Competing Discourses of Scientific Identity among Postdoctoral Scholars in the Biomedical Sciences

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ABSTRACT

The postdoctoral period is generally one of low pay, long hours, and uncertainty about future career options. To better understand how postdocs conceive of their present and future goals, we asked researchers about their scientific identities while they were in their postdoctoral appointments. We used discourse analysis to analyze interviews with 30 scholars from a research-intensive university or nearby research institutions to better understand how their scientific identities influenced their career goals. We identified two primary discourses: bench scientist and principal investigator (PI). The bench scientist discourse is characterized by implementing other people's scientific visions through work in the laboratory and expertise in experimental design and troubleshooting. The PI discourse is characterized by a focus on formulating scientific visions, obtaining funding, and disseminating results through publishing papers and at invited talks. Because these discourses represent beliefs, they can—and do—limit postdocs' understandings of what career opportunities exist and the transferability of skills to different careers. Understanding the bench scientist and PI discourses, and how they interact, is essential for developing and implementing better professional development programs for postdocs.

INTRODUCTION

Principal investigators (PIs) and postdoctoral scholars tend to assume that postdoctoral training is a step on a focused trajectory toward becoming a faculty PI at a research-intensive institution (National Academy of Sciences, 2014). This assumption is not realistic; the majority of postdoctoral scholars do not transition into faculty careers (Alberts *et al.*, 2014; National Academy of Sciences, 2014). However, there is little time in postdoctoral training to develop skills translatable to other scientific careers. Recent initiatives from the large funders of postdoctoral training in the United States, such as the National Institutes of Health and National Science Foundation, have begun to address this problem by advocating for individualized development plans (IDPs; Fuhrmann *et al.*, 2002; Hobin *et al.*, 2014; National Institute of General Medical Sciences [NIGMS], 2016; National Science Foundation [NSF], 2018). IDPs (Fuhrmann *et al.*, 2002) encourage postdocs to plan the training component of their positions. *The Postdoctoral Experience Revisited*, a report published by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (National Academy of Sciences, 2014), recommended limiting the total length of postdoctoral positions to 5 years, encouraging scientists to subsequently transition to staff positions. Collectively, these changes reveal competing discourses, or underlying beliefs, that postdoctoral scholars in the academy are simultaneously considered employees, who are bench scientists working in a supportive role for the employer-PI, and trainees (e.g., National Academy of Sciences, 2014; Bernstein, 2017), with low pay, long hours, term positions, mentorship, and the expectation that they will become PIs.

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Much of what is known about the experience of postdoctoral scholars comes from large surveys that focus on factors that determine success, including demographics, structural determinants such as mentoring, career guidance, and opportunities to present research (Alberts *et al.*, 2014; National Academy of Sciences, 2014, pp. 35–36). For example, in a survey that included more than 1000 postdoctoral biomedical scientists, participants described their career goals and knowledge about career options at three time points: PhD entry, PhD completion, and as postdocs. Although knowledge about career options increased from PhD entry to PhD completion and postdoctoral training, clarity on personal career goals decreased through time (Gibbs *et al.*, 2015; Kuo, 2017). This disconnect between options and personal goals may be in part due to the fact that postdocs focus on supporting their PIs' research. Moreover, as beginning postdocs see more senior postdocs struggle on the job market, they realize the low probability of advancing to a position as a PI. However, they are also ill-prepared for other types of positions in science (Hobin *et al.*, 2014). These survey-driven studies describe population-level trends and signal toward changes in postdoctoral training, but additional research is needed to closely examine how individuals navigate this pivotal stage in their careers.

One way to understand the postdoctoral experience is through a developmental lens. Previous research has focused on the formation of scientific identity during undergraduate and graduate education. For example, Gazley *et al.* (2014) identified three elements in a scientific identity: doing science, being a scientist by developing a sense of self as a scientist, and becoming a scientist through educational and career choices. Carlone and Johnson (2007) framed these stages slightly differently, focusing on performance, competence, and recognition. They note that scientists who identify as researchers must recognize their own achievements but must also be recognized by others. The authors also comment on the intersectionality of identities, specifically the interplay between a scientific identity and racial, ethnic, and gender identities. Underrepresented ethnic and racial minority PhD students describe facing additional barriers, including the lack of role models who look like them, feeling like a trailblazer, and lack of understanding by their PIs (Williams *et al.*, 2016).

To our knowledge, no research has examined the way postdocs form their scientific identities while they are in their postdoctoral positions, as opposed to when they are at a later stage of their careers looking backward. Understanding how their scientific identities develop may be particularly helpful for developing strategies to support them as they navigate a time of uncertainty and stress, when they begin to realize the number of career options outside academia and the limited opportunities within academia.

In this paper, we explore the discourses that postdocs used to describe themselves as scientists. We then document how postdocs choose between these discourses and the way these discourses support academic science. We conclude by analyzing the way these discourses interact in complex, sometimes contradictory, ways. This analysis leads us to reaffirm the previous suggestions that institutions provide more opportunities for professional development.

METHODS

Recruitment and Participants

Participants were recruited by distributing an invitation to email lists for postdoctoral scholars; at events likely to be attended by postdocs, such as professional development opportunities and research seminars; and by word of mouth. Eligible participants had to be employed as postdoctoral scholars in the life sciences or related fields at the time of the interview, speak English, and work at a large, research-intensive university in the Pacific Northwest region of the United States (25 participants) or at one of the many nearby research institutes (5 participants). The postdocs each received a $50 retail gift card in appreciation of their participation. Interviews occurred between April 23, 2015, and July 14, 2015. We used convenience sampling to restrict the sample size to 30, a design that does not allow comparisons across demographic groups. We provide the demographic data in aggregate to describe the entire sample (Table 1).

