EARLY-CAREER FACULTY PERCEPTIONS

OF SEEKING EXTRAMURAL FUNDING

FOR ACADEMIC BIOMEDICAL RESEARCH

by

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ABSTRACT

Biomedical research over the last century in the United States has resulted in new drugs, medical procedures, and medical devices that have dramatically increased the health and lifespan of individuals and global populations. However, after decades of growth, the federal appropriation to fund grants for biomedical research has decreased since 2002. Thus, the pressure on early-career faculty to obtain federally funded grants to perform biomedical research has increased due to competition for limited grant resources. Therefore, it was important to understand their perceptions about research funding, and the effect on achieving their career goals. First, a review of the literature was provided. The literature review included studies involving analysis of factors influencing the productivity of early-career faculty and provided a theoretical framework for interpreting the data. Next, an overview of the research methods was provided. The challenges facing early-career faculty were studied through a qualitative examination of their perspectives and experiences. This study used a qualitative case study research design at a single institution. Tenure-track and non-tenure-track faculty members at the rank of Assistant Professor were selected by purposeful sampling for participation in the study. They were interviewed using a semi-structured interview protocol. The interview data were presented as well as the major themes that emerged from the analysis of the data. Finally, a discussion of the data was provided in the context of the literature review and theoretical frameworks. The findings were aligned with three theoretical frameworks that were used to understand the results, namely Self-Determination Theory, Academic Capitalism, and Bourdieu's Theory of Practice. The findings identified the importance of mentoring in learning

how to write grants effectively. The findings also revealed that the competition for limited grant dollars has contributed to heightened stress and anxiety among the participants. In conclusion, the findings of this study could provide useful information helpful to both faculty and academic administrators. Because of this study, higher education leaders have useful data that support the importance of an environment that is conducive to successful grant-seeking strategies.

DEDICATION

"Everything is possible in Him who has strengthened me." Philippians 4:13

LIST OF ABBREVIATIONS AND SYMBOLS

CV	Curriculum Vitae
F&A	Facilities and Administrative
FIRST	First Independent Research Support and Transition Award
FY	Fiscal Year
HERD	Higher Education R&D Survey data
HHMI	the Howard Hughes Medical Institute
IDC	Indirect Cost
IP	Intellectual Property
K99/R00	NIH Pathway to Independence Award
LCME	Liaison Committee on Medical Education
MCAT	Medical College Admissions Test
MERIT	Method to Extend Research in Time Award
NHMRC	National Health and Medical Research Council
NIH	National Institutes of Health
PI	Principal Investigator
PO	Program Officer in the NIH
R01	This NIH Research Project Grant is the original and historically oldest grant mechanism used by NIH for investigator-initiated projects
R21	NIH Exploratory/Developmental Research Grant Award
R23	a grant funding program phased out by the NIH in which early-career investigators could fund postdoctoral fellows in their laboratories

R29	the FIRST grant funding program phased out by the NIH to fund early-career investigators
R37	MERIT awards used to provide long-term grant support to investigators whose research competence and productivity are distinctly superior and who are highly likely to continue to perform outstandingly.
R&D	Research and Development
RePORT	Research Portfolio Online Reporting Tools
SBIR	Small Business Innovation Research Awards
STTR	Small Business Technology Transfer Awards

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CHAPTER 1

INTRODUCTION – A FUNDING CRISIS FOR BIOMEDICAL RESEARCH

1.1 Biomedical Research in the United States

Biomedical research represents an important area of science that involves the investigation of normal biological processes and the abnormal changes that cause disease in humans. Biomedical research in the U.S. has resulted in decreased disease burden, improved health and longevity, and advancement of scientific discovery (Sampat, 2011). Developed through federal policy over the last century, the National Institutes of Health (NIH) plays a major role in supporting biomedical research as well as clinical and behavioral research (National Institutes of Health, 2015). Currently, the NIH is made up of some 27 separate institutes and centers, focusing on different human diseases, organs, and health missions (National Institutes of Health, 2015). In addition to conducting interdisciplinary research at its Bethesda, Maryland campus, the NIH is responsible for funding biomedical research conducted at more than 2,500 universities, medical schools, hospitals, independent research organizations, and private industry throughout the United States (National Institutes of Health, 2016a). The NIH budget request for FY 2016 was $32.3 billion, of which over 80% was devoted to extramural research; medical schools and teaching hospitals received over half that support (National Institutes of Health, 2015). In the U.S., there are 141 Liaison Committee on Medical Education (LCME) accredited medical schools as well as about 400 major teaching hospitals and health centers conducting NIH-funded biomedical research (Association of American Medical Colleges, 2015). In assessing NIH award data (National Institutes of Health, 2016a), higher education institutions

