't [sought accommodations in research], just because I didn't think that was a thing."

Recent research has unveiled that DRCs typically do not have blanket accommodations for modified learning environments, such as active-learning or online courses (Meeks and Jain, 2015; Gin *et al.*, 2020, 2021a). As such, many DRCs may not be equipped to provide accommodations for students in UREs, and students may be unaware of the potential role of the DRC in providing accommodations for undergraduate research. Interview participants, such as Albert, also expressed doubt that the DRC would be able to accommodate their needs in this unique context.

Albert (learning disability): "Honestly, I don't know what kind of accommodations would even be available for people with ADHD in research. And so, if I had thought that my DRC had accommodations I could use, I guess I might have looked into it."

It is not clear to what extent DRCs are aware that students with disabilities in undergraduate research need accommodations. However, some standard classroom accommodations could be used or adapted to an undergraduate research setting. For example, students with a disability that typically requires a note-taker in a lecture classroom may need one-on-one research meetings or lab meetings to be recorded and transcribed. This could be particularly helpful if a mentor is describing how to do a complicated step-by-step procedure that students with disabilities would need to do on their own in the future. An alternative accommodation may be to have another undergraduate researcher work closely with the student on a project and help take notes. For common lab techniques, the lab could be asked to create detailed written protocols available for everyone in the lab. Another common standard classroom accommodation is extended time for testing or assignments. For students who need extra time to complete assignments, an accommodation in the research lab may be longer time frames to complete tasks or more advanced notice about an experiment or task. While this may slow the pace of the research, not feeling rushed will likely result in better research products and may help students avoid making mistakes. Finally, excused absences are often provided to students whose disabilities are interfering with their ability to come to class; this accommodation can be administered in a research environment by allowing for flexible work hours or lab members to work from home if the task allows it. While students and mentors could likely arrive at some of these solutions on their own, having the DRC facilitate these accommodations relieves students from the burden of self-advocacy and likely would decrease the time lapse for students to receive the accommodation (Meeks and Jain, 2015; Gin et al., 2020, 2021a; Pfeifer et al., 2020, 2021). Additionally, students who are participating in paid UREs may be eligible for workplace accommodations through human resources and other employee support services. However, students who are participating in undergraduate research as volunteers would likely be ineligible for services through the DRC and human resources, making it important that students and research mentors work together in reaching solutions to make a research space more accessible.

Undergraduate Research Experiences Require That Students with Disabilities Self-Advocate to Maximize Their Experiences in Research and Most Accommodations Are Developed on an Individualized Basis between the Students and Their Research Mentors. No student who was interviewed reported using the DRC to receive accommodations in research, although nearly all students who dealt with disability-related challenges in their UREs needed to self-advocate to mitigate their challenges. Self-advocacy involves voicing needs and concerns to identify potential solutions and having a "knowledge of self," defined as one's own understanding of one's strengths and weaknesses, rights, and policies related to the accommodation process as well as the communication skills to be able to discuss accommodations (Eckes and Ochoa, 2005; Test et al., 2005). Pfeifer and

colleagues have further described a model of self-advocacy for science, technology, engineering, and mathematics (STEM) students with ADHD and/or specific learning disabilities (SLD), which also includes the knowledge of the STEM learning context (e.g., laboratory courses), the knowledge of available accommodations, and the knowledge of the process to successfully obtain these accommodations. Studies have shown that undergraduate students with disabilities may find it challenging to self-advocate, particularly in science, as they navigate interactions with instructors, peers, and DRC support staff (Pfeifer et al., 2020). For some students, like Hugh, self-advocacy comes in the form of communicating with mentors to help them become aware of his disability. These explicit conversations to personally inform his mentors about his disability can help ensure his safety in the lab and explain how his disability may affect his overall experience in undergraduate research.

Hugh (chronic health condition, hearing loss, learning disability, mental health disability, physical disability): "I have to advocate a bit more than anyone would normally have to personally advocate for themselves to make sure that they're just getting what they want out of the experience and making sure that they have a positive experience. I need to make sure that I can go to [medical] appointments when need be and I need to advocate for myself and say that if I'm working in a BSL-2 [Biosafety Level 2] space to be really safe about it so I don't get too sick with it or get too sick while doing the research."

Other students used self-advocacy to foresee potential issues that may arise in their research experiences. Students like Temple described that being upfront about their disabilities and what they need can help prevent misunderstandings, because a research mentor may misunderstand a certain situation for a student with a disability in research.