Each interview was conducted in a location agreeable to both the interviewer (I.K.-G.) and the interviewee, away from the postdoc's work area. A semistructured interview guide (Table 2) was used flexibly to conduct a conversation that would uncover ideas of scientific identity formation in the participants, so questions varied to some degree across all interviews. For each participant, we used the entire interview in our analysis, rather than focusing on individual answers to specific questions. Because single participants can hold a set of contradictory beliefs about scientific identity, this set of questions—and the way in which they were modified during each interview—can unearth complexity about scientific identity.

Interviews were audio-recorded; after each interview, the participant completed a brief demographic questionnaire (Table 1). Research assistants subsequently transcribed the interviews, removing identifiers. We include transcript numbers in parentheses after the quotations we present, so that

TABLE 1. Demographics of interview participants

Gender	57% female 40% male 3% trans*
Age	27–40 years (mean = 32.7 years, SD = 2.8 years)
Marital status	80% in a committed relationship or married
Children	73% without children 17% with one child 10% with two to four children
Race	63% white 20% Asian 3% Black 14% other or combinations
Ethnicity	80% not Hispanic 20% Hispanic
U.S. citizens	70%
Years since PhD	1–7 years (median = 4 years, 2011)
Biological disciplines	23% neuroscience 20% molecular and cell biology 13% biochemistry/biophysics 10% bioengineering 10% immunology 23% other

TABLE 2. Interview guide

Tell me about when you first knew you *wanted* to be a scientist.
Tell me about when you first knew that you *were* a scientist.
What did you imagine your life as a scientist would be like?
How does your current life compare to what you imagined?
What does it mean to be a scientist working in a university?
What does it mean to be a scientist outside a university?
How does your life as a scientist fit in with your life outside science? Are there conflicts between these different lives? Do you anticipate any problems in the future?
What do you hope your life will be like in 5 years? In 10 years? What will make this successful?
What do you think are the barriers toward achieving your 5/10-year goals?
Anything else you would like to share?

readers can see which quotations are from the same participant. We use the gender-neutral pronouns "they," "them," and "their(s)" to refer to each postdoc to obscure gender identity. Our sampling strategy allows us to comment on how a collection of postdocs perceive their scientific identities, but it does not allow us to make general claims that characterize different demographic groups. Therefore, obscuring the gender, cultural, national, and racial identities of the participants helps the reader avoid extrapolating from the quotations that we present in the *Results*. The University of Washington Institutional Review Board determined that our research protocol was exempt from federal regulations (exemption #49476).

Discourse Analysis

Professional identities are shaped by many beliefs about the world and society (Foucault, 1973). Discourse analysis is a method of analyzing textual data that is based on the idea that all of reality is shaped by such beliefs (McCloskey, 2008). These beliefs, or discourses, are crucial to how people think, talk, and act within the many different social and institutional systems in which they live. The conduct of science is similarly controlled by discourses (Foucault, 1973). Foucault (1973) identified the power that institutions hold to maintain professional knowledge. When this approach is used to understand interviews, the goal is to identify what discourses underlie the interviewee's statements and how those discourses influenced the interviewee's decisions and actions. Some discourses represent the power dynamics of the institution that houses the interviewee, and other discourses can resist those dynamics. It is possible for a single person to switch among discourses. In our approach, we view the temporary nature of a postdoctoral position as an institutional construct whose influence we wanted to explore (the Foucauldian discourse described in Willig, 2013).

Two of us (R.M.P. and I.K.-G.) worked in tandem to analyze the transcripts iteratively. We began by taking notes on each transcript independently, and then we discussed them, highlighting the themes we noted. We included the following steps, although not necessarily in this order, to interpret the first 20 transcripts (Willig, 2013; Gee, 2014):

- A brief, initial, independent reading of the transcript to get an overview of its meaning and content, focusing on how a postdoc described their identity.
- An in-depth, independent reading of the entire transcript to identify implicit and explicit discourses focusing on beliefs about science and scientific careers. We highlighted relevant sections, coding them for the discourses we identified.
- A discussion exploring discourses about identity that we identified in the interviews, describing their characteristics and their power of explanation across the different contexts within the participants' accounts. We identified the limits of the discourses when the participants' own words appeared contradictory and/or suggested alternative explanations.
- A discussion in which we documented how these discourses accomplished social goals that led to consequences for the postdocs—both intended and unintended—and how they established social and institutional structures that constrained individual choices and actions.
- Continuous discussion until we reached consensus about our interpretations.

After completing these steps on the first 20 transcripts, we compared and contrasted the major themes that we had identified, noting when each participant used each discourse. We also explored the role of the institutions that shape these discourses.

We then read the last 10 transcripts to assess the consensus we had formed. No new insights were uncovered from those additional transcripts, indicating we had achieved saturation.

We evaluated the credibility of the discourse analysis using Potter and Wetherell's (1987) criteria: coherence—that the discourses model the participants' worldviews in ways that are consistent and complete; participant orientation—that the model was evident in the participants' words and experiences; new problems—that the models generated new questions and problems; and fruitfulness—that the discourses developed new perspectives and explanations. These evaluation criteria do not include any quantitative thresholds, consistent with a qualitative methodology that is highly interpretive (Sandelowski and Barroso, 2003). The identification and elucidation of discourses in the data are accomplished simultaneously by iteratively examining individual transcripts and the corpus of all transcripts. This iterative approach verifies that the discourses explain the data adequately and consistently. This is an analytic process that aims to understand the meaning behind the text rather than to quantify words, phrases, or themes (Sandelowski and Barroso, 2003).

