

# Agency and career indecision among biological science graduate students

Biological  
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Kimberly A. Griffin

*Department of Counseling, Higher Education, and Special Education,  
University of Maryland, College Park, Maryland, USA*

Candace Miller

*Department of Sociology, The University of North Carolina at Charlotte, Charlotte,  
North Carolina, USA, and*

Josipa Roksa

*Department of Sociology, University of Virginia, Charlottesville, Virginia, USA*

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## Abstract

**Purpose** – The purpose of this study is to examine how student agency influences career decision-making for doctoral students in biological sciences. The authors address the following questions: How do biological science graduate students navigate career indecision? And how does agency relate to their experiences with career indecision?

**Design/methodology/approach** – The authors analyzed interview data collected from 84 PhD biology graduate students. Researchers used a grounded theory approach. After open codes were developed and data were coded, code reports were generated, which were used to determine themes.

**Findings** – More than half of the sample had not committed to a career path, and undecided students were bifurcated into two categories: Uncommitted and Uncertain. Uncommitted graduate students demonstrated agency in their approach and were focused on exploration and development. Uncertain students demonstrated less agency, were more fearful and perceived less control and clarity about their options and strategies to pursue career goals.

**Practical implications** – Findings suggest some forms of indecision can be productive and offer institutional leaders guidance for increasing the efficacy of career development and exploration programming.

**Originality/value** – Research on doctoral student career decision-making is often quantitative and rarely explores the role of agency. This qualitative study focuses on the relationship between student agency and career indecision, which is an understudied aspect of career development.

**Keywords** Career decision-making, Graduate education, Agency, STEM

**Paper type** Research paper

Over the past decade, scholars have increasingly called attention to graduate students' shifting patterns of career decision-making, particularly in science, technology, engineering, and mathematics (STEM) fields. Several studies show US STEM graduate students are reporting less interest than previous generations in pursuing academic research careers and



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more openness to working outside of the academy and the science workforce more generally (Fuhrmann *et al.*, 2011; Gibbs *et al.*, 2014; Gibbs and Griffin, 2013; Roach and Sauermann, 2017; Sauermann and Roach, 2012). While there is some disagreement over the size and scope of this phenomenon (Huang and Shen, 2019; Wood *et al.*, 2020), there has been an increased demand for information about career paths in and outside of research (Fuhrmann *et al.*, 2011; O'Meara, 2013; O'Meara *et al.*, 2014; Sauermann and Roach, 2016; Seo and Yeo, 2020). Simultaneously, studies are reporting that graduate students are uncertain about their professional options post PhD (Fuhrmann *et al.*, 2011; Sauermann and Roach, 2016). These trends are particularly notable in the biological sciences, where academic positions have not grown in alignment with increased doctoral degree production, and students must learn to navigate a less linear career pathway than previous generations (Fuhrmann *et al.*, 2011).

A growing body of work has documented the factors related to students' interest and intent to become faculty, pursue nonacademic research careers or explore career pathways outside of science and research (Fuhrmann *et al.*, 2011; Gibbs and Griffin, 2013; Layton *et al.*, 2016; Roach and Sauermann, 2010, 2017; Seo *et al.*, 2021). While this literature offers important insights, much of it is quantitative, and it rarely explores how graduate students engage in the developmental process of choosing their career path post-PhD. More specifically, there has been limited attention to how agency, or the degree to which individuals feel control over their lives and outcomes (O'Meara, 2013; O'Meara *et al.*, 2014), may relate to how graduate students think about their careers, articulate their career intentions and aspirations and make choices about how to participate in preparatory training experiences.

This study focuses on the relationship between student agency and a specific, understudied aspect of career development: indecision, which we define as a lack of certainty about career objectives and steps to achieve them. When studied, indecision has been framed as a phase that should be moved through quickly or avoided altogether, if possible (Creed *et al.*, 2004; Germeijs and de Boeck, 2003; Mau, 2000, 2001; Prideaux and Creed, 2001). However, Trevor-Roberts (2006) notes that indecision is typical and calls for more attention to how individuals experience it, in addition to addressing how it can be navigated in productive ways toward intentional training experiences and satisfying career choices. The purpose of this study is to examine whether and how student agency plays a role in career decision-making. Specifically, we address the following questions: How do biological science graduate students navigate career indecision? And how does agency relate to their experiences with career indecision?

