“Science Sort of Started Moving Me”: The Links Between Socialization and Academic Self-Efficacy in Undergraduate Research

By

Deborah Faye Carter, Julie Posselt, & Carmen McCallum

University of Michigan

PLEASE DO NOT CITE WITHOUT AUTHORS’ PERMISSION

Paper presented May 1, 2010 at the American Educational Research Association in Denver, CO. Address correspondence to Deborah Faye Carter, 2117 SEB, University of Michigan, Ann Arbor, MI 48109-1259. E-mail address: dfcarter@umich.edu

The authors would like to thank the Howard Hughes Medical Institute for funding of this research project.
It is not clear the extent to which undergraduate students are interested in pursuing biomedical research careers nationally. There seem to be factors that may attract individuals toward such careers and factors that detract able students from such careers. For example, over the past decade, many academic leaders have sounded the alarm regarding the country’s future in supporting talent in the biomedical fields. Most of the concern seems to be focused on the stagnant funding of research by the federal government and that this lack of increased funding has had deleterious effects on the amount of published research, which in turn has discouraged some from pursuing research careers (National Institutes of Health, 2007; 2008).

In contrast, individuals successfully completing graduate education and pursuing research careers may gain significant individual benefits. Such careers are predicted to be a growth area in the economy and can be lucrative jobs for those who have completed advanced training and go on to careers in academe, private industry, or government. Medical scientists, biochemists and biophysicists earned salaries that were at least $40,000 more than the median salaries for individuals in the U.S. (Bureau of Labor Statistics, 2010).

The main aims of this paper are to: a) understand the processes by which students in biomedical and related fields choose their academic majors, decide to pursue graduate/professional school, and pursue particular career interests; and b) understand specifically the role that undergraduate research plays in this process. In addressing these aims we are particularly interested in how students are socialized into their academic disciplines and future careers, utilizing an interdisciplinary framing of socialization.
Career Choice and Undergraduate Research

There have been decades of research in the area of career choice in higher education and other disciplines. Pascarella and Terenzini (1991) summarized the higher education literature finding that “career development during college is more a process of implementing a career than of choosing one” (p. 424). This statement seems to indicate that college students enter college with a good idea of their set of possible career choices and their subsequent academic course-taking and major choices correspond to these plans. While it may be true that many students enter college with a solid idea of their future career paths, Pascarella & Terenzini (1991) also present evidence that 33-67% of college students change their career plans during college. This dual nature of college students' career paths — that some students change their minds about their career choices and that others are implementing an already chosen career path — may be explained partially by the different kinds of experiences students have in college.

Pascarella & Terenzini (2005) update their previous research summary with work published in the 1990s, and much of that research supported their previous analyses: “consistent with the conclusions from our 1991 synthesis, the weight of evidence from the literature of the 1990s suggest that faculty play a potentially important role in student career choice through their contact or interactions with students in informal, and often non-classroom settings.” (p. 524) It is in the area of undergraduate research — which occurs specifically in non-classroom settings — that is the focus of the paper. We study the relationship between undergraduate research and students’ early interest in research careers (academic or private industry).
We define “undergraduate research” as inquiry by an undergraduate student that makes an original contribution to the discipline or field (Hu, Scheuch, Schwartz, Gayles, & Li, 2008). Programs that encourage such inquiry differ in their quality and structure and previous authors have made various distinctions on the elements that comprise quality undergraduate research experiences (Hu, et al.). Kremer and Bringle (1990) discuss a “colleague model” of undergraduate research where the student “takes a significant role in many phases of research” (Hu, et al., p. 9) as opposed to a technician model where the student is only involved in low skilled roles.

Kinkead (2003) discusses the modern origin of undergraduate research programs, citing the National Science Foundation’s (NSF) 1995 strategic plan as the main factor for the rapid growth of undergraduate research programs in the last 15-20 years. NSF felt that the U.S. was falling behind other countries in training students in the STEM disciplines and felt that sweeping changes needed to be instituted in K-12 and higher education curriculum to produce more scientists. The Boyer Commission published a report recommending that research universities be restructured to focus on learning outcomes, with much of the learning occurring through mentoring relationships and in research settings (Kinkead, Boyer Report, 1998). Although, NSF and the Boyer Commission focused national attention on these matters, “the heritage of undergraduate research derives significantly from faculty enterprise…faculty members, intellectually stimulated by their own research and intrinsically interested in their own students’ development, have been largely responsible for driving undergraduate research” (Kinkead, p. 9).
Russell (2006) finds that 89% of the roughly 15,000 participants in the National Science Foundation's undergraduate research opportunities report that their research experience proved to be fairly or extremely important to their career decisions and 67% cite the experience as a factor increasing their commitment to STEM and/or research careers. Pascarella and Terenzini (2005) conclude that the research designs of the reviewed studies make it difficult to understand the causal nature of the relationships: are students who are interested in being college teachers those who chose to engage in faculty research projects? Does work on faculty research projects encourage students to pursue careers in research or become physicians? Untangling the direction of causal influence would facilitate a better understanding of students' career development in college and the contributions university programs can make to this process.