RESULTS

Discourse analysis is an approach used to identify the ideals or beliefs within oral or written communications and interpret the meaning behind the words and the concepts embedded in phrases (McCloskey, 2008; Willig, 2013). Here, we report that postdoctoral scholars construct their identities through two different discourses: bench scientist and PI. We describe how postdocs grappled with their perceptions of each identity as they considered the next steps in their careers. In this section, the phrases "bench scientist" and "principal investigator/PI" refer to the postdocs' subjective perceptions, not objective representations of these careers. Each discourse reflects a way of thinking of oneself as a scientist, and participants could implicitly or explicitly engage with both discourses depending on the context of different points within the interview (McCloskey, 2008; Willig, 2013). We do not report the frequency of various aspects

TABLE 3. Common perceptions in the bench scientist discourse, with examples from postdoc interviews of each

Perception	Example
Close to the data	*Experimental design* "To be an independent scientist is, I guess, I would say, to have an idea for a project, figure out what you need to do to get it up and running, and carry it through to completion" (6). *Collecting the data* "The kind of very basic work of collecting the data where you're sitting at the rig watching neural activity … and that's a huge part of the initial … analysis … a lot of people who are PIs say that they miss that, that they miss the actual doing of science where you're collecting the data and then just straight analyzing it" (2). *Working alone* "Most of the time it's me and the data and it's a very solitary existence, I'm not interacting with people as much" (2). *Analyzing the data* "I do want to stay engaged in experiments and data analysis and interpreting experiments and not just hand that off entirely" (29).
Avoiding tasks distanced from the data	"I see faculty members constantly writing in their offices day in and day out, that's not what I want to do" (13).
Advanced experimental skills	*Difficult experiments* "Then I started doing very difficult experiments that many, like, most people can't do and that he trusted me with those experiments that I realized, 'Okay, like, I'm actually really good at this,' and so towards the end, I think that's when I started kind of developing the confidence that, okay, it's not just that this great man is training me, like, I actually have what it takes to do this" (5). *Troubleshooting experiments* "There was a point there where I was … troubleshooting my own experience I was like, 'wait, this isn't, this isn't just grunt work anymore, this is truly doing science and asking questions" (14).
An approach to all life	"I play lots of board games and so that takes the same skill set but in a different way, critical thinking, problem solving, if I try this, what will happen, hypothesis forming, that kind of stuff" (14).

Parentheses contain transcript identification numbers.

of the discourses. Because discourse analysis is necessarily qualitative, quantification can obscure the complexity of the way participants use discourses in different and overlapping contexts. We conclude this section by explaining how the discourses that postdocs used support academia as an institution.

Bench Scientist

Postdocs using the bench scientist discourse construct a scientific identity that values direct or intimate interaction with the real world through experimentation, a sentiment captured by a postdoc saying "I'm good with my hands, like, and I have that tenacity to make very difficult experiments work" (5). This engagement occurs through physically conducting experiments; using advanced, hands-on skills; applying expert judgment to troubleshoot; and making decisions about which specific experiments to perform (Table 3). In this discourse, scientists collect their own data, "just playing with the tools I have around" (12). This approach means that doing science is tangible and physical, and can describe the work that postdocs conduct in the laboratory. These scientists are physically in the laboratory wearing lab coats, holding pipettes, and getting their hands wet. They look and act the part: it was when I was "full-fledged dressed in a lab coat, gloves, pipette in hand that I was like, 'I am a scientist.' So it was more the physical appearance, maybe, of looking like a scientist before I really thought of myself as a scientist" (13).

Conducting Experiments. In this discourse, the postdocs stay close to the data by designing and conducting experiments. One postdoc emphasized a personal approach to science in graduate school and beyond as "I love, um, designing experiments and reading papers and learning about this, all this stuff…" (23). The ability to conduct these experiments comes with the confidence of designing experiments, for example, "To be an independent scientist is, I guess, I would say, to have an idea for a project, figure out what you need to do to get it up and running, and carry it through to completion" (6).

The focus on collecting data makes the postdoc years golden. Collecting data is fulfilling, gratifying, and balanced: "The postdoc is … the best time for [chuckles] … enjoying science [chuckles]. It's really good, you just have to do your experiments, you are focused on your project, you don't have to worry" (9).

The ability to troubleshoot and think about experiments can be solitary: "Most of the time it's me and the data, and it's a very solitary existence. I'm not interacting with people as much" (2). This solitary existence is not lonely, but rather independent and self-sufficient. As a postdoc, "you are more independent, and, of course, you are more experienced" (17).

Avoiding Tasks Distanced from the Data. A bench scientist can remain focused on experiments and avoid the distracting work of describing a broader program to funders. This approach makes staff scientist positions attractive: "I wouldn't mind being in an academic lab under someone else,… supported by the PI, and then I'm doing the science and writing manuscripts and training graduate students and postdocs" (14). Another observes that "I see faculty members constantly writing in their offices day in and day out, that's not what I want to do, so I see trying my hand in industry or getting a nontraditional academic position after the postdoc" (13). Additional context from this interview indicates that a "nontraditional academic position" means staying in the academy without becoming a PI.

Writing papers is another way in which this discourse encourages postdocs to focus on data they collect rather than big picture questions that need to be formulated for a grant proposal. For papers, reviewers

> are not looking at … "Are you worthy?,"… they are looking at, "Is your science solid…?" I feel like I'm telling a story and having a little bit more of a narrative there more so than a grant, which is all perspective … writing manuscripts, that doesn't, that doesn't bother me at all. (14)

Moreover, as this postdoc observes, writing papers is satisfying and "not a struggle like writing grants" (14).

Advanced Experimental Skills. Bench scientists conceive of experiments to help solve the problem they are working on, and sometimes these experiments are difficult. One postdoc began to self-identify as an expert when no longer doing exactly what was advised, moving from "'I'm just going to do whatever this great man tells me to do,' … towards … doing very difficult experiments that many, like, most people can't do and … he trusted me with those experiments" (5). Other scientists in the lab, department, or beyond recognize this expertise in the fully developed bench scientist and come to them for advice. This expertise can bring great pride:

> I have my name on, like, a techniques paper. So then now I can be considered, you know, an expert on this technique and take it wherever I go. Um, which is kind of … definitely going to be a boon to my career … I'm hoping that it makes a big impact. (28)

In the bench scientist discourse, a suite of intellectual skills make these scientists more advanced in their careers than technicians. One postdoc began feeling like a scientist after tackling "troubleshooting … I was like, 'wait, this isn't, this isn't just grunt work anymore, this is truly doing science and asking questions'" (14). Moreover, success is perceived, in part, as the ability to troubleshoot when an experiment does not work: "If something goes wrong, I have a pretty clear idea that it was either me who messed it up or there's something that I need to fix … you … get your data and troubleshoot whatever happened along the way" (1).