## Background

### *Understanding agency*

Agency is perhaps most simply defined as “assuming strategic perspectives and/or taking strategic actions towards goals that matter” (O'Meara, 2013, p. 2). It is important to note that agency is context specific. It is not equivalent to assuming one has free will or complete control over their life; instead, social forces and external factors play a significant part in decision-making and outcomes, as well (Archer, 2000; Emirbayer and Mische, 1998). However, rather than perceiving these external forces as the primary determinants of their experiences and outcomes, individuals with higher levels of agency understand that despite constraints, they have a role to play in their ability to make successful progress toward their goals (McAlpine, 2012; McAlpine and Amundsen, 2011; O'Meara, 2013).

Within this framework, agency comes in two forms: perspectives and actions. Agentic perspectives focus attention on cognition, emphasizing how individuals make meaning of their ability to reach their goals. Having an agentic perspective is closely related to self-

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efficacy and reflects a belief in oneself and an ability to complete goal related tasks. Indeed, self-efficacy is key to agency, as it reflects beliefs that you can obtain desired outcomes and that individual action is important in striving toward one's goals (Bandura, 1982, 2000). Agentic actions are the translation of those beliefs into specific behaviors in which individuals engage in direct pursuit of their goals (O'Meara, 2013). While some research aims to distinguish between agentic perspectives and agentic actions and suggests that perspectives precede behaviors, this is not always the case (Jaeger *et al.*, 2017).

#### Agency in graduate student socialization and career decision-making

Agency has been increasingly applied to studies of graduate education and socialization, leading to deeper understanding of student experiences and outcomes. Rather than assuming that external forces are primarily responsible for shaping and molding doctoral students, work that centers agency shows that graduate students can and do have a role in co-constructing their experiences and can engage in acts of resistance in the face of oppressive structures (Hopwood, 2010; O'Meara, 2013). For example, McAlpine and Amundsen (2009) found that while it was often uncomfortable, graduate students can and do exert agency as they aim to shape their doctoral programs and experiences, including engaging agentially with their principal investigators (PIs). Griffin *et al.* (2015) also noted the importance of faculty in the development and demonstration of an agentic perspective and connected student agency to more educational risk-taking and exploration, confidence and decision-making about potential life paths to pursue. Other scholars have described how students exhibit agency in the face of racism and identity-based oppression during graduate education, navigating marginalization through the development of networks and critical discernment of feedback (Dortch, 2020; Hopwood, 2010; Perez *et al.*, 2019).

With a few notable exceptions (Jaeger *et al.*, 2017; O'Meara *et al.*, 2014), prior literature on career development in graduate education has rarely employed agency as a framework. Studying the role of agency in graduate student career development, O'Meara *et al.* (2014) found that STEM graduate students reported relatively high levels of agency in their career development process, with higher levels of confidence in their ability to take strategic action than their perceived level of control over career outcomes. Jaeger *et al.* (2017) examined how identity and agency shaped graduate students' perspectives of their career choices and opportunities. Findings revealed racial differences in how students perceived the impact of affirmative action policies and practices, leading to distinct agentic actions and career strategies. White and Asian students voiced a perceived lack of agency and feared being overlooked, while Black and Latinx students engaged in agentic actions, joining identity-based support groups and applying for financial and career development programs for students of color. The authors also framed the desire to prove others wrong, mentor the next generation of scientists and increase diversity in the field as agentic perspectives, intentionally influencing the career choices scientists of color made. While these studies provide important insights into how external forces can influence agency, perceived opportunity and career development, they do not focus specifically on how agentic perspectives and behaviors can shape not only training opportunities but also certainty about career choices and how students experience indecision.

#### *Career decision-making and indecision in graduate education*

While there is little work that addresses how agency, either in the form of agentic perspectives or behaviors, translates to how graduate students experience and navigate indecision, extant research indirectly addresses the extent to which graduate students are undecided about the next steps in their careers. Overall, research suggests students start

their training with greater certainty about their career paths, often initially reporting high levels of interest in pursuing faculty careers (Fuhrmann *et al.*, 2011; Gibbs *et al.*, 2015). Over time, they express increased interest in other pathways and, perhaps most interestingly, less certainty about their career choices. For example, Fuhrmann *et al.*'s (2011) longitudinal work revealed that interest in the academic path declined, and nonresearch careers increased between students' first and second years of graduate training. Participants also reported high levels of uncertainty about their career choices through their fifth year of graduate school. Similarly, postdoctoral trainees participating in a study by Gibbs *et al.* (2015) reported that they were less clear about their career goals over time, even as they reported more access to information about various career paths and options.