Temple (learning disability): "I try to always actively talk about what I need [in research]. If I think it's going to be an issue, I try to never assume that [my mentor] is going to know not to put me in a situation or not to ask me to do something when I can't do that. I try to be clear to avoid problems later. I do feel like I always need to personally advocate because otherwise somebody is not just going to get it."

Students who self-advocated often found solutions through working with their mentors. For example, Anita, Tia, and Rebecca did not use the DRC for accommodations, but did work directly with their mentors to acquire accommodations for their research experiences. It is worth noting that many of the solutions that students and mentors agreed upon can be relatively simple to implement, such as being flexible with a student's schedule or providing written instructions or pictures to students. However, this requires that a mentor knows about the student's disability and how it impacts the student. Students like Anita and Tia have disclosed their disabilities to their research mentors, which has benefited them through accommodations such as additional notes, instructions, or figures.

Anita (learning disability, mental health disability): "My grad student does his version of accommodations where he basically gives me notes for what he needs me to do. And then he'll also give me a list of instructions and stuff that he says to lay it

out for me. Just to make it a little bit easier for me to remember things."

Tia (hearing loss, mental health disability): "I started asking for pictures and figures instead of things being written out, which was a huge help. It led to me making a lot of [concept] maps that were interesting but also equally useful that I don't think we would have even thought about using for communication before."

Further, even if research mentors are unaware that a student has a disability, inclusive mentoring strategies can help provide a level of accommodation. For example, the accommodation that Rebecca described, which was rescheduling a meeting to a later date, is a general strategy that mentors could use with all students, independent of having a disability.

Rebecca (learning disability): "The level of patience [my research mentors] have had is one of the best accommodations that I could have. They understand what takes [another undergrad] like a week to do, it's going to take me two weeks. When we come to like, 'Do we need to push the meeting?' I'm like, 'We need to push the meeting.' Having that level of patience and saying like, 'It's okay, it happens.' That's been really nice."

In addition to self-advocating with mentors, student researchers with disabilities also described self-advocating with their lab mates. Lab mates knowing about students' disabilities and their needs may help facilitate efforts to maximize students' experiences in undergraduate research (Quinn and Earnshaw, 2011; Quinn *et al.*, 2014). For example, students like Naomi discussed that other members of her lab were able to check in with her to see how she was doing and if she needed anything after she had talked to them about her disability.

Naomi (physical disability): "I needed to take a break during fieldwork, [the people in my lab would] be like, 'Okay, do you want me to take over what you're doing or you want to just go take a break together?' They were very supportive and just, 'Hey, if you need help, just let me know.' It created a family-type situation."

Studies have shown that individuals with depression have also noted that once they disclose this CSI, their lab mates are more likely to support and check in on them (Cooper *et al.*, 2020b). Studies have also shown that students who disclose identities are more likely to come in contact with similar others, because disclosing one's CSI can lead to others disclosing a CSI if they have one (Quinn *et al.*, 2014). Additionally, the ways in which one views one's own disability can have an influence on one's ability to self-advocate effectively (Pfeifer *et al.*, 2020). For example, if students have a more positive views of their disabilities, they may be better at self-advocating. As such, self-advocacy can be a powerful, albeit sometimes draining, way for students to access accommodations and the resulting benefits (Lynch and Gussel, 1996; Test *et al.*, 2005; Hong, 2015; Pfeifer *et al.*, 2021).

Students Also Relied on Their Own Creative Solutions to Maximize Their Research Experiences. In addition to working directly with their mentors and lab mates to maximize their research experi-

ences, some students discussed creating their own solutions to challenges that they encountered in their research experiences. This is aligned with Pfeifer and colleagues' framework of self-advocacy for ADHD/SLD in STEM through the component of "filling gaps," which is when the individual student takes action to mitigate a perceived limitation in a given accommodation (Pfeifer *et al.*, 2020). This is illustrated by Naomi and Katie, who both developed unique ways to adapt to challenges and barriers that their research environments posed, such as using sunglasses for bright computer screens or positioning themselves toward their mentors when having conversation.

Naomi (physical disability): "I'd have to make sure that if I could, I would have to work with a darker screen or a tinted screen or sunglasses or something. So, I would have to adjust what I'm doing."