With the exception of Hunter, et al. (2007), the scholarship on undergraduate research lacks an examination of how undergraduate research affects aspirations and career-related outcomes. We know, for example, that research opportunities influence students' career choices, but the mechanisms by which they do so remain unclear. This absence creates what Seymour (2004) describes as, “a ‘black box’ between program goals and activities on the one hand, and the outcomes claimed for them on the other” (p. 497). We believe that faculty have an important role in affecting students’ career choices and plans and we attempt to understand this “black box” through the theories of organizational socialization and career self-efficacy.

**Organizational Socialization**

Many articles and books have focused on the concept of organizational socialization. The body of literature has typically been used to focus on individuals’ relationship to a particular organization, but we see application of this literature to undergraduates’ socialization to
academic disciplines, to the role of future graduate student, and to the role of future professional researcher.

Van Maanen & Schein (1979) define organizational socialization as “the process by which one is taught and learns ‘the ropes’ of a particular organizational role” (p. 211). Austin (2002) supports this definition and, in studying the socialization of doctoral students to the professoriate, describes the “learning the ropes” process as encapsulating “socialization to the role of graduate student, socialization to the academic life and the profession, and socialization to a specific discipline or field” (p. 96). Learning is a key part definitions of socialization and such learning includes the time-period individuals are in organizations as well as the learning that occurs prior to joining an organization — a process often referred to as “anticipatory socialization” (Austin, 2002). Much like the study of adult development processes, socialization is also a lifelong process that does not have a clear ending point (Van Maanen & Schein).

Previous researchers also emphasize that socialization is “a two-way process where individuals both influence the organization and are influenced by it…[Socialization] is a dynamic process in which the individual newcomer brings experiences, values, and ideas into the organization” and by extension may change the organization as well (Austin, p. 97). Socialization may not always be functional for the individual or the organization (Van Maanen & Schein, 1979). Individuals’ learning process may help their adjustment to the organization setting initially, but there may be ways in which some socialization practices lose value for the individual and may negatively affect the organization. Recent research in business and human resources share this perspective of socialization as a two-way process, and in this literature, it is called the “interactionist perspective.” The interactionist perspective unites literature on the
socialization tactics of organizations and the literature on proactive behaviors of individuals in
the socialization process (Griffin, Colella, Goparaju, 2000; Gruman, Saks, & Zweig, 2006).

Widely discussed in organizational socialization literature are the tactics of socialization
described by Van Maanen & Schein (1979). These tactics represent dimensions and are described
along a continuum: collective vs. individual (whether newcomers experience common learning
experiences through the organization); formal vs. informal (are newcomers isolated from other
members of the organizations); sequential vs. variable (is there a clear sequence and progression
of activities leading to organizational membership); fixed vs. variable (are there clear timetables
associated with completing the stages of socialization); serial vs. disjunctive (are veterans of the
organization serving as role models in contrast to newcomers learning on their own); and
investiture vs. divestiture (this tactic refers to whether organizations support newcomers’
identities or act to strip newcomers’ identities away) (Gruman, et al.. 2006). These polarities of
organizational tactics are useful ways of categorizing types of organizational structures, and it is
of profound interest to relate these tactics to individual behavior.

Griffin, et al. (2000) proposed propositions to address how newcomer proactive behavior
might be affected by various organizational socialization tactics. For example, they believe that
newcomers will be less likely to seek information from coworkers and supervisors, engage with
informal mentors, and perform extra work related activities in situations where organizational
socialization is formal and collective (p. 465). In addition, they believe that newcomer proactive
behavior “should be more strongly and positively related to socialization outcomes” when
organization tactics are more individualized than institutionalized (less formal). Griffin, et al.
mention the practical implications of their work: organizational structures may encourage or
inhibit some kinds of proactive behavior of newcomers. The use of informal mentors may be important in individualized organizational settings — particularly settings that are stressful or ones in which formal mentors are unavailable and provide conflicting information.

Undergraduate research programs are one means by which students can learn through the mentorship of a faculty member, particularly through the “colleague model” of research. Such research experiences can also be thought of as key areas of socialization for undergraduate students. The students are exposed to (and learning) content about the discipline and they are learning about what it means to be a professional researcher and gaining early socialization into graduate school. In addition, undergraduate research has other notable elements from Van Maanen & Schein’s (1979) framework: a) the socialization processes are individual (although there might be collective features if the students are in a program); serial (in which mentors are clearly serving as role models to the students); and show investiture (where undergraduates own skills and talents are typically encouraged as opposed to having them stripped away).