Indecision has also emerged as a theme as scholars have explored decisions to pursue postdoctoral training. Traditionally, graduate students have secured postdocs to prepare for a career as a faculty member, and in many cases, these positions are viewed as prerequisites for a tenure-track position at a research university. However, recent studies (Gibbs *et al.*, 2015; Gibbs and Griffin, 2013; Sauermann and Roach, 2016) show that there are many who are uncertain about their next steps and have little interest in faculty careers. In fact, postdocs are at times viewed as the "default" option after receiving a PhD, and a temporary, transitional role while a more specific career goal and path is identified (Gibbs and Griffin, 2013; Sauermann and Roach, 2016; Schnoes *et al.*, 2018). Thus, while authors acknowledge that pursuing a postdoc can be an intentional, agentic decision, it also may be a more passive choice made because the trainee is not sure what else to do (Schnoes *et al.*, 2018).

Although there has been little theorizing or focused attention on indecision within the literature on graduate student career development, the larger discourse on indecision may provide some useful insights that suggest agency may be related to how graduate students experience this phase of career development. Multiple scholars have addressed how barriers can influence one's ability to confidently engage in the career development and choice process (Albert and Luzzo, 1999; Creed *et al.*, 2006; Creed *et al.*, 2004; Prideaux and Creed, 2001). Germeijs and De Boeck (2003) organized barriers into three categories, including: a lack of information or not knowing or understanding the alternatives available, a lack of value clarity or enough information about oneself to make choices that align with strengths, needs and goals and uncertainty about outcomes and likelihood of successfully reaching one's goals.

Albert and Luzzo (1999) connect the ways that individuals make sense of the barriers rather than the barriers themselves to career development and decision-making. They suggest that in addition to self-efficacy and expectations about career outcomes, attribution style and *locus* of control may be related to how individuals navigate barriers and progress in their career development. They state, "research has consistently revealed, over time, significant career decision-making benefits associated with a belief that career decisions are internally caused and controllable" (Albert and Luzzo, 1999, p. 433). In comparison, those who see career barriers and challenges as externally caused, uncontrollable and difficult to change may feel less invested and struggle making meaningful choices. Thus, this body of work implies that while all graduate students may encounter barriers, those who are more agentic may perceive them in ways that allow them to respond strategically and make more intentional choices than those who are less agentic and see themselves as having less control over the process.

## Data and methods

### *Sample*

The data for this study were drawn from a large mixed-methods longitudinal study of PhD students in biological sciences who entered their graduate programs in the fall of 2014. More

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specifically, the study is focused on “bench biology” – doctoral programs in fields including microbiology, cellular and molecular biology, genetics and developmental biology.

To recruit students for participation, the research team reached out to program directors and department chairs of the 100 largest biological sciences doctoral programs in the USA as well as all public flagship universities (research intensive), historically Black colleges and universities and Hispanic serving institutions offering PhD programs in appropriate biology subfields. They were asked to forward recruitment information on behalf of the study to students, who then contacted the research team expressing interest in participation. In instances where programs’ incoming cohorts consisted of six or more students, campus visits were arranged for a member of the research team to present information to eligible students and answer questions during program orientation or an introductory seminar meeting. Three hundred thirty-six respondents across 53 different institutions agreed to participate in the study.

In addition to completing regular biweekly surveys, a subsample of students were also invited to participate in yearly interviews. Given the focus of the larger project on inequality in students’ experiences, interviews were conducted at the institutions that had study participants from minorized racial/ethnic groups. All students from minoritized racial/ethnic groups and a random sample of students from other racial/ethnic backgrounds were invited to participate. Analyses in this article are based on interviews with 84 PhD biology candidates, including 60 students who identified as White and 24 that identified as students of color. Fifty-eight participants identified as women, and 26 identified as men. Twenty-five were the first in their families to attend college.

### *Methods*

Data for this study were drawn from interviews conducted during the summer after students’ fourth year in their graduate program. End of the fourth year represents an ideal point in time to consider questions raised in this study. By this point in time, students have spent adequate time in graduate school considering and preparing for their career paths, and they are approaching the end of their programs and thus are keenly aware of the need to plan for next steps. The median time to doctoral degree for biological and biomedical sciences is under six years ([National Center for Science and Engineering Statistics \[NCSES\], 2019](#)).