Katie (hearing loss): "I would try and position myself like on [my mentor's] left side so I could hear her. I would take lots of notes when she was trying to explain some sort of process so I could make sure I didn't miss anything."

As Naomi and Katie describe, they are often having to adjust to societal standards and structures that may not be suitable for those with disabilities, which can be both physically and emotionally taxing. Such standards and structures, which were built on a history of ableism, were not created with individuals with disabilities in mind (Goodley, 2014; Peterson, 2021). The juxtaposition between students with disabilities working with mentors to change something about the structure of a lab or the behavior of people within a lab and students with disabilities changing their own behaviors to maximize their experiences as someone with a disability in research reflect the social and medical approaches to disability, respectively (Brisenden, 1986; Shakespeare, 2006). Considering the social model of disability, the mentor or lab mate recognizes that the way research is being conducted is excluding the student from participating. In contrast, students with disabilities who change their own behavior reflect an assumption (perhaps of their mentors or lab mates) that their disabilities limit what they can do in research. This has also been illustrated with students who are deaf or hard of hearing in undergraduate research, where some individuals created their own communication strategies with hearing mentors, including writing on laboratory whiteboards or texting to communicate (medical model), whereas others had hearing mentors who were willing to learn basic American Sign Language as a way to establish a deaf-friendly research environment (social model; Braun *et al.*, 2018; Majocha *et al.*, 2018). Previously, our research group has argued that developing accommodations on an individual basis will meet the unique needs of the student, but that it often takes longer to secure the accommodations and requires the student to encounter a problem before an accommodation is offered (Gin *et al.*, 2020). The wasted time spent encountering the problem and responding to the problem may be sufficient to derail that student from persisting; in some cases, the problem may never be addressed. Thus, we urge future research to explore what, if any, accommodations are available and scalable in hopes of identifying standardized accommodations that would allow students to be supported in undergraduate research before they encounter a

challenge. Some of these solutions may be difficult for individual mentors to provide for students, because a lab may not have the funding or resources available to assist a student (e.g., adaptive equipment, software, or technologies). Therefore, it would be increasingly important to have assistance from outside sources, such as the department, the university's DRC, or national funding agencies, to better accommodate students with disabilities in research. As universities are required to accommodate students (Section 504 of the Rehabilitation Act, 1973; Americans with Disabilities Act of 1990, 1990; ADA Amendments Act of 2008, 2008), policies need to be in place so that a lab mentor can know who to go to for funds for these accommodations.

Finding 3: Students with Disabilities Reported Distinctive Benefits from Participating in Undergraduate Research. Studies have shown that, on average, students benefit from engaging in undergraduate research (Seymour *et al.*, 2004; Russell *et al.*, 2007; Thiry *et al.*, 2012; NASEM, 2019), but we wanted to examine whether students perceived that they reap unique benefits from research, given their disabilities.

Undergraduate Research Can Counteract the Narrative That Students with Disabilities Cannot Do Science or Enter Scientific Careers. Systemic ableism has resulted in few examples of scientists who identify as having a disability, so students with disabilities often lack role models in science who may be able to provide them with navigational capital and advice for how to pursue a career in science (Listman and Dingus-Eason, 2018; Cooper *et al.*, 2020b). Further, the absence of role models, coupled with the often hostile environment in science for individuals with disabilities (Dunn *et al.*, 2012), can erroneously present a narrative that individuals with disabilities cannot pursue careers in science. This perceived identity incompatibility has been shown to be a factor in the attrition of science students (Rosenthal *et al.*, 2011, 2013; Good *et al.*, 2012). As such, bolstering the confidence of students with disabilities to counteract that narrative of their ability to do science may be integral to promoting retention among these students (Adedokun *et al.*, 2014; Daniels *et al.*, 2016). When students in this study were asked about their confidence in their ability to do science, they often described that their confidence before they started research was low, because it was based on their sometimes poor performance in traditional lecture courses. Yet studies have shown that these undergraduate courses are often inaccessible for students with disabilities and may not accurately reflect their ability to do science (Mason and Hedin, 2011; Harshman *et al.*, 2013; McMahon *et al.*, 2016; Braun *et al.*, 2018). After conducting undergraduate research, some of these students felt for the first time that they could be a scientist. For example, Odette and Tia highlight how their experiences conducting undergraduate research disrupted their initial impressions of their abilities to do science.