**Socialization in a Higher Education Context**

Golde (1998) discusses the four general socialization tasks that graduate students face: “Can I do this?” “Do I want to be a graduate student?” “Do I want to do this work?” and “Do I belong here.” The first question is one in which students begin to understand the intellectual challenges of the work and assess whether they can gain mastery of the content. The second is a task that focuses on whether the sacrifices of being a graduate student are worth it, while the third Golde describes as students learning about the profession and deciding “whether it is the best choice for them to make” (p. 56). Golde believes that the second and third tasks together represent the process by which students determine whether the career they are preparing for is
the right choice and if graduate school is a good path toward that choice. Finally, the fourth socialization task is one of assessing the student’s fit in the department: “relationships with faculty, staff, and peers play a critical role” in helping students assess their fit (p. 56).

Golde interviewed 58 students who began doctoral programs and left during the first year of their programs in the late 1980s and early 1990s. One main reason that many left their doctoral programs is “several students realized that they preferred to live a life that was broader and more balanced. The academic life was an enticing one, but the tradeoff of focus and commitment of time would be substantial” (p. 57). In particular, the doctoral students in science who left did so because of two main reasons: wrong department (which included poor relationships with their advisors) and job market considerations. Job market considerations included those who decided they could perform a desired occupation with a terminal master’s degree, or those who discovered that the faculty pool in their academic area was too saturated and s/he would have a difficult time getting a job. All who left due to poor fit with the department and/or advisor transferred to another institution and completed their degrees, but those who left due to job market considerations did not complete their doctoral degrees.

Department structure also was a factor in affecting doctoral students’ experiences and reasons for leaving the programs. For example, some doctoral programs match students with an advisor at admission while others have the students rotate 2-3 times during their first year. The students who experienced the rotation structure were less likely “to find advisor mismatch to be a problem that led to attrition” (p. 61). In addition, other students in the sciences found difficulty integrating into their departments because their work assignments were at a large research facility external to campus and their primary affiliation was in the research center and not the
THE LINKS BETWEENSOCIALIZATION AND ACADEMIC SELF-EFFICACY

campus or department. A final way that department structure seemed to affect attrition in the first year was the relationship of the master’s program to the doctoral program. Individuals enrolled in a doctoral program that facilitated transfer between the master’s program and the doctoral program -- where master’s students took similar courses as doctoral students and who worked side-by-side doctoral students in research settings more easily could complete a master’s degree and begin an industry career if they chose. Those in master’s programs that were a strictly course-based program, one-year in length, and isolated from doctoral students were more likely to remain in the doctoral program after the first year, but that was due to the limitation of viable other options because of limitations in training.

Self-Efficacy

Albert Bandura's (1989) social cognitive theory which explains individual learning as a function of observing others' modeling. One of the core concepts of this theory is self-efficacy, or “individuals' confidence in their ability to organize and execute a given course of action to solve a problem or accomplish a task” (Eccles & Wigfield, 2002). Bandura's conceptualization identifies different dimensions of self-efficacy (e.g., how strong one's self-efficacy is; its relation to difficulty of tasks; and what kinds of tasks people may feel efficacious performing), and individual self-efficacy has been linked to expectancies for success.

Bandura posits that individuals' feelings about their abilities to perform tasks may affect outcomes. Bandura (1989) believes that human agency is a core idea of self-efficacy and that it affects individuals' behavior: Individuals must believe they can act and achieve their desired outcomes; otherwise they have no incentive to act.
Recently, researchers have been using the concept of self-efficacy to explain what may predict newcomers’ proactive behaviors in organizations. Gruman, et al. (2006) found that “newcomers with higher self-efficacy are more likely to engage in proactive behaviors” and that self-efficacy has an important effect on newcomer proactivity independent of organization socialization tactics (p. 101). One implication the authors noted from their work is that organizations may want to consider developing strategies to train newcomers to be proactive -- particularly in organizations whose socialization tactics are individualized (as opposed to collective in Van Maanen & Schein’s formulation).

Academic and career self-efficacy beliefs have an important role in the development of career interests, in that individuals' beliefs about their abilities influence the range of career options considered and the effort exerted in pursuit of those options. It might be true then that well-structured undergraduate research programs may produce higher levels of career self-efficacy if students begin to feel they are able to perform research tasks well and if students perceive research tasks to complement future occupations of interest.

Method

Setting

Administrators and faculty at a large, public research university in the Midwest have received funding from a biomedical research foundation to implement a summer undergraduate research program engaging rising sophomores, juniors, and seniors in original research with faculty. The program is designed to involve students in the intellectual and practical tasks of conducting full-time research in biomedical and related science fields, with the ultimate goal of stimulating interest in biomedical research careers. Applicants to the summer program prepare a
research proposal in collaboration with a faculty sponsor and, if selected, their participation consists of three activities: (1) full-time research with faculty for ten weeks during the summer months; (2) weekly seminars organized by program staff and oriented around the practice of biomedical research and careers in biomedical sciences; and (3) “journal clubs,” in which faculty regularly lead small groups of participants in discussions of scholarly journal articles.