Our focus on a single field prevents us from conflating variation in career expectations and labor market prospects across disciplines with the key constructs examined in this study. For example, the degree of uncertainty may vary across fields, as do opportunities to obtain jobs outside of academia. Focusing on biological sciences is warranted given that it reflects the largest number of doctorates awarded annually within STEM fields, according to the Survey of Earned Doctorates ([National Center for Science and Engineering Statistics \[NCSES\], 2019](#)). Moreover, the biological sciences award doctorates to the largest proportions of women and underrepresented racial/ethnic groups among STEM disciplines.

All interviews were semistructured, recorded, transcribed and coded using Dedoose. To protect the identities of the participants, we use pseudonyms throughout our analysis of the interviews and do not disclose respondents’ institutions. The interview protocol largely focused on students’ reflections on their experiences throughout their training, contributions to research and writing projects, relationships with their PIs and thoughts about their career preparation and pathways. Most relevant to this study were questions that interrogated their overall thoughts on their professional options, factors most central in determining the careers they were considering, how well prepared they felt for taking the next steps in their careers and opportunities central to their career development.

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Our analysis used a grounded theory approach, which is a qualitative methodology particularly appropriate for exploring phenomena about which little is known, allowing for the generation of a theory or explanation of a process (Corbin and Strauss, 2008) such as navigating career decision-making generally, and indecision specifically. The second author developed an initial set of open codes by sorting all mentions of career planning and goals. All authors reviewed the codes and revised the codebook until reaching a consensus (Saldaña, 2013). Initial rounds of coding revealed that students were split between those who had decided on a career path and those who had not. Later rounds of coding focusing exclusively on undecided students, examined factors shaping these students' perceptions about their professional futures, which illuminated the role of agency. After data were coded, code reports were generated. These reports were read and reread to determine themes, similarities and differences across participants based on their level of certainty and indecision about the next steps in their careers.

#### *Trustworthiness and positionality*

As we engaged in this research, we remained attentive to how our individual and collective level of personal knowledge and connection to this topic could inform our assumptions and interpretations. The first author is a continuing-generation Black woman who studies barriers and strategies to foster diversity and equity in the faculty, career development and mentoring. The second author is a first-generation Black woman whose research focuses on social inequalities in organizations. The third author is a first-generation White woman whose research examines various dimensions of inequality in higher education. We are not working or studying in a STEM discipline, and do not have personal knowledge or experience with conducting laboratory-based research or completing a biological sciences graduate degree program. However, we each navigated our own career decision-making processes as graduate students in our respective fields, and one author's research agenda includes career development in graduate education. To mitigate the challenges associated with our respective positionalities and enhance the trustworthiness of our analyses and findings, our team structured numerous opportunities for discussion and feedback. We frequently met to discuss the themes emerging from the data and collectively examined how literature on agency and indecision could inform our understanding of students' narratives about their career decision-making. We presented specific data points to support each theme and sought disconfirming evidence to challenge our initial interpretations.

#### **Findings**

By the end of their fourth year, graduate students in our sample were considering next steps following graduation. Our initial rounds of coding revealed that more than half (57%, N = 48) of the students in our sample had not committed to a career path by the time we spoke, and they constitute the focus of our analysis. Subsequent rounds of coding uncovered that students who had not committed to a career by the end of the fourth year were bifurcated into two categories based on students' perceptions of their ability to reach their career goals and their reported actions to meet those goals – agency. Individuals with higher levels of agency recognize that they play a role in planning and executing their career goals, despite constraints (McAlpine, 2012; McAlpine and Amundsen, 2011; O'Meara, 2013). We term these two categories: *Uncommitted* and *Uncertain*.

*Uncommitted* students were not committed to a specific career, but they were strategically exploring and considering different options. Their narratives suggest they had a high degree of agency, engaged in strategic actions and demonstrated a positive affect in relation to their career decision-making process. In contrast, *Uncertain* students expressed a

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limited ability to shape their career paths and did not engage in much strategic action. Moreover, they exhibited a great deal of anxiety and negative emotions. In other words, *Uncertain* students' narratives signal that they had a relatively low degree of agency.

### *The uncertain students*

Nearly 46% (N = 22) of the graduate students who were undecided about a career described feeling that they lacked the ability to control their career path. Elaine, a first-generation Black woman, is one such example. Her account revealed that she experienced much uncertainty and fear about her career prospects. She detailed:

I need to sort out my own feelings about if I want to continue in academic science or not. Really, that's the idea of perseverance – and, also my own personal background – I feel like I've always been one that had to struggle to get through things. There's always a hoop to get through and I don't know if I have what it takes to continue going through hoops all the time.