> Odette (learning disability, mental health disability): "My grades were not always that great (…) I would just flunk a test because I didn't understand what they were asking or I studied a graph that was different and then they laid it out differently. And I was like, I don't know how to read this, things like that. So, when all that would happen [in class], I would still be

doing posters, writing papers, participating in this research that I thought was really worthwhile and impactful [in undergraduate research]. And it just made me feel like I can be a scientist."

> Tia (hearing loss, mental health disability): "Because of the anxiety and the very bad situations with my math courses, I really thought that I wasn't going to be able to do any amount of research. [My PI] really helped me realize that as soon as I could put data in a table or in a graph, I could understand it better. I didn't even think [doing research] was a possibility and honestly is the reason that I want to do science now."

Overall, the reflections from Odette and Tia demonstrate that their experiences in undergraduate research changed their confidence in their ability to do science, because their experiences demonstrated that they can be successful as researchers. Doing undergraduate research allowed them to feel like they were actually "doing science," showed them that they could be scientists, and helped them in adopting a science identity (Hazari *et al.*, 2013).

There is ample evidence that UREs can be career defining for students; for example, UREs are one of the best predictors for continuing on in research careers (Bauer and Bennett, 2003; Seymour *et al.*, 2004; Russell *et al.*, 2007; Carter *et al.*, 2009; Estrada *et al.*, 2016). However, for these students with disabilities who do not often see role models in science, UREs allowed them to disrupt their assumptions that they could not pursue careers in science and see themselves as future researchers. For students like Tia, the URE allowed her to recognize the value of doing research and showed her that it is a possible career path, although she initially doubted her ability to succeed in research.

> Tia (hearing loss, mental health disability): "I definitely like to work with research and data collection, but also particularly fieldwork. I didn't even realize how important [undergraduate research] was to me until I got into research because I didn't think that I'd be able to do research. That seemed too academic and too, I don't want to say hardcore, but I thought that it was going to be too hard for me to deal with, and it turns out that it wasn't and that I actually flourished and I continue to want to seek it out [as a career]."

One of the students in the study, Jesse, described working in a research lab that studied autism. Based on his experience as someone who identifies as autistic, he developed an understanding of some of the limitations of this research if it is not done by someone whose community is directly affected by the work. Additionally, as someone with a chronic health condition, he noted that having the opportunity to conduct research has given him better insights into what he needs for an accessible work environment, such as having comfortable seating or having the option to leave the lab space as needed.

> Jesse (chronic health condition, learning disability): "I mean, [my undergraduate research] has definitely influenced what I want to do. I definitely want to continue to research autism, especially because I find that most of the research that's done on autism and autism spectrum disorders is research done on children predominantly and then people who are assigned male at birth, as opposed to people that are assigned female at

birth, when it presents itself differently in every person. Wherever I work has to be accessible, otherwise I can't work there. (…) I have to make sure there is a chair to sit, leave the lab from sensory overload… and the building has an elevator."

While students with disabilities often enter undergraduate programs with the same level of interest in science as students without disabilities (Thurston *et al.*, 2017), their completion rates and matriculation rates into advanced degree programs and science professions remain lower (U.S. Bureau of Labor Statistics, 2020). As such, this finding highlights the important potential for UREs to have a positive impact on career choices for students with disabilities. In this case, undergraduate research can serve as work-based learning experiences that can be influential for individuals with disabilities (Lave and Wenger, 1991; Bellman *et al.*, 2014). The ability to explore career options before joining the workforce can be particularly helpful for individuals with disabilities who may inaccurately assume that they cannot pursue a career in scientific research (Hershenson, 2005).

Students with Disabilities Discussed That Undergraduate Research Provides Them with a Unique Context to Build Resiliency and Overcome Obstacles. Failure, particularly student response to failure and fear of failure, has been proposed to have implications for student attrition and retention to science programs (Harsh *et al.*, 2011; Simpson and Maltese, 2017; Henry *et al.*, 2019, 2021). The use of maladaptive coping, or not being able to cope properly, has been shown to negatively affect an individual's well-being and also prevent the individual from making progress, finding a resolution, or moving beyond the initial failure (Carver *et al.*, 1989; Struthers *et al.*, 2000; Skinner *et al.*, 2003; Henry *et al.*, 2019). Conversely, students who experience "productive failure," defined as engaging students in unstructured, complex problem solving and challenging tasks that students know they may be unable to complete (Kapur, 2008; Kapur and Bielaczyc, 2012), can develop resiliency and behaviors that may help them successfully navigate future challenges in science (Skinner *et al.*, 2003; Gin *et al.*, 2018; Henry *et al.*, 2019, 2021). Undergraduate research has been described as a potentially impactful way to teach students to deal with obstacles, setbacks, and failure (Auchincloss *et al.*, 2014; Firestein, 2015; Gin *et al.*, 2018; Henry *et al.*, 2019). However, the failure inherent in research has been shown to be particularly difficult for some students, including students who have disabilities like depression (Cooper *et al.*, 2020b; Gin *et al.*, 2021b), although we know of no studies that have examined how students with disabilities broadly navigate failure in the context of research.