A Way of Living. The bench scientist discourse describes an approach to discovery and interpretation that carries over into the rest of life. It is a disposition toward being an experimentalist in any context and having a love of learning:

> I try and be quite logical and, kind of, well, if something is not working, then you test a different way, kind of thing and, and I think I do that with not just work and academia, I think that kind of translates into how I deal with the rest of life and decisions. (20)

The problem solving that a bench scientist does can also be fun: "I play lots of board games and so that takes the same skill set but in a different way, critical thinking, problem-solving, if I try this, what will happen, hypothesis forming" (14).

Principal Investigator

The postdocs in our study perceived PIs as scientists who envision entire research programs, ask research questions addressed by that program, and are "pushing, you know, the limits of knowledge" (3). According to our participants, this focus on the big picture necessarily shifts PIs away from the bench, while also elevating them into superstar status. They see PIs as writing papers, as bench scientists do, but also writing grants and traveling around the world to give talks. They perceive that becoming a PI is the—sometimes unachievable—dream, the ultimate career goal. This dream is based in part on the impression that PIs have enormous intellectual freedom, which the participants express as the ability to pursue whatever research questions interest them (Table 4).

Academic Freedom. A postdoc may see a PI as having great freedom to choose which scientific questions to pursue: "There's this idea that in academia it's about truth and knowledge and, um, in industry, for example, it's about, kind of, making a product that will sell" (5).

Postdocs who constructed this vision of freedom seemed to take for granted both that PIs obtain funding and that they retain complete control over the science performed in their laboratories. These postdocs found this concept of a PI to be particularly appealing, focusing on "the independence that it offers as far as career … to … be your own boss … [to do] what you want" (15). The sense of freedom may be even more meaningful than the area of research:

> That sense of freedom to go after ideas, come up with ideas, design experiments, ask questions, answer questions, that feeling is the feeling that I try to go after … I choose where I work and who I work with … the science that they do is almost entirely secondary. (10)

We also observed the belief that funding for this kind of intellectual freedom would always be available. For example, one participant argued that academia is preferable to industry, where

> a project can be cut off at any time, so it's, it's less, less independence because your, your project could be pulled out from under you at any time … that doesn't really happen in academics, you know, you gradually find out that you can't fund something, but, um, you can still sort of pursue little side projects, even if you don't have direct funding for them, you know, at least in small amounts. (15)

The notion of academic freedom about what research to conduct is tempered, in part, by the need to be successful, finding a balance between risky, exploratory research and safe experiments:

> We just kind of have to do safe experiments in order to write the papers, in order to get the next grants, kind of thing. Um, but I think you can still work within that framework, you just have to decide how you ask your questions and what questions you ask, um, you just kind of have to tailor it to the, the funding situation. (20)

In contrast, other postdocs acknowledged that "maybe academia isn't as free as, as, as what one might assume or what it

TABLE 4. Common perceptions in the PI discourse, with examples from postdoc interviews of each

Perception	Example
Academic freedom	"That sense of freedom to go after ideas, come up with ideas, design experiments, ask questions, answer questions, that feeling is the feeling that I try to go after … of doing science, of being, uh, free to pursue what I want" (10).
	Grants limit academic freedom "Your academic freedom is limited by the amount of money you can pull in" (4).
	Grants do not limit academic freedom "[My PI] never felt constrained [by] the, the current grants he had, um, and it, you might promise one thing in a grant, and you do something very similar, um, but if you found something else, you let the science lead you there and, um, that's kind of a good, you know, he kept things in perspective, he was a bit loose that way" (10).
Grand vision	*Writing grants* "You need to think about what's your next step, what's your next grant, how are you going to pitch yourself" (5).
	Grand science "In 10 years I hope that there would be something that I could say, 'I discovered this' [chuckles] … because, um, like, that's kind of the problem that I'm having right now, like, scientifically … everything [is] … kind of like a permutation of what's been done previously" (16). "I think it's a very high honor to be a scientist, I think. That's the way I feel. I wouldn't call anybody a scientist, actually, I think" (8).
	Invited talks "People get to the positions they're in because they are successful scientists, they're good at giving talks, they travel around and present research, they are supervising a huge staff of people" (2).
Removed from the bench	"My PhD supervisor really wanted to and, to the point where, we kept a lab bench open for him, even though we were all struggling for space [chuckles] … and he had pipettes there, and he had that space open for them to do experiments, and he always said, 'I'm going to do experiments, I'm going to get back into the lab,' and he never could, because there is always something" (20).
Work comes first	*Little work–life balance* "The majority of really successful scientist have made a decision one way or the other, family life or science life. Um, even my own boss who I work for now has a really funny interview from probably about 20 years ago where he said when he was in his late 20s/early 30s, he had the choice between starting a family or starting a lab. And he started a lab and he doesn't have any kids and he's been insanely successful" (25).
	Having it all "One of my postdoctoral mentors here, he has a young kid and so, you know … I've, I've seen how he has, and I've heard stories about how he has … learned to partition his time now that he has a young child, and so one story I remember hearing, uh, was that, eh, this was before I got here, that he, you know, he would … have meetings with his graduate students and, at least on one occasion, uh, they went for a walk … while he was pushing his young child around in the stroller " (4).