Sample

Our sample consists of three cohorts of summer research fellows, for a total of 102 participants. Please see Table 1 for demographic and cohort breakdowns of the participants. Females and Asian/Asian Americans are slightly overrepresented in the summer research program relative to the university’s population. Eighty percent plan to pursue graduate degrees and/or careers in biomedical and health sciences upon graduation, making a program such as this summer fellowship an ideal opportunity for academic and professional learning. The most common academic degree aspiration is the M.D. (42%), followed by the Ph.D. (25%).

Table 1. Demographic and cohort traits of study participants

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Total</th>
<th>Gender</th>
<th>Race/ Ethnicity</th>
<th>Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Fem</td>
<td>White</td>
</tr>
<tr>
<td>2007</td>
<td>35</td>
<td>17</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>2008</td>
<td>29</td>
<td>12</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>2009</td>
<td>38</td>
<td>16</td>
<td>22</td>
<td>20</td>
</tr>
<tr>
<td>TOTAL</td>
<td>102</td>
<td>45</td>
<td>57</td>
<td>51</td>
</tr>
</tbody>
</table>

Data collection

The research team interviewed most participants within the first month of the summer program and follow-up interviews were conducted in fall, after students had given a poster
presentation of their completed research at a university research symposium. Most interviews were conducted by two members of the research team and followed a semi-structured format, with the interview protocols including a range of questions about students’ past and present research experiences, their relationships with the faculty sponsor and others in the lab, and their academic and professional aspirations and plans. Central to our aims for the initial interviews was understanding how previous research experiences may have affected their interest in participating in the summer program and whether they perceived a relationship between their learning in coursework and in the lab. Through the follow-up interviews, we also tried to capture students’ changing sense of self as researchers and whether their experience of the summer program had at all affected their future plans. The major themes we present in this paper—socialization and self-efficacy—were not elements of the research protocol, but rather emerged organically from students’ descriptions of their experiences.

Interviews were approximately 45 minutes long, and conducted in a private room away from the lab environment. All interviews were digitally recorded and transcribed verbatim by an individual with professional experience in biomedical sciences.

Data analysis

Our analytic processes have been iterative, beginning with interview transcripts from the 2007 cohort, and have included line-by-line open coding as well as axial and selective coding as recommended by Corbin and Strauss (2008). The research team read the transcripts to determine emerging themes and connections to extant theories. After labeling observed patterns, the team created a set of codes that were then grouped into themes and sub-themes.

Multiple strategies were utilized in order to provide trustworthiness and to support the
validity of the findings (Creswell, 2003; Merriam, 1998). Through debriefing after each interview, the research team discussed how the perspectives a participant expressed relate to others. Coding has been collaborative, with interviews coded by two members of the research team to check for inter-coder reliability. Moreover, throughout data analysis, we have also employed expert checks by discussing emergent findings with program staff, whose years of experience help corroborate and refine our findings.

Results

Through the interviews conducted, we find the interactionist perspective on socialization—that individuals are socialized through a combination of their own proactive behaviors and structural/organizational processes—aptly describes our participants’ experience of undergraduate research as a mode of professional learning that helps facilitate career decision making. Students learn about the research enterprise through conducting research; they gain exposure through experience. As a result, the outcomes of their learning have both content and social dimensions.

The process begins with students proactively seeking opportunities to learn what it means to conduct research. Individuals who participate in proactive socialization behaviors actively seek information in order to learn about potential careers and their own aptitudes and abilities. The students seem to seek such information so that may adjust their behavior (and expectations) for future academic success (Gruman, 2006). Although the majority of studies on research socialization focus on graduate school experiences (Austin, 2002; Golde, 1998) our participants demonstrated proactive socialization behaviors as early as high school. Maya discusses the project she began in high school and finished during her first summer in college.
I was a research intern down in Arizona… I didn’t have my own project per se but… we were studying how certain birds recover from basically having strokes …I was analyzing their neuro activity after having a stroke…. The results of that research had really visible application.

After discussing the benefits of that research experience, she also indicates that without the opportunity to practice science she would never have discovered a passion for doing research. Others students sought more practical science experiences like internships or job shadowing, but they all participated because of a desire to connect science academic content to scientific work.

*Content Learning*

*Students gain practical skills.* During the summer program, students gain an array of valuable skills. In the course of conducting their own research study, not only are there opportunities to learn skills required for data collection and analysis, but also leadership, communication, and organization, among others. As Anthony explains:

I was in charge of doing it all by myself and I felt like I gained a lot of leadership skills. And I felt like I gained communication skills. I had to find out all about what I could do and what I couldn’t do in the clinics, how it is all organized. And I felt like I gained organization skills…because I went to Johns Hopkins and I got all the material, and then I had to organize it for everybody else to use…I also feel I gained statistical skills. I’m sure I’ll like—we’re probably going to submit this. We have submitted this to a conference. And I went to a conference last year and so I’ll probably get to do a poster presentation at a national conference. I feel like I’ve gained presentation skills from that too.