Many individuals with disabilities face challenges in their everyday lives (Campbell *et al.*, 1999; Koon *et al.*, 2020). Studies have shown that, while resilience is important for individuals with disabilities, it can be a challenging skill to build (Alschuler *et al.*, 2016). However, individuals with disabilities who build resilience and overcome obstacles can experience a better quality of life, more overall satisfaction, and improved health benefits (Alriksson-Schmidt *et al.*, 2007; Silverman *et al.*, 2015). Thus, providing students with an opportunity to build resiliency to obstacles and overcome challenges in a context such as undergraduate research may have a positive broader effect on students with disabilities. Indeed, as Skylar and Naomi point out, their perseverance in undergraduate research has helped them overcome obstacles in other aspects of their life and made them proud of what they have accomplished.

Skylar (learning disability): "It takes me longer to process information a lot of the time (…) I think it will mean more for me than for other people just because the person with the learning disability is the only one who knows how hard it is. (…) And to overcome that adversity [can help me] overcome other things as well."

Naomi (physical disability): "I have obstacles [related to completing certain physical tasks] in my path, including with research. They're just there. I come with obstacles. So, I've just got to figure out how to get over them and always just a, 'Hey, that's just how it is.' [Doing research] makes me feel pretty proud, pretty happy. Of all the students that my professor could have asked, she knew I had a disability. She still asked me. So, it makes me feel pretty happy and pretty proud."

Temple also highlighted how her experience in research altered the way she perceives failure, as well as how she reacts when others experience failure.

Temple (learning disability): "[Having a disability] does make me very determined. I think that aspect of motivation is obviously important because in research you need perseverance. Things rarely work out the first time the way you expect them to. But I've learned that achieving that end goal is something that I can push myself toward. I think a big thing is sort of altering my perspective toward mistakes and failure. I've learned how to be more accommodating to myself and more accepting to myself. And that also comes out in my interactions with other people. If somebody else makes a mistake, I am also accommodating to them because I know that I am struggling with something, regardless of whether or not they are. A mistake is not enough to be angry at somebody."

Because these students experienced challenges and failure in the context of undergraduate research, they have been able to gain new perspectives on how obstacles should be approached and have become more understanding of others who may encounter difficulties in their research experiences. Although we present these examples because the students highlighted overcoming challenges and failure as a benefit of participating in research, there has been critique of asking students to persist through difficulties, which has been termed "grit" (Duckworth *et al.*, 2007), and other research has shown that failure can be detrimental to students (Brunstein and Gollwitzer, 1996; Smith *et al.*, 2006). As such, we want to acknowledge that we are not advocating for putting the burden on the student to persist and overcome the failure; mentors can provide students with projects with a lower likelihood of failure, and sufficient guidance from a mentor can help students identify a mistake earlier in the process, help make sense of confusing patterns in the data, and even recognize when to give up on a project. In sum, we do not feel as though students, including students with disabilities need to experience failure to become a scientist, but we do want to highlight how "productive failure" may be beneficial for some students (Kapur, 2008; Kapur and Bielaczyc, 2012).

Finding 4: Students with Disabilities Recognize Unique Contributions They Can Make to Undergraduate Research, Owing to Their Unique Perspectives

Students with Disabilities Described Bringing a Unique Perspective to Research. In our interviews, we also aimed to examine the ways in which students with disabilities bring particular assets or strengths to their research experiences based on their own unique traits, thoughts, and experiences as individuals with disabilities (López, 2017). Students described that they felt as though their disabilities gave them unique viewpoints and perspectives that influenced the ways in which they approached their research. In particular, some students described that they were able to provide a unique lens for solving problems in science that they would not have if not for their own lived experiences as individuals with disabilities. For example, Hugh described how his understanding of the patient perspective, given his own disability and breadth of experience with medical doctors, can help him with formulating research questions and his approach to problem-solving in research.