Parentheses contain transcript identification numbers.

was like, maybe, even 10 years ago" (29). These participants also identified the increasing difficulty in obtaining grant funding as a major challenge to a PI's academic freedom.

Grand Vision. Developing a vision of a research program and spending time disseminating one's work are key features of the PI discourse, which makes giving talks and publishing important goals. This visibility is external validation of the PI's achievements as a scientist, and it is recognition of one's elevated reputation. Writing grants and obtaining funding form a substantial component of this scientific identity. Grants synthesize the work of all the lab members into a cohesive, impactful vision. Formulating this vision is so important that it may diminish the role of other activities, such as mentoring postdocs: "I think that a lot of PIs will choose not to [mentor postdocs] because they feel like their time is better spent on writing grants [chuckles]" (14).

In the PI discourse, the title "scientist" is reserved for giants of research and not for those doing everyday benchwork: "I never thought, 'I am a scientist.'… I think it's a very high honor to be a scientist" (8). The postdocs in our study who think of scientists as particularly grand also think that the title needs to be earned through groundbreaking work:

> In 10 years, I hope that there would be something that I could say, "I discovered this" [chuckles] … because, um, like, that's kind of the problem that I'm having right now, like, scientifically … everything [is] … kind of like a permutation of what's been done previously. (16)

When postdocs mention this idea of a scientist as a grand achiever, they may also bring up their own sense of inadequacy:

> You read textbooks and stuff about studies and things people have discovered and it's, they're kind of the people behind that are in, like, a different league than, I just feel like, I don't often think about the big picture, I'm more caught in what I'm doing on an individual day. (19)

In addition to obtaining funding and making groundbreaking scientific discoveries, PIs are perceived by postdocs as disseminating their research by "giving the seminars, um, traveling to conferences and giving poster presentations, you know, all of that adds to the persona, I guess, of being a scientist … being able to present your data and answer questions" (13).

Removed from the Bench. In this discourse, PIs do not have the time to collect data: "The life of an academic scientist was … very little, if any, benchwork; you're basically writing and mentoring and whatever, uh, duties or department requires beyond that" (15). PIs may want to conduct experiments themselves, but the perception is that benchwork is a low priority. One postdoc described this tension in a graduate advisor:

> We kept a lab bench open for him, even though we were all struggling for space [chuckles] … and he had pipettes there, and he had that space open for them to do experiments, and he always said, "I'm going to do experiments, I'm going to get back into the lab," and he never could, because there is always something. (20)

Another postdoc provides an example of this perception by saying that

> it surprises me that as, uh, as I look at PIs now, how little actual science they get to do, and it's for the most part administrative and writing tasks, and not, like, actually keeping up with literature and things, like, I don't think my PI reads papers hardly ever, because he's just so busy with other things. (27)

Does Work Come First? Participants who prioritized work perceived that PIs consider socialization and family life as secondary interests; they described PIs as people who have very little work–life balance. These postdocs see PIs as willing to sacrifice everything for their careers, noting that the PIs cannot choose where they live, and even stating that location should not matter to them because of their passion for their work. In this discourse, the postdocs also indicate that PIs work long hours:

> The majority of really successful scientists have made a decision one way or the other, family life or science life. Um, even my own boss, who I work for now has a really funny interview from probably about 20 years ago where he said when he was in his late 20s/early 30s, he had the choice between starting a family or starting a lab. And he started a lab and he doesn't have any kids and he's been insanely successful. (25)

A downside of this view is that the PI discourse can clash dramatically with a postdoc's priorities. In fact, placing work first may at times be unreasonable:

> The conflicts are with … my PI wanting me to be in the lab, and me needing personal time. Um, so there was a death in the family, and I had to leave the country, and … I knew that my boss wouldn't want me to be gone for very long, I had to limit my trip to, like, 1 week. Um, which was okay with him. And then, um, later on, like a few months down the road, I had to go back for a, um, burial ceremony. And he was not okay with that. (22)

In contrast, other participants saw the PI discourse as a way to prioritize work and family simultaneously, for example, "I've worked with a PI, a female PI that, at age 40, yeah, I joined her lab, and at age 40, 41, she got married, had her first kid and got tenure all at the same time" (5). Under this conceptualization, the PI may even be seen as a family-friendly role:

> One of my postdoctoral mentors here, he has a young kid and so, you know … I've, I've seen how he has … learned to partition his time now that he has a young child, and so one story I remember hearing … he would … have meetings … and, at least on one occasion, uh, they went for a walk … while he was pushing his young child around in the stroller. (4)

Choosing a Discourse: Principal Investigator or Bench Scientist

Participants were, at times, actively considering what to do in the next stage of their careers, with some planning to be PIs and others exploring more options. The discourses of bench scientist and PI influenced how they framed the choices that lay ahead.

Maintaining the Bench Scientist Identity. Participants who wanted to maintain a bench scientist identity within the academy looked for positions that would allow them to continue the same kind of work they were doing as postdocs, for example, as research scientists, research professors, or acting instructors (at the university where this participant worked, "acting instructor" is a fixed-term research position that typically does not involve teaching): "I guess I'm, I'm now moving into acting instructor, uh, you know, I kind of am at the good spot, where I've kind of proven myself to the lab, and I can kind of coast on some of this" (26).

Participants identified industry careers as another way to maintain the identity of a bench scientist. However, the idea of moving to industry may accompany a feeling of disappointment, or even failure, at leaving the academy:

> I wouldn't mind being, like, an editor or a scientific advisor to a IP firm … I'd be happy … not as happy … another thing about those, those kind of back-up plan jobs is I feel like I would [chuckles] be very, reading about that stuff all day long, and I would be very frustrated [chuckles]. (23)

This quotation, along with other context from the interview, reveals that the postdoc thinks of switching to industry as abandoning research altogether, when in fact many industry jobs involve research. In fact, pursuing the bench scientist identity through industry can be empowering, for example, when combined with entrepreneurship. One postdoc first imagined being a scientist in childhood, but envisioned being an entrepreneur in the future, elaborating that "I imagined myself in, in a lab in, in or in a garage full of tools or, [with] laboratory equipment and, and just like, playing with … stuff …" This postdoc notes that "the university wasn't really my thing … the other thing that I had always wanted to do is, like, making my own company … doing something … that I could actually, I mean, build and sell" (12).