Without stating it specifically, Anthony shows strong self-efficacy along with greater confidence in his skills. This is generally typical of the students we interviewed, with most of them feeling increased confidence in their skills and in their ability to be accepted into graduate school and
pursue the careers of their choice. Michael concurs, noting how the skills developed translated into experiences and opportunities that will further his career.

Yeah. I feel like I’ve gained a lot of knowledge about current issues in Medicine. And I feel like I’ve gained clinical experience, interacting with patients. And I feel like I—especially when I went to the Research Conference—they have all these presentations on projects. I felt like I gained a lot. They have debates about current medical issues. That kind of thing is going to really help me in Medical School interviews because people will ask me questions and I actually have experience that I know about it. And then like, also I heard to get a good residency—it’s better if you have publications. And I heard that one or two publications are good but I have like two already for sure and then I have like three that have the potential to get published. And I just feel like I—like that sets me up to be able to do more Research in Medical School.

By gaining a range of skills and observing the research activities of others in the laboratory, students also come to appreciate variation in the complexity of scientific work and come to see themselves and their own work in relation to varying levels of complexity.

Students learn to distinguish ‘basic’ from ‘real’ science. Numerous students describe the tasks they were completing when they first began conducting research as ‘basic science’ and the more complex tasks that they learned after mastering basic skills as ‘real science.’ Students clearly articulate the importance of learning ‘basic science’ in order to master ‘real science.’

Michelle described the process of moving to more complex tasks:

So I was doing a lot of basic science—like the PCR machine and just running reactions for people and kind of doing the bottom—not really like my own research yet. And then toward the end, I started running more of my own experiments and having a more extensive lab notebook and actually… start like, investigating something.

Michelle’s comment implies how important it is to students that they have responsibility to make decisions that will affect the outcome of their project. This process builds
confident and provides a deeper understanding of what it means to ‘do research.’ Oscar
explains,

Well, I guess to put it really simply, is that in the first lab, I didn’t have my own bench.
This lab I do. I have my own desk and my own lab bench and my own supplies and tools
and pipette tips. It’s my area. I feel much more in charge, I guess. So I get to control the
science a little bit more which makes me feel really great.

And

During the summer I had to do it myself so I really saw why I was doing everything.
What decisions have to be made. And, yeah, I got a lot more perspective on it. Why I was
doing stuff and a lot more practice in doing it too, so. I just think it was a lot better.

Although students occasionally grew frustrated with the research process, having
responsibility for one’s own study provides an opportunity to move beyond the basics of
someone else’s work as well as encourages an emerging sense of scientific independence.

Students learn science is non-linear and requires significant time commitment. Students
also learn that scientific research is not a linear process. It can be very time consuming and
requires a lot of patience. As Maria indicates, “It is not a 9 to 5 job.” In order to complete
projects scientists must adequately prepare for the time that it takes certain elements within
experiments to process. Thus, scientists often spend many hours in the lab—-a realization many
students in the summer came to understand firsthand. Arthur explains how he attempted to
manage his hours at the lab and came to realize the commitment research takes. He provides a
brief synopsis of an average day:

…okay, my things are incubating. I guess I’ll go grab lunch for an hour and then I’ll be
here till nine. [Laughing] like I really didn’t understand the fact that—they always say,
‘There are no hours in science. You’re like driven by your experiments. You have to live
by their hours.’
Many of our participants had previous part-time or for-credit research experiences with faculty, but they found the summer experience to have a much stronger influence on their socialization and career decision-making due to their full-time commitment to a lab.

It was just really nice to be able to go in and do like a life-- a day in the life-- of a researcher. That’s exactly what it was for like three months as a researcher. I think that was the best part… You’re really getting in there… So, this gives you a [feeling] like maybe I want to do research. So, you actually get like full on summer of exactly what you would do when you graduate. So it’s really like good prep in deciding what you want to do.

As with many other of the learning themes that arose from our analysis, learning the non-linearity and time commitments of research not only affected participants’ experience of the summer program, but their understanding and interest in future research involvement.

*Students learn to connect science to the real world.* Participating in the summer program also provides students with an opportunity to see the connections between science, coursework, and the real world. Students no longer learn about science as a body of knowledge communicated in textbooks and classrooms; rather they learn about problems in the real world, how to explore those problems theoretically, and how to empirically test their hypotheses in labs.

As William indicates,

In high school I knew I just liked science. And I when I saw what I could actually do with science…[I knew] that’s what I like to do…like learn it and keep applying and you know create or discover new things about science.