received 75.2% of all extramural funding, compared with research institutes (at 8.8%), independent hospitals (at 9.0%), domestic for-profit institutions (at 4.1%), other domestic nonprofit institutions (at 2.2%), and foreign institutions (at 0.7%). Although receiving a relatively small proportion, these organizations compete with higher education institutions for scarce NIH funds.

1.2 Seeking Extramural Research Funding

The trend in biomedical research that has resulted in the demand for federal funding exceeding availability is a recent phenomenon, which has been exacerbated by the 2008 recession and federal budget sequestration in 2013 (Alberts, Kirschner, Tilghman, & Varmus, 2014). Previously, the NIH budget for biomedical research at U.S. academic institutions doubled from 1998 to 2003. After 2003, stakeholders including faculty and administrators erroneously assumed that the rapid growth in biomedical science would continue indefinitely, leaving them unprepared for the changing funding conditions. In addition, there have been disincentives to changing the biomedical research infrastructure at U.S. institutions. For example, research institutions have become dependent on indirect cost (IDC) reimbursement (defined as administrative overhead costs not readily identified with a particular grant activity), resulting in the growth of "soft money" faculty positions (Daniels, 2015). As noted by Alberts et al. (2014), "Salaries paid by grants are subject to indirect cost reimbursement, creating a strong incentive for universities to enlarge their faculties by seeking as much faculty salary support as possible on government grants" (p. 5775).

Soft money positions require faculty to obtain up to 100% of their salary from extramural research grants and contract. In contrast, faculty in "hard money" positions receive institutional salary support. In addition, the majority of biomedical research is conducted by trainees,

resulting in growth of the pipeline of graduate student and postdoctoral trainees fueled by the doubling of NIH dollars (Alberts et al., 2014). Faculty in soft money positions typically require teams of trainees to support their research while applying for grant support in a vicious cycle of production to capture NIH funding (Bourne, 2013).

Despite the crisis in NIH funding for research over the last decade, many questions remain unanswered. For example, how do research faculty cope with the competition for funding? Are there gaps in funding that affect these individuals? Also, how have early-career faculty adapted their career ambitions to the current funding opportunities? What are the efforts by administrators to incorporate changes in institutional expectations about faculty grant funding? Since increases in research funding are unlikely in the near future, are there alternative productivity assessments that are considered in promotion and tenure decisions?

For this study, early-career faculty are defined as pre-tenure at the rank of Assistant Professor within the first decade of their appointment. Transitioning from trainee to early-career faculty presents many challenges, including the expectations to obtain extramural research funding (Silva et al., 2016). An investigation in this area is necessary because it could lead to an understanding of which factors are associated with faculty grant productivity in the current funding environment. In addition, investigating this area could lead to an understanding of how faculty members develop coping skills because of their experiences in seeking extramural research grants during the tenure process. Thus, investigation in this area could also guide administrators including department heads for assisting faculty in the development of their skills to increase funding productivity. Tenure committees could also learn from research in this area on how to assess contributions to faculty scholarship that did not result in grant funding. The decline in grant funding levels from the NIH is likely to negatively affect biomedical research

institutions that depend on indirect cost recoveries (Bourne & Vermillion, 2017). Institutional administrators could profit from information gained through investigation in this area by understanding how to recruit and train future faculty to be successful in their particular research environment.