There Is No Plan B. Postdocs who are beginning to assume the PI identity are determined to succeed. They may hold the optimistic view that they are working harder than others, that they want the goal more than others, and that their effort will guarantee their success: my "work ethic is, I think my, my strength

… I think that half the battle is just wanting it bad enough … I think if you want it bad enough, that you just keep trying, that it will happen … there is no Plan B" (5).

One strategy that participants used was to ignore barriers, perhaps even perceiving well-documented institutional discrimination as an asset. For example, one claims that "fortunately for me, I think it kind of helps a little bit that I'm a woman, there's not a lot of women that are out there in this, doing this particular thing" (5). Another postdoc indicates that "as a woman, I have never experienced in my life, any kind of discrimination, in science, never … I, I have worked very hard, and I always got the same thing that, for example, my husband got, so I don't see that as, as a disadvantage…" (9); earlier, she observed that her minority status "could be a problem or an advantage because now people is so interested in, uh, hiring minorities that, that can place on your favor" (9).

Participants who felt trapped by the academy felt that there was no "plan B" because they felt ill-prepared to pursue other careers. They insisted that their research skills were not transferrable: "There are postdocs … whose research can go either way, they can be in industry or they can be in academia and, um, I can never make a drug to, kind of, make a blind man see" (5). Similarly, another claimed that "my job skill set has not been curated to be industry relevant" (11). Another argued that "being an academic postdoc doesn't prepare you for anything else but academia" (22). They felt that their training left them no choice but to look for a PI position at a university.

Holding Both Discourses. Participants considered a variety of positions for which they qualify. Those who wanted to maintain both discourses, as well as those committed to staying in the academy, were thinking of applying for professorships at different kinds of institutions. We observed a hierarchy in their goals: being a PI at a research-intensive university; the perception of an easier to obtain position as a professor at a university that combines research and teaching; teaching-intensive positions, for example, at community colleges, that retain the prestige of being in the academy; and industry positions. This hierarchy was implied throughout the interviews but never stated explicitly.

When our participants talked about seeking faculty positions that involve a considerable amount of teaching, they did not always recognize the competitiveness for these positions. They did not realize that their intensive research training might not prepare them to obtain or succeed as an assistant professor in this context. For example, we asked what one postdoc would do if there was "trouble getting grants"; the reply was that "at least I'll have a teaching, so, because I like teaching" (21). The interviewer prompted "Have you had much, uh, experience teaching?," and the postdoc replied, "Uh, I didn't teach a full quarter but … I, I like teaching" (21).

The idea of being a professor at a liberal arts college instead of obtaining a PI position at a research-intensive university appealed to participants who wanted to maintain both the bench scientist and PI identities:

> I don't think that being a research professor is going to be the right choice for me, because having to support myself and my lab on my ability to write seems like a bad plan when I'm not real good at it. Um, so the things that I've been considering are finding a teaching position at a liberal arts university, somewhere that has a small research program but mainly I'll be supported by the university through teaching duties. (14)

The preceding passage also implies the inaccurate expectation that most liberal arts colleges can afford to support biomedical research. In fact, postdocs interested in liberal arts colleges did not necessarily recognize that their research required the facilities and staff of a research-intensive university.

Participants who were passionate about teaching were committed to teaching college, even if it meant an unstable, adjunct position compared with a stable, higher-paying position at a high school, expressing that they would like to be at "a 4-year institution. Or maybe community colleges if they paid better [chuckles] … I don't know if I can do high school teaching" (18). In contrast, another participant embraced the opportunity to teach high school, despite having received two offers for tenure-track positions at liberal arts colleges, because high school was a better match geographically and because it was still consistent with their scientific identity: "the type of scientist I wanted to be … has a large role mentoring other developing scientists … teaching a lot … contributing to … the development of people's scientific identities more than the cutting-edge research that people push" (11).

Discourses Support Academic Productivity

Discourse analysis allows us to understand how postdocs' underlying beliefs reflect institutional power (Foucault, 1982). In this section, we explore how these discourses reinforce an academic system based on productivity. We focus on productivity, because success for professors in academia is often measured by the ability to procure external grant funding and to publish peer-reviewed articles (e.g., Kenny, 2017). The classic perception of the path to success is: grants are awarded to productive PIs who run labs with productive postdocs who publish frequently in high-impact journals and then become PIs (Kenny, 2017). Systems are reinforced by their actors (Foucault, 1982)—here, PIs and postdoctoral scholars—and by resources and criteria that lead to appointment and promotion (Kenny, 2017). Our participants observed that this productivity requires personal sacrifices that include accepting lower salaries than they would receive in industry or living in a less than ideal place. Nonetheless, the sacrifices feel worthwhile given the appeal of an idealized vision of the academy.

Scientific Productivity versus Other Forms of Career Development. Building a portfolio of published research is key to the advancement of postdocs, but study participants indicated that this may come at the cost of gaining other skills: "Most PIs … don't want you to waste your time getting funding, because it takes a considerable chunk of your time. They want you to focus on the science … it doesn't necessarily give me a lot of experience for when I need to tackle my own grants" (25).

Both the bench scientist and PI discourses value productivity. However, there is often conflict around other forms of professional development that detract from research: "I think, people go into labs and you're supposed to, you know, really be mentored and there's a lot of professional development that's supposed to happen that often just doesn't happen" (6).

Sacrifices That Postdocs Make

Losing Work–Life Balance. Participants who sacrificed work–life balance worked long hours, but this choice seemed justified by the demands of science and necessary for future success and was not necessarily described or acknowledged as a sacrifice. One participant

> decided that, you know, balance is overrated that, you know, the way to make it in science is to, kind of, just go all in … I work 7 days a week. I take 1 day or 1/2 a day off every 4 or 5 months, and that's mostly to do something for my family or to run an errand that I can't otherwise … if you want to achieve a certain kind of level of excellence in the field or you want to, um, yeah, you want that, then science wants you to work every day. It's not a 9 to 5 job. It's something that demands way more than that. (5)

It is noteworthy that the postdoc does not posit working long hours as a sacrifice, but situates it as a lack of balance. The postdoc instead views working long hours as a challenge that a personification of science makes and that successful scientists accept: "I realize that science is a very selfish field. It wants you for itself … it rewards you for giving up other aspects of your life" (5).

Even participants who emphasize the need for work–life balance assumed they would work long hours, for example,

> Work–life balance is very important, um, so I, I try to, to strike that balance, uh, you know, spending time with my wife and friends and, uh, I certainly couldn't, you know, I know there's some postdocs that do work 70/80, 80 hours a week, I could not, not to do that, um, I'm probably more in the 50/60-hour range, um, and even that kind of pushes that sometimes as far as, uh, [chuckles] having a balance and, uh, uh, still being happy with what you're doing. (15)

In this example, the postdoc paradoxically interprets balance as pushing oneself as far as possible. This participant also framed the excess work as reasonable for a postdoc, but in another part of the interview, anticipated that they would find more balance as a faculty member. Their perspective was that spending time writing—rather than at the bench—would allow for a more flexible schedule and one that is compatible with, eventually, having children.

Postdocs who perceived family life and the PI discourse as mutually exclusive, but who wanted to have children, were motivated to consider leaving research: "If it comes to the sacrifice of the science, for me that's the choice that I would make in a heartbeat. That the life with the family's much more important" (25). Others found that this stage of their careers may be incompatible with having children, despite the fact that other postdocs are parents: "It may always be that we choose not to have kids because we are interested in pursuing our own careers" (14).

On the other hand, participants with children saw their families as a way to reset the balance between work and life. They enjoyed a fluidity between work and family life, although even this fluidity continues to emphasize work:

> Um, well, we have kids, so we are quite busy, when we come home, but, uh, it, like I said, my husband is in science, as well, and so it's kind of like we don't stop thinking about science … and, uh, it's most often dinner conversations [chuckles], so, or either of us looking at each other's work or whatever, and late-night lab runs and that's what's nice about being married to a scientist because you [chuckles], you understand each other's [chuckles] need for going in on early Saturday mornings and things like that. (23)

Having a postdoctoral mentor who modeled spending time with children helped those contemplating having children one day:

> [My] PI, so I think he spends quite a bit of time with his children. When he had no children, he was very, very good, mm, I mean, in the time frame he was coming on time and early, like, whatever, time he was going h—, but now almost every other day, he goes early just to pick [up] his child, so I think I have the same thing with me, that probably I will take more responsibility once I, we have [a] child. (21)

Seeing PIs with children did not, however, impact the work–life balance decisions of other postdoctoral scholars. For some, balance was something that could be achieved in the future as a PI, but not necessarily in the present.

Low Salaries. Despite the long hours, low postdoctoral pay has been justified by positioning postdoctoral scholars as trainees. Participants who were frustrated by their salaries indicated that they were financially burdened at a time in life when other professionals earn higher salaries: "It's kind of hard work for, relatively speaking, not much recompense, compared to other, you know, like, my peers that went and did medicine" (20).

Impermanence. The participants were at a stage of life when job stability is more common, but postdoctoral positions are temporary: "When you are younger and more naïve, I don't think you realize, kind of, all the sacrifices, and stuff, you have to make and, 'Oh, I'm going to be 30 years old and still in a temporary position'" (19). The temporary nature of the position means that postdocs are unable to build roots and settle, despite the fact that they are at a stage of life when many of their peers are settling down and/or starting families. Participants who wanted to establish roots near family recognize that this priority might limit their chances of finding a position as a PI:

> My goal is, um, to be back in my, where I grew up, and, uh, there's a big university there, and I want to be close to my parents as they get older, I would like to get back in time before my grandmother dies, and my best friend and his, his wife and child are there, so that's where I'd like to be, and for that reason, I have to think what jobs are there. (10)

The desire of participants who wanted to find a job in a particular city contrasted with the reality of the difficulty of finding a PI position in any given location.

DISCUSSION

The postdoctoral scholars in our sample used the bench scientist discourse and the PI discourse to describe their scientific identities. These discourses interact with each other in complex ways, at times revealing contradictions and at times supporting

the productivity of the lab where the postdoc works. Through contextualizing our results with others' recommendations and the results of other studies, we reaffirm the suggestion that institutions, rather than postdocs' PIs, provide the needed opportunities for professional development.

The Discourses Frame Career Choices

The ways conceptions of different scientific identities overlap, intersect, and even contradict each other have not been studied extensively, especially among postdocs. Our study sheds some light on the way postdocs navigate the bench scientist and PI discourses. Postdocs whose beliefs reflect the bench scientist discourse (Table 3) may also have beliefs that reflect the PI discourse (Table 4). One postdoc represents a scientist who is transitioning from an identity that is characterized primarily by benchwork ("where you're sitting at the rig watching neural activity" [2]) to one recognizing what is necessary to assume a PI identity ("they are successful scientists, they're good at giving talks, they travel around and present research, they are supervising a huge staff of people" [2]). At times, a single quotation embodies both discourses, such as when a postdoc describes the appeal of obtaining a position as a research assistant professor:

> I think the realistic path for me is … being a research assistant professor … so that would be all soft money, which isn't ideal, but, um, I think I could, uh, make do with the, the fact that I get more freedom, uh, and just apply for grants, I can give up that job security of a tenure-track thing … I'd rather stay in academia … and … find … a good way to keep doing science without, um, the pressures of a tenure-track professorship. (27)

The postdoc wants to avoid the perceived, incompletely understood demands of being a PI. The way this participant straddles the two discourses illustrates one way to change and develop a scientific identity.

Our participants held a number of assumptions that may or may not be accurate. The postdocs in our sample who wanted to become PIs, for example, assumed that they would achieve this goal, a belief that exceeds the number of available PI positions (Alberts *et al.*, 2014). The belief that becoming a PI, or at least obtaining an academic position, is the only true, successful career objective obscured other options. We found it noteworthy that those who were interested in teaching were committed to teaching college, even if it meant an unstable, adjunct position. Other teaching positions, for example, teaching at a high school, can offer more stability and higher pay, but postdocs tended not to consider this possibility. Those who prioritized research believed that their expertise would not translate to industry positions. Exaggerated notions of academic freedom further supported the glamor of becoming a PI. Many postdocs in our study held an idealized belief that PIs could research anything they desired, downplaying the obligation to address the research questions that were funded and the difficulties of obtaining grant funding.

One assumption revealed in our interviews was the belief that all faculty positions are similar to the PI positions at research-intensive institutions. The postdocs did not recognize the way professorships at other types of institutions—including community colleges, liberal arts colleges, and master's regional universities—balance the two discourses differently (Kelsky, 2015). For example, at a master's regional university, a professor can be actively involved in bench science, while also working collaboratively with professors at similar positions. These faculty positions require expertise in teaching, a neglected area for most postdoctoral scholars.

Adherence to the bench scientist and PI discourses for postdocs' career development holds consequences. Postdocs who did not want to become PIs reported that they wanted to have more opportunities to develop skills translatable to other careers in education, industry, and government. By working as postdoctoral scholars for longer periods of time, they delayed attaining entry-level positions into their 30s or later (Kahn and Ginther, 2017). Their long working days led to a loss of work–life balance, unsustainable schedules, and delays in having children. Although these sacrifices may result in progressing through an academic career, that path is far from guaranteed. Graduate students and postdocs constantly need to adjust their career goals (National Academy of Sciences, 2014).

Institutions Can Mentor

The discourses we identified do not posit mentoring as helping trainees build careers. Instead, the participants' concepts of mentoring focused on teaching their mentees to do experiments or collecting data to support their own mentors' research programs. This result is noteworthy because it differs from the recommendation to posit postdoctoral appointments as traineeships (National Academy of Sciences, 2014) that receive mentoring that addresses all aspects of scientific careers. *The Postdoctoral Experience Revisited* (National Academy of Sciences, 2014) strongly recommends that institutions shoulder more of the responsibility of supporting postdocs, especially in light of the many demands that already exist on PIs:

> Host institutions should create provisions that encourage postdoctoral researchers to seek advice, either formally or informally, from multiple advisors, in addition to their immediate supervisor. Host institutions and funding agencies should take responsibility for ensuring the quality of mentoring through evaluation of, and training programs for, the mentors. (National Academy of Sciences, 2014, p. 73)

The postdocs in our sample already focus much of their time on developing technical skills, but not those skills associated with the PI discourse. Therefore, mentoring should target the skills that are necessary to advance careers, including grant writing, speaking at conferences, networking, mentoring, and teaching, thus providing skills that support a variety of career options (Sinche *et al.*, 2017).

Institutions may be in a better position than PIs to facilitate postdocs' professional development (e.g., Thakore *et al.*, 2014; Faupel-Badger *et al.*, 2015; Rybarczyk *et al.*, 2016; Williams *et al.*, 2016; Price, n.d.). Institutions can implement informal mentoring around professional development that is initiated through workshops and followed through with periodic interactions, such as teleconferences, in which scholars who are established in their careers act as coaches (Thakore *et al.*, 2014; Williams *et al.*, 2018). Extending the mentoring network to include informal coaches also avoids the problem that PhD advisors often encourage their

students to pursue postdoctoral positions regardless of career goals (Sauermann and Roach, 2012). Moreover, this approach can increase the representation of traditionally underrepresented groups (Thakore *et al.*, 2014; Williams *et al.*, 2018). Such programs include mentors other than the PI with life experiences and goals that parallel those of the mentees, modeling the success of different life histories, values, and experiences (Pain, 2014; Lazzari, 2016; Williams *et al.*, 2016).

Successful mentoring from institutions can also include thoughtfully writing and reflecting on IDPs. Given the popularization of IDPs, (Fuhrmann *et al.*, 2002; Hobin *et al.*, 2014; NIGMS, 2016; NSF, 2018), we found it surprising that none of our participants mentioned them. IDPs have been used to identify and support the development of skills necessary for a suite of scientific careers (e.g., Hall *et al.*, 2016; https://myidp.sciencecareers.org). Hall *et al.* (2016) model institutional collaboration around developing IDPs for postbaccalaureate students (see also Hobin *et al.*, 2014): staff works on skill development, and the PI consults about how to help the mentee seek professional development. This approach frees PIs to focus on their priority of conducting research, while also serving the mentees' needs. However, as Hobin *et al.* (2014) report, the great potential of IDPs cannot be realized until both institutions and mentors treat them as serious commitments.

Limitations

As is common in qualitative analysis, our sample is small—in this case 30 participants primarily from one research-intensive university. We acknowledge that regional differences are possible and that our participants chose to be interviewed for this study, both of which are aspects of our study design that could introduce bias. Interestingly, a survey study with a large and national sample reports the complementary result that postdocs are less clear about their career goals than they remember being as graduate students (Gibbs *et al.*, 2015). The interaction of the bench scientist discourse with the PI discourse may contribute to the confusion that postdocs report over their career goals. A better understanding of both the adaptive and maladaptive beliefs held by postdocs can improve career development programs.

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