Another student’s experience vividly illustrates the power of learning across contexts. Here, he reflects on the connections that can be made between science theory and practice:

It brings like a big connection between what you’re doing in all your classes. And it makes it seem like you’re not just taking random classes. You’re actually taking
something that relates to each other. And it is all like real, life stuff. I have an example… We read this book—Fast Food Nation—which eventually talked about antibiotics and the cattle industry and how it is a big deal. And then, I went to my 171—Evolution and Ecology-- and we also talked about antibiotics. And then I had my lab and we had an experiment on antibiotics and I wrote a paper on it. And it was like, “This is awesome…. It really grinds into your head. Oh, man, this is an issue. It’s a big deal and that’s why we’re learning it three times over. This is a real thing.”

By making connections students are able to understand the importance of learning the concepts as well as application. Louis explains how learning concepts without the application seems meaningless:

I think that one reinforces the other, inextricably. If I had just taken my Molecular Biology course without actually doing any of the techniques, it would become meaningless to me in a matter of weeks. But the fact that I get to repetitively use them and see how the connection should be applied …to a real science plan… to a real experimental design and be incorporated in it [is] really great. Because you stop seeing them as these isolated cases and really just part like tools and parts of discovering something of one goal instead of just running one gel…you look at it and it’s like…great, what is it doing now? …And then interestingly enough, you know in courses like Genetics… some of these silly things and [techniques] come up.

It is very important to the students that in their future careers they themselves improve people’s welfare as physicians or that their research will make an impact on society. This characteristic may be because our sample of students is concentrated in the biomedical sciences, but it also shows the kind of learning experiences the students sought out through their proactive behavior by engaging in undergraduate research. Students in other fields and disciplines may not find it so critical to have their content learning so tightly coupled with the application of the learning.

Social Learning
Students cultivate dispositions and attitudes of researchers. Through their experiences in the summer program, students learn key dispositions that characterize researchers, and many begin to internalize them. In some cases, faculty and others in the lab play an active role in encouraging students to adopt specific attitudes, such as perseverance.

I always knew like that research—people are in labs— but I learned more about the, I guess the drive… the kind of perseverance, the message of you just got to keep working on research you can’t give up. And uh—that was the message I got a lot from my older research sponsor, who says it just takes perseverance sometimes, and you usually will make it.

In other cases, these dispositions develop more spontaneously, without the express intent or effort of others. Monique, who had planned to become a doctor, discusses learning perseverance through a series of failed experiments. But she goes on to describe the possibility of adding research to his career plans because of the passion research inspired:

This summer with the fellowship I started, I don’t know, developing a passion for what was going on the lab…. Science sort of started moving me and I had never really felt that way before. I mean I was always looking for something to, you know, dedicate my life and put forth good effort toward.

Consistent with research using both social cognitive career theory and academic socialization (Bandura, 1989), developing passion, or at least interest, seems to be a key step in students’ career decision making. Few of the students with whom we spoke express doubts about their ability to accomplish their professional goals. Rather, whether considering careers in health sciences, research, or some combination of the two, their primary consideration seems to be whether they had the interest or desire to do so. Indeed, testing out the strength of their interest in research is a major motivation for some to pursue the summer fellowship. As one aspiring female researcher puts it:
THE LINKS BETWEEN SOCIALIZATION AND ACADEMIC SELF-EFFICACY

…if you have an interest in science already, I would say definitely it’s really a great kind of next step to see if that’s something you want to do. I think they always mention that these research things teach somebody [whether] they really like it and they want to do it. And other people, that’s not what they’re meant to be. Research and this life is not for them. I would say having this experience is a win, win thing.

From this perspective, the affective outcomes of summer research serve an important socialization function in facilitating students’ career choices. They help undergraduate students answer the socialization question, “Do I want to do this?” (Golde, 1998). The relationships they observe and develop in the lab also contribute to students’ socialization and career choices.

Students are socialized to typical research career paths through lab relationships/interactions. Austin (2002) and others highlight the primacy of the discipline as a context for socialization, but within the broad field of biomedical sciences, we find the laboratory in which a student works also serves as a critical context for socialization. In becoming a full-time member of a dedicated, multi-generational community of scholars—even just for a few months—students reflect on their own status and possible futures as graduate students and researchers. They closely watch the other members of their lab for clues on ways to behave in the research setting, interact with them in ways that provide formal and informal career and academic advising, and also are watching lab members’ interactions with one another to glean information about the social dynamics of the scientific research profession.

Undergraduate researchers are, in a sense, participant-observers in the lab environment, privy to the work, demands, and opportunities faced by students, post-doctoral researchers, and faculty alike. Literature on undergraduate research emphasizes the mentoring role of a single faculty sponsor (Chase, forthcoming), but in the labs at this research university, most of our participants experience the benefits of multiple mentors from a range of academic career stages:
I’m the only undergrad working there… but I’m not treated as an undergrad, I’m treated as you know, a master’s student….. There is Dr. Zhou who is head of the department—so obviously, he’s had a lot of experience. I work with post-docs that are doing their research. And I work with other professors and other Ph.D. students and other Master’s students. So you get like—at every level what people’s experience is and how they’re thinking. So it’s been very helpful.