Declining research grant funding "has created an unsustainable hypercompetitive system that is discouraging even the most outstanding prospective students from entering our profession – and making it difficult for seasoned investigators to produce their best work" (Alberts et al., 2014). The commentary by Alberts et al. (2014) suggested that excessive growth of the biomedical research enterprise has been encouraged by federal policies. Ironically, the need for a cheap labor pool of graduate students and postdoctoral fellows to perform biomedical research while investigators spend increasing amounts time pursuing grant funding has also created an oversupply of Ph.D. graduates (Chiacchia, 2017; Mason et al., 2016).

The probability of grant funding by the NIH has fallen "from around 30% into the low teens" in the past decade (Alberts et al., 2014) and the average age of a first-time recipient of an NIH grant is now more than 42 years (National Institutes of Health, 2014). Although federal funding accounts for the primary source of research support, many researchers seek private funding sources, such as charitable foundations and industry collaborations, as an alternative to NIH grants (Grant, 2015). Universities have also increased intramural support for research (Jahnke, 2015). Nonetheless, successful competition with awarding of an NIH grant remains the "gold standard" expectation for tenure and promotion of biomedical research faculty. Therefore, it is also essential to understand further the relationship between faculty productivity and funding levels.

1.3 Statement of the Problem

Early-career faculty members face challenges in obtaining grants because federal grant funding for biomedical research has decreased dramatically over the past decade (Yates and Warren, 2017). The consequence of these challenges is reduced funding for their research programs. Given the current emphasis on obtaining extramural grants for favorable tenure decisions (McGroarty et al., 2014), the promotion and retention rates for early-career faculty members are likely to decrease in the future. Unfunded faculty members also require institutional support to maintain research productivity (Yates & Warren, 2017). In addition, there is a significant opportunity cost imposed by the process of seeking grant funding when federal grant funding for biomedical research is low (von Hippel & von Hippel, 2015). By spending an inordinate amount of available time on writing unsuccessful grant applications, faculty members reduce their research productivity that ultimately results in driving many away from academic research careers.

1.4 Purpose of the Study

The goal of this study was to understand the experiences of early-career faculty better as they seek extramural grants for biomedical research, in light of the current funding situation. This investigation was also undertaken to provide insights into their perceptions of their professional career trajectories.

1.5 Statement of the Research Questions

The research questions of this study were designed to understand the individual perceptions of these early-career faculty who seek to obtain funding for their research laboratories. The following broad set of research questions were addressed using a qualitative research design:

1) What were the backgrounds that early-career faculty members drew upon in seeking grant funding for their research?
2) What did grant-seeking look like from the faculty perspective, and how have their grant-seeking experiences affected them professionally and personally?
3) What reflections did early-career faculty have on the meaning of their grant-seeking experiences?

1.6 Significance of the Study

Academic research in the biomedical sciences drives innovation in producing new clinical devices and drugs. In fulfilling this mission, many academic research institutions involved in biomedical research rely on extramural grants from the NIH and other agencies that are awarded to faculty to fund their research programs (Anania, 2015). However, after decades of growth, federal funding for grants for biomedical research has decreased since 2002 (Cook-Deegan et al., 2015). Thus, the pressure on early-career faculty to obtain federally funded grants perform biomedical research has increased due to competition for limited grant resources. Although the funding level for new grant applications from early-career researchers is usually higher than for applications from experienced investigators, this advantage is no longer available for subsequent grant applications (National Institutes of Health, 2017a). For early-career faculty, the competition to secure grant funding can be a particularly daunting career obstacle in obtaining promotion and tenure (Daniels, 2015). Therefore, it was critical to understand the perceptions of faculty toward research funding and the effect of funding on their career goals.

1.7 Philosophical Assumptions

In undertaking the research study, it was important to define the philosophical assumptions that reflect the background and beliefs that are brought into the investigation.

Quantitative research is typically aligned with a positivist perspective, a single reality through which phenomena can be observed and measured. This point of view is independent of the researchers and their "habitus," as described by Pierre Bourdieu (1977). In contrast to positivism, a post-positivist perspective assumes a single reality but also recognizes there are researcher limitations in studying a phenomenon and accounts for potential researcher bias. Qualitative research arose from post-positivist criticism of quantitative studies. In this regard, the research approach described below was post-positivist: it used