> Hugh (chronic health condition, hearing loss, learning disability, mental health disability, physical disability): "I think being able to use my own experiences with doctors or in the hospital, I think it gives me ways to look at problems differently and to ask different questions. (…) I think that with the asking different questions, sometimes that comes from just knowing the patient side of the experience. (…) Maybe seeing how my rheumatologist talks about it versus how a cardiologist or anyone else talks about it and trying to use some of those different ways of thought [in research]."

Moreover, Odette describes that her disabilities contribute to research because of the overall diversity she brings to the scientific research community and the unique perspectives that she has as someone with mental health and learning disabilities. She describes that she is able to "think outside the box" and has had other researchers tell her that they have not considered research problems or research questions in the same ways in which she considers them. This is consistent with other arguments that position individuals with disabilities to be some of our society's best forward thinkers and problem solvers, because they encounter problems, obstacles, and challenges that require solutions at a greater frequency than those without disabilities (Emery, 2018).

> Odette (learning disability, mental health disability): "I think [having a disability] gives me an advantage in that it brings more diversity to the table and it brings kind of a unique perspective I guess because I'm not always used to seeing what some people see inside the box, I just kind of like to think outside the box pretty freely. And so people have told me, I guess that … like some of the research ideas that I think about are things that they'd never really considered."

Additionally, some students mentioned that traits and characteristics related to their disabilities can provide an advantage in conducting certain research-related tasks, although students also described how this can be challenging for their overall productivity in research. For example, as Tia described, she felt as though her anxiety gave her better attention to detail, which helped her avoid mistakes in the research process, even though it led to spending additional time working to get her tasks done. Another common example, illustrated by Skylar, is that students with attention deficit disorder (ADD) may be able to hyperfocus on certain tasks, such as data entry or data collection, whereas they may be unable to focus on completing tasks at all at other times.

> Tia (hearing loss, mental health disability): "I definitely feel that my anxiety gives me better attention to detail. (…) The worry that I'm going to screw up so badly, it's helpful towards the research, it is detrimental towards myself in the way of making sure that I got everything done or that I would put in late hours to make sure that the work that was asked of me got done, but it makes the research better."

> Skylar (learning disability): "But a part of like ADD is that you can really focus on stuff, as well as not being able to focus on stuff. You can hyper-focus on certain tasks. (…) I'm able to hyper-focus on some things for long periods of time and then other times I just can't focus on anything."

These students' perceptions support the notion that including individuals with disabilities and their perspectives has the potential to diversify the scientific community, could increase the objectivity of science, and may reduce the amount of bias that may exist in scientific reasoning (Anderson, 2006; Solomon, 2006; Intemann, 2009). For example, scientific researchers get to select the research questions that are asked and answered, defining what is important for their disciplines (Hrdy and Bleier, 1986; Wylie and Nelson, 2007). In addition, individuals with disabilities may also leverage their unique perspectives to identify limitations of existing models and propose new ones, incorporate a fuller range of alternative hypotheses and interpretations of data, and open up new lines of evidence (Intemann, 2009; Braun *et al.*, 2018).

Some Students Reported a Greater Sense of Empathy and Understanding for the Process of Research because of Their Experiences with Their Disabilities. In addition to feeling as though they bring unique perspectives and experiences to undergraduate research, several students noted that they specifically felt as though they brought a greater sense of empathy and understanding to the research process, participants in research studies, and fellow researchers. This was often particularly true for students whose research experiences involved working directly with human research subjects. Jesse, who conducts autism research, describes that his own motivation for wanting to do research is because he feels as though he has insights into the disabled experience that shapes how he approaches his research. For example, he notes that he has his own personal experience with autism.

> Jesse (chronic health condition, learning disability): "I wanted to do research [on autism] because I am disabled, and I know other people have different experiences, and I know that just because I experience something doesn't mean that everyone else with the same disorder does. But there's a lot of similarities and a lot of things that two people with the same disorder might both experience."

Additionally, some students, such as Michael, noted that they feel more empathetic for their peers and other researchers within their research groups who may have disabilities.

Michael (mental health disability): "I've tried to be more empathetic when working with other volunteers [researchers]. We have a volunteer who has autism in our lab. And I try to be more empathetic. It's awesome and really great that we have him."

There has been a broad critique of able-bodied individuals not understanding the challenges of students with disabilities (Dunn *et al.*, 2012; Moon *et al.*, 2012). One concrete benefit that could result from engaging more students with disabilities in UREs is the potential for them to serve as more culturally competent research mentors for students with disabilities, as future upper-level undergraduates, as graduate students, as postdocs, and as faculty (Eddey and Robey, 2005; Balcazar *et al.*, 2009).

Recommendations for Research Mentors Looking to Make Undergraduate Research More Inclusive and Accessible for Students with Disabilities

In our interviews, undergraduate researchers with disabilities described elements of accessible and inclusive research spaces that have the potential to inform how research mentors structure their research experiences, which has allowed us to assemble the following recommendations:

- Recommendation 1. Provide students with flexibility in deadlines, meetings, and schedules. This could include having students work remotely or set their own work hours or providing options for students to attend a meeting via Zoom.
- Recommendation 2. Get to know students and understand their accessibility needs. One way to do this is to conduct check-ins for group access needs during lab meetings (Reinholz and Ridgway, 2021) or anonymously survey students on the overall accessibility of the lab.
- Recommendation 3. Self-assessment of the accessibility of research space. This could include consulting with DRC staff to determine how one could make current practices and research spaces more inclusive for individuals with disabilities.
- Recommendation 4. Advocate on behalf of students with disabilities. This may include communicating with DRC staff to see what is available for students with disabilities in research or serving as an additional voice for students seeking certain accommodations from the university. The onus of the responsibility for providing accommodations does not have to be solely on the mentor.
- Recommendation 5. Professional development on how to better support individuals with disabilities. One option is that mentors can encourage their research groups to participate in workplace trainings that raise awareness about the needs of students with disabilities (e.g., AccessZone).

Limitations

The students in both studies were recruited from life sciences undergraduate programs, and as such, there may be discipline-specific differences in student research experiences in the sciences. Future work should explore UREs in other science disciplines, as each discipline may present unique challenges for students. For example, some students in our study discussed experiences with fieldwork or computation that may be unique to the life sciences. Additionally, our studies primarily included students who reported learning disabilities, mental health disabilities, and chronic health conditions and did not include any students who identified as having vision loss. Future research could take a targeted approach to recruit students who have specific disabilities who were underrepresented in this study. However, in general, our interview sample was relatively representative of our survey sample, indicating that studies examining what prevents students with particular disabilities from engaging in research may be a needed first step.

Similar to any interview study, it is possible that students in this study experienced social desirability bias so that students may have given socially desirable responses to interview questions rather than responding with what was reflective of their true feelings (Bergen and Labonte, 2020). This could be particularly concerning, given that individuals with disabilities are a historically marginalized group who may be reluctant to identify their challenges or weaknesses (Logan *et al.*, 2008; Merrill *et al.*, 1997). While we tried to limit this by anonymizing their experience, individuals in our study may actually be underreporting and underestimating some of the challenges they have experienced in undergraduate research because of the hierarchical nature of research and concerns about anonymity. In addition, our conclusions are limited to students' perspectives. As such, we did not identify an exhaustive list of the ways that students are challenged in, benefit from, or contribute to research. Additional interviews with stakeholders such as peers, research mentors, and DRC support staff would be needed to fully answer these questions.

CONCLUSION

Together, our data suggest that students with disabilities are underrepresented in life sciences UREs, and students with disabilities who do participate in research report that they experience challenges specific to their disabilities. According to the students interviewed, these challenges seem to only be mitigated if students reveal their disabilities and self-advocate for accommodations or identify solutions themselves. However, in addition to the array of benefits that all students can gain from engaging in research (Bauer and Bennett, 2003; Thiry *et al.*, 2012; Adedokun *et al.*, 2014; Daniels *et al.*, 2016; Olimpo *et al.*, 2016), this work also suggests that students with disabilities may garner unique benefits by using UREs to counteract the narrative that they cannot pursue careers in research. Importantly, undergraduate researchers with disabilities highlighted ways in which they brought assets to undergraduate research, namely, providing unique insights and being empathetic toward others. This work emphasizes the need to recruit undergraduate researchers with disabilities and retain them by providing more inclusive research environments.

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