More advanced undergraduates and graduate students in the lab are viewed as having wisdom and expert information that help students know and meet the expectations graduate programs will hold for them. Fellow students are accessible, and often friendships develop between our participants and the other students in the lab.

I was really glad that I was working and, you know, bettering myself and my experience and had this great, I guess, support system in the lab. It was all these guys who worked with me were a year ahead of me - all the undergrads. So they know what’s going on and they’ll tell you. And even now when I’m having trouble with, I guess, Chemistry, they’ll say, ‘Oh it’s just this you know.’ It’s not condescending but just, ‘You just gotta look at it this way.’ … They’re really good guys.

And

The grad students are a huge source of insight into everything. They’ve already been through undergrad here. They’re already years into their grad school. They know who I should be talking to. What kind of research I should be doing and the fact that I should be doing it in the first place… And then how it should be—how my research should be related to my interests in a career choice.

In addition to discussions about future opportunities and expectations, students also feel they are being socialized to the graduate student role by conducting research projects similar to those of the graduate students in their lab, and in a few cases, by being given the opportunity to supervise other undergraduates.

Many students also receive training and direct supervision from post-doctoral or other full time researchers, but none of our participants expressed an aspiration to hold such a position.

---

1 Names have been replaced with pseudonyms to protect participant confidentiality.
they had their eye on the faculty sponsor as both a researcher and individual. In almost all cases, students receive important academic and career advising from their mentors as the research collaboration develops. A female student considering a surgical career describes the multidimensional nature of the mentoring relationship with her faculty sponsor:

_Student:_ I first met him over a year and a half ago and I was doing a job shadow with him. He was just like really nice. He’s been so helpful to me…like he’s given me so many opportunities. I’ve met with him so many times. We’ve gone out to dinner before. He’ll give me advice on how to apply to Medical School. We’ll talk about future career goals…. I would never expect to do any of the stuff he’s done. He let me go to the conference. He sent me to Johns Hopkins and he let me do projects. We published like four papers…like we haven’t published them all but we’re going to. It is just like a really good opportunity. And he’s just like a really cool person.

_Interviewer:_ What kind of career advice has he given you?

_Student:_ Well just like…he’s a transplant surgeon. He’s kind of like said—transplants—I find it really interesting and all that. It’s a really cool field. But also um…it’s hard for women to do it because you’re always on call because you never know when the organ is going to come. And so he’s kind of—shown me the dynamic of what my life would be like if I was a transplant surgeon. But also he’s kind of like told me more about Med School—his experiences and how you should go about getting a good residency. Like you should try and pursue research while you’re an undergrad and just things like that.

As has been found in previous research on student mentoring, we also find that a common theme in participants’ descriptions of meaningful mentoring relationships is perception of an ethic of care that extends beyond the obligations of research supervision and career advice. Jamila expresses this particularly well:

_We worked on the project together but beyond that we would talk about future education plans, future goals in life, what we were doing that weekend. He invited us over to his house at the end of the summer and his wife and he cooked lunch for us. He invited us over to his house at the end of the summer and his wife and he cooked lunch for us all. So it was very much, kind of like a little family. He was caring for us on all different sides—all different perspectives._
In contrast to labs in which friendships among students formed and the faculty sponsor created a family-like atmosphere, some students described labs that were very quiet and impersonal and in which faculty-student relationships were singularly focused on the research. Often, these were smaller labs and/or run by faculty who had not yet achieved tenure. As sites for socialization, however, the differences among types of labs and mentoring relationships may be formative to students, even affecting their interest in research careers. John explains:

Even though I really did enjoy my research experience… I don’t think that it is a good career for me. It’s interesting at the time but I can’t see myself doing that every day of my life… I really like to work with people. I feel in the lab, there were days I could come in and not say a word. You know you get so busy and it’s kind of your own—you’re so engrossed in what you’re doing. I just would like to spend more time with people.

Lacking other research experiences or exposure to other contexts for scientific research, students form their impressions of a scientist’s career from their observations and experiences with the faculty sponsor and lab. Students tend to regard their lab and the faculty sponsor’s example as normative or typical of a scientific research career, which can have consequences for their interest in pursuing a research career. For example, while on average researchers may work more with data than with people, experience in other research labs or institutional settings might have given John a broader picture of science and its communities of practice. The knowledge about scientific research and careers that program participants gain about life as a scientist is valuable, but partial and not necessarily representative.

Students develop an image of faculty lifestyles. By being in the lab full time, students are better able to assess the range of activities researchers participate in—and the time those activities demand.
It’s been helpful being in a lab, seeing my faculty sponsor, my P.I., and how many hours he put in. You know you’re writing grants, and if you’re not writing grants, you’re reading papers. And if you’re not reading papers, you’re writing papers. And if you’re not reading papers, you’re helping undergrads. And if you’re not cleaning up after undergrads, you’re doing your own research. If you’re not doing your own research, you’re helping the people next door. And if you’re not doing that, then oh, we have to order more pipettes for next week. It’s very much like… having your own small business. And so, I just realized that—and if you want to do anything well, you have to be able to put enough time into it.