Elaine's uncertainty hung, in part, on the hoops she felt she was persistently made to jump through. She described feeling as though she lacked the steadfastness – the perseverance – to continue surmounting the obstacles she perceived to lie ahead in an academic career. She continued:

Academic science – I feel like the forecast is rather gloomy about that. I feel like I need to consider other careers, but whether or not the way I'm being prepared now will help me achieve that is very frightening as well, because I see all the upperclassman, my friends, graduating – these brilliant people are already struggling to find jobs even outside of academia, so I'm really worried about my prospects as well. I feel like my family expects, "Oh, a PhD from [prestigious public institution]! You're going to be really alright!" I'm like, "No, not really." They think as soon as I'm graduated, I'm going to be set, but really I'm afraid that's not going to be the case. What if I struggle with finding a job? I think that's also a fear that's setting in at the conclusion of this year (fourth year).

Elaine was disappointed that she was not clearer about her postgraduation plans. She noted that many of her friends had struggled to find jobs in both academic and nonacademic sectors, and she worried that she might suffer the same fate. Just as she questioned the promise of academic job opportunities in her future, she also pondered whether she had been prepared for success in careers outside the academy. It is important to note that Elaine's sense of uncertainty was not rooted in a total lack of knowledge about or exposure to a variety of career possibilities. She mentioned discussing academic and industry work with an extended network of more senior scientists. Instead, she was concerned that she might not be able to anchor herself in a career. She continued: "I'm really fearful that I'm going to go through all of this training just to be [spit out] somewhere along the processing line."

Still, Elaine explored career opportunities by attending informational sessions about careers in scientific policy, managing an outreach program at an elementary school and applying for industry internships. She hoped that her engagement across settings might yield more clarity in her career decision-making. She thought an industry internship might be particularly insightful; however, she felt the opportunity hinged on her advisor's approval. She added: "There are more things in place, like connections to biotech industries or startups or opportunities for internships [. . .] I just don't know if my PI would let me, but I feel like once I have a paper or maybe a second one on the horizon, maybe she'll be more permissive of me going on this internship." Simply put, Elaine felt her ability to control her career outcomes was impeded by several external factors.

In addition to a sense of limited control over career outcomes, uncertain students less often mentioned using specific preparation strategies as compared to other students.

Instead, they used vague language to describe steps taken or needed in pursuit of a career. One example is William, a continuing-generation White man. He explained that he was turned off by the politics he observed in academia and thought he might pursue a career in industry. When pressed to expand, he simply stated: "I think I want to do a postdoc, but then I probably want to go into industry afterwards." William did not offer any additional information about his next steps.

Similarly, Stella, a continuing-generation White woman, lacked specificity when discussing what would be her next steps. She had several interests, but she grappled with outlining strategies to get closer to securing a career that engaged those interests. She detailed:

So, I really enjoyed teaching this last year. I don't know if it's enough to take me away [. . .] So, my ideal thing that I was hoping to do after this was [to] be in some sort of a veterinary public health position.

I think I'd be fairly equipped to jump into a job like that, but talking to the public vets that I know, it seems like a nightmare. So, I don't know. Maybe it's kind of put me off big cities and traffic. But, I think, I would potentially like to work in a public health job. I'd really love to make maps. I just love making maps, I've discovered. I'm not good enough at it that I could just do that, though. But if I could find a public health job in a smaller city like Boston's size rather than [current city] size or maybe smaller than that, that would be [. . .] And just make maps for displaying data.

And talking to people at shelters, I think that would be fun – the National Park Service focusing in wildlife research – something like that would be really nice, but those jobs are impossible to come by, especially in the current political climate, so. I don't wanna be like, "I'm gonna work for the National Park Service." And just totally let myself down, when that's not an option.

It's hard to say. I'd love to still work with wildlife. I don't really know. And it's been like every time I had some sort of plan with my life, my life just takes me in a completely unexpected different direction. So, I figure, the average time to a PhD in our department is 5 to 7 years, so I'm guesstimating I'm probably gonna be on the 6-side. And, I'm hoping that I just have enough time to figure that out in the next two years.

Stella seemed to be caught between a sense that the types of jobs in which she was interested were largely unavailable and that she might be underprepared. This was compounded by a sense that she might not have full control over her professional future, as Stella anticipated being taken in an unexpected direction.

Uncertain students also often expressed an anxious emotionality. Janelle, a first-generation White woman, for example, described a sense of uncertainty that weighed on her emotionally. She explained:

I'm trying to figure it out, but I really don't have a good idea, honestly. I don't know! I took a class, about careers with a PhD in life sciences, and we went over: "here are the options," and we set up and interviewed people in their chosen fields. It didn't make me really feel any closer to what I'm going to do.

What I don't think I'm going to do is go into academia. But even that, there are days when things are going well. I'm just like, "do I want to do this?" But, I think ultimately I don't because to be in this position – like, to be a professor at a large institute means I'm going to have to do a postdoc for the next four or five years and I am not – I don't think I can handle that. You know, it's even the good days I have don't outweigh the bad. Yeah, I have no idea what I'm going to do, but I think getting away from this type of institution is a good idea.

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Janelle had experiences as a graduate student that gave rise to negative associations and emotions about academic careers. She also described a sense that the compensation in academic jobs would not be commensurate with the emotional and financial stress she believed she would likely encounter. She continued:

I think the whole deal where there aren't enough positions really for the amount of people who want them, is a problem. That means you have to go do a postdoc, and you have to do it to be successful for a number of years – like over two, probably more like four and then there's still no guarantee you're gonna get it. So that means for four years I was [...] I'm making no money right now. I'm gonna be 35 years old and making no [expletive] money. I'm gonna go be a postdoc and make no money for another four years and then have no guarantee at the end. That's a huge deal for me.

It's just a lot of pressure. I've seen professors and I've seen how their moods are influenced by their funding situation and it's just I'm moody enough. I don't need the additional stress of having to find money. You know? I don't think I'm a really good teacher either, so if that's part of it, I'm just like [...].

To be sure, Janelle had little good to say about the potential of an academic career. She also struggled to cite even one alternative career option despite participating in workshops that provided her with information about potential career opportunities post-PhD.

### *The uncommitted students*

The other subset of undecided students differed from the uncertain group in their strong sense of control over their professional outcomes and are better described as *Uncommitted*. Comprising approximately 54% (N = 26) of the students who had not committed to a career path by the end of their fourth year, they often detailed a panoply of potential career paths, each equally accessible. Cheyenne, a Black continuing-generation woman, describes a proactive openness to several career possibilities. She explained:

I had a site meeting this morning with a woman. They have an in-house post doc opportunity at [institution redacted]. So, I'd like to apply for that this fall with her, just working out the details and all. There's a woman at the [institution redacted], I want to apply for the post doc with her [...] just finding those things. I've been doing a lot more writing lately, which has been really good. I'm just keeping that groove going. Right now, my eyes are really to finish up in 2019 and have a post doc opportunity or job opportunity right after.

[The interviewer recalls that Cheyenne mentioned wanting to move closer to her hometown.] Yeah, I'm also looking at the [state university system], they have a President's postdoctoral fellowship. I'm going to apply to that as well. There's one woman at [public institution] that I would like to work with, and then another two at [another public institution]. I'm going to apply for those because my fellowship now comes from that same office. They paid for me to get a PhD and would eventually like me to stay at a [state university system institution] as a professor. But I'm not sure about that. I would take the post doc for sure.

Not only is Cheyenne clear about the steps she needs to take to pursue her long-term career interests, but she is also deliberately pursuing opportunities near her hometown – a factor that she indicated was important in her decision-making process. While Cheyenne expressed an interest in academic careers, she was also open to nonacademic jobs. She was intentional about pursuing a postdoctoral position that overlapped in relevance across career sectors. She continued:

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The post docs that I've been looking at, specifically, have been genetics and molecular biology-oriented for a reason. Because if I were to go into a private sector with those skills, I'd be much more marketable with the skills I already have. I can go and work at a pharmaceutical company, because they use [organic] compounds in a lot of their formulas. Having the genetics background after a post doc in genetics, I feel like that would make me more marketable. When the time comes, I feel I'm still going to look, at least, at private sector jobs. But I'm also going to look at tenure-track. I still don't know if want to work at a large institution, like [current institution]. But, I'll cross that bridge when I get there, because it might be beneficial to work there for a couple years and then call it quits and go work somewhere else.

Indeed, Cheyenne was not concerned that she had not yet locked into a career. Rather than a negative experience, her account of how she was navigating her career was characterized by an opportunistic openness, an advantageous open-minded disposition referenced in the *planned happenstance* theoretical framework (Mitchell *et al.*, 1999). Cheyenne's account revealed an intentionality in her academic pursuits, as she described using a targeted strategy to pick up relevant skills. She wanted to leave her options open, and though she was not committed to any one career path, she was sure that she was acquiring the necessary toolkit for wherever she might end up.

Similarly, Kennedy, a continuing-generation White woman, was uncommitted to a particular career path when we interviewed her, she clearly laid out strategies to ready herself for the job market. She said:

It's kind of a multi-branching path. I think there are tons of options, and because I sort of cross-trained in computational work and in benchwork, I think there are even more options. There's going directly to dry-lab setting and doing more computational work, which is something I'm somewhat interested in, but I'm also really interested in teaching in the future, and so one position that I've been looking into is working in a bioinformatics core facility. The one at my institution – the people who work there collaborate on bioinformatic analyses for projects across our whole institution, but then they also do a lot of teaching for students and faculty in basic computational skills, and so I think a position like that would be great. Not every core facility works like that, so that is kind of not a necessarily widely available position, but the other option that I'm really thinking of is doing research and teaching, with the emphasis on teaching, so teaching in a small institution. I went to a very small institution for my undergraduate degree, and I really like the environment. I really like having smaller classrooms, and I think I would like that as an educator as well, and so that would be probably a post-doc for two to four years, and then trying to find an academic position.

Kennedy also sought out opportunities to learn more about various career paths. She went on to say:

I've had the opportunity to teach a little bit while I've been here, which is great, and my program doesn't have a mandatory teaching requirements, so obviously the PI would rather not have me leave the lab to go teach for long periods of time, so I haven't TA'd a course, but I've done some modular teaching for graduate students, and so that's been helpful and opening my eyes to the fact that I am pretty good at being in front of a classroom and teaching material, and then also helping me have the experience in developing a lesson plan, things like that, so I think that opportunity has helped me see that I could be a teacher.

Kennedy noted that she was not interested in being a PI at an R1 institution, explaining that she had little desire to manage a large lab. Still, she followed the “New PI Slack” group and several Twitter accounts to learn more about others' experiences running labs. These experiences and others helped in her discernment. She also sought out career resources, such as conducting informational interviews and attending a career symposium hosted by the National Institutes of Health. Kyle, a White continuing-generation White man, who had

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recently finished his PhD at the time of the interview, mentioned recently securing a postdoctoral position. He noted:

I'm in a postdoc right now. I suspect it'll last – I probably will do it for about two years. I could potentially do it longer, but I hope that after a couple years, I might be able to move onto a more permanent job. But, the postdoc kinda' builds on some of the strengths that I developed over the course of my PhD, so I'm pretty excited about it. And, then after the postdoc, I will pursue either academic jobs or data science jobs. Just see what happens.

Kyle explained that he considered several postdoctoral positions but ultimately chose his current appointment because “this one definitely seemed like the best fit.” When asked to explain why he felt a postdoc was the best next step, he explained:

The work, the science was gonna be cool, was gonna be big. I was gonna be able to do some things that I, you know, thought about and wanted to do and just couldn't do as a PhD student' cause I didn't have the resources. I also knew that I would learn a lot and it would help me regardless of where my career goes. Either in academia, which of course you'd have to do a post-doc to if you wanna stay in academia, or going into data sciences, much of my post-doc is basically developing new data science methods. So I knew that a post-doc would help me either way. That's why I decided to do it.

Transitioning to a postdoctoral position was a strategic next step for Kyle, not only because it meant he would have access to additional resources but also because he believed that a postdoc would position him well for careers in industry or academia.

Kennedy, Kyle and Cheyenne continued to leave their options open regarding the sector in which they would work. They appeared hopeful and described engaging in strategic actions to further their career development.

### Discussion and implications

While a growing body of literature has considered graduate students' career choices inside and outside of academia, one area remains largely understudied: indecision or a lack of certainty about one's career decisions. Almost 60% of biology PhD students in our study expressed some degree of indecision about their career at the end of their fourth year, suggesting that this is a common phenomenon among graduate students. Notably, students who are not committed to a particular career path can be quite different. The data reveal two distinct groups of students: *Uncommitted* and *Uncertain*. What distinguishes the two groups is their sense of agency. Uncommitted students are not committed to a particular profession but believe in their ability to shape their trajectories and engage in strategic exploration and preparation for different career pathways. While they acknowledge that there are some unknowns that they cannot control, they demonstrate both agentic perspectives and behaviors as they consider various career options and steps postgraduation. Uncertain students are virtually paralyzed by their indecision and remain in limbo without a clear path forward. They rarely describe agentic behaviors or steps they are engaging in to prepare for a wide range of options, and they lack confidence in their abilities, particularly as they compare them to others' skills in a potential field.

In addition to providing empirical evidence and a more nuanced understanding of career uncertainty among graduate students, this study illuminates the importance of agency in how students understand and prepare for their careers. Graduate education literature is increasingly paying attention to the ways in which graduate students are able to interact with and even change the socialization processes, although these insights have been rarely applied to the study of careers (for recent exceptions, [Jaeger et al., 2017](#); [O'Meara et al., 2014](#)). Our results illuminate how the degree of agency shapes not only whether students are

committed to a particular career path but also how they experience and navigate indecision. While it may be expected that students who are committed to a particular career path adopt agentic perspectives and engage in agentic actions, we find that a group of students who are not committed to a specific path do so as well. Students in the uncommitted category have agentic perspectives and engage in agentic behaviors, and their overall approach is one of exploration and development. Through their agency, they shape their path forward, even if what is ahead may not be certain.

Although indecision is often framed in the career development literature as something to be avoided and moved through quickly (Creed *et al.*, 2004; Germeijs and de Boeck, 2003; Mau, 2000; Mau, 2001; Prideaux and Creed, 2001), our data suggest that is not always the case. Given uncertainties in the PhD labor market, limited opportunities for tenure-track jobs as well as growing interest among graduate students in a broader range of careers, being narrowly committed to only one path may not be advantageous. Being open to different careers and engaging in activities that both expand one's horizons as well as prepare one for a variety of opportunities may indeed be quite strategic. The uncommitted group of students in our study were positioning themselves for a range of possible options and a landscape in which they may need to change careers, necessitating versatility and a range of skills.

However, to experience the positive side of indecision, students need agency. Students in the uncertain category are not engaging in agentic perspectives and actions. They seem largely caught in a veil of indecision that is more closely aligned with how indecision is framed in extant career development scholarship (Creed *et al.*, 2004; Germeijs and de Boeck, 2003; Mau, 2000, 2001; Prideaux and Creed, 2001). The data are somewhat unclear regarding whether their lack of engagement in agentic behaviors is a direct reflection of their questions about their self-efficacy, but it does appear that they occur.

These findings can also inform institutional leaders about the efficacy of common career development interventions. While many doctoral programs have engaged in enhanced education, scheduling a variety of talks, presentations and activities that expose graduate students to a variety of careers, our findings suggest that simply providing more information on career options and choices is not an adequate career development strategy. Students in both the uncommitted and uncertain categories knew a lot about various career options. But only uncommitted students were able to benefit from that information. Without simultaneously cultivating student agency, information may either not be beneficial or lead students to feel overwhelmed by a plethora of choices that they seem to have no ability to affect.

Importantly, agency is not static or something individuals do or do not have; agency can be cultivated and developed (O'Meara, 2013). While it is important to note that graduate student communities can offer support and affirmation that can boost student agency (Perez *et al.*, 2019), graduate programs can and should be intentional about creating opportunities to develop graduate students' agency as well. O'Meara *et al.* (2014) highlight five ways departments can promote student agency in career development: encouraging and validating the legitimacy of exploring multiple career paths, offering structured opportunities to develop and practice skills across multiple environments, offering financial and informational resources, helping students expand their networks and through the provision of mentoring and guidance. Faculty are particularly well positioned to support these efforts (O'Meara *et al.*, 2014), and work by Griffin *et al.* (2015) found that the formation of genuine mentoring relationships between students and their advisors that integrate empathy, challenge and support and the encouragement to explore new opportunities and interests supported student agency. It is also important to note that access to professionals

and training specifically focused on career development and guidance can translate to increased confidence and agency as students navigate career decision-making. Notably, Fuhrmann *et al.* (2011) recommend early and structured career development interventions, providing access to mentorship and learning experiences outside of the lab to foster confidence and certainty.

By drawing attention to indecision and highlighting the role of agency in how students navigate indecision, this study provides a new lens on career decision-making in graduate education. Future research is needed to examine how indecision is experienced by different groups of students and especially marginalized populations (students from racial and ethnic minority backgrounds as well as women in STEM). Given the inequitable experiences across different dimensions of graduate education, uncertainty may be yet another dimension along which racial/ethnic and gender inequality is manifested. Understanding whether and how agency in the career decision-making varies across sociodemographic groups is a crucial area of future research and of understanding how institutions can facilitate successful labor market transitions for all students.

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### Corresponding author

Kimberly A. Griffin can be contacted at: [kgriff29@umd.edu](mailto:kgriff29@umd.edu)

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