Students therefore learn that to be a successful faculty member in a research university is a lifestyle, not just a job. For those whose faculty mentors or lab members shared or revealed detail about that lifestyle, it became another factor in their career decision making. The scientist role, as students come to perceive it by observing their faculty sponsors, consists partially in the amount of stress they expect accompanies the role and in the balance they think scholars strike between their personal and professional lives. Lindsey described her decision to become a professor instead of a physician after seeing her mentor’s example.

I didn’t want the life of a doctor. It was just something… just something that I always thought that I wanted to do. But the more that I learned about it, it was just not for me. I could do it if I wanted to, definitely, but … I don’t know if I necessarily wanted all that pressure on me… Going to grad school and possibly ending-up… getting my PhD and being a professor is still going to be stressful… but it’s just a different kind… I mean Dr. Smith is actually an MD. But he is not a practicing physician anymore… And you know his wife is also a professor and they have kids. And so, it was nice to see the family aspect. And you know he gets to go home. He works very hard but he does get to see his kids. I think the family issue was a big part of it.

Other students retained their plans to become physicians, but discussed plans to choose specialties based on the time commitments those careers would require. In the case of all who spoke about it, though, having the opportunity to work as a full-time researcher encouraged learning that helped students decide if a full-time research career was a suitable path. Reinforced
commitments, new rationales, and specific pathways within broad career tracks may well be thought of as outcomes of the socialization students experience in the summer program.

**Summary and Conclusions**

We share the perspective of Van Maanen and Schein (1979) that the outcomes to socialization generally should be seen as neutral. It is just as important for students to do undergraduate research and know they aren’t interested in the field or profession as it is for students to learn that they are interested in the field and profession. The combination of content and social learning that undergraduate researchers experience constitutes anticipatory socialization that deepens their understanding of research careers in practice. By learning behind-the-scenes professional dynamics, students gain a more realistic view of research and careers involving it. Having “the whole picture… [provides] a lot more perspective,” in one participant’s words. They experience what it is like to conduct original research and to collaborate with others in the lab. They come to see the unique forms of politics and bureaucracy scientists face, and encounter ethical dilemmas surrounding knowledge production and dissemination. They see their colleagues struggle, and work through struggles of their own. Many experience the thrill of discovery—sometimes following struggle and sometimes by happy accident—and the satisfaction of having their work accepted for presentation and publication.

As Anthony put it, the experience made him “respect research.” When asked to clarify, his response captured many of the themes described throughout this study.

I never really truly understood it before. I just thought of people in labs. That was as far as, I mean I didn’t know what they were for—what they were doing or how they go about doing it. And there’s …the structure of how things are done and how papers are written… how you establish yourself in the research community. That I’ve learned about and it really takes a lot to do… I wouldn’t understand it as well without having the
experience.

Socialization to laboratory and research life constitutes professional learning, through which students establish a rich base of knowledge gathered from practical experience, advice from peers and colleagues, and personal reflections. Learning about themselves and research environments provides an important basis for program participants’ career decisions.

The findings from this study highlight two important contributions of this work. First, theoretical conceptions of organizational socialization have important explanatory power for explaining the impact of undergraduate research programs on student outcomes. Socialization in these settings not only assist students in considering graduate school and research careers as future options, but socialization also has a key element of providing content learning about science fields and disciplines. Learning the content and the social aspects of doing science work go hand in hand for this group of undergraduate students. Socialization theory for undergraduate students may need to incorporate students’ self-assessment regarding the quality of their content learning in addition to the social learning related to future career choice and graduate school.

Second, individual behavior and characteristics (e.g. proactive behavior and self-efficacy) may be difficult to disentangle from socialization outcomes. All of the students in our study applied to and were selected for the summer program; they showed enormous wherewithal to seek out information and seek out the kind of research experiences that would help them gain knowledge about future careers. We concur with Gruman, et al. that institutions need to create more structures to encourage and support proactive behavior. More students would benefit from this kind of summer experience — whether they go on to research careers or not.

In addition, Golde’s (1998) research on the experiences of doctoral students who left their
THE LINKS BETWEEN SOCIALIZATION AND ACADEMIC SELF-EFFICACY

programs is instructive here. Not only is it important for students to do undergraduate research
with faculty to better learn disciplinary content and about graduate school and the profession of
research, but it is equally important that students gain experience working in multiple labs.
Mentoring serves an important purpose in anticipatory socialization processes, and students’
exposure to multiple kinds of mentoring relationships may provide broader learning experiences
as they progress.
References


*Research in Organizational Behavior, 1*, 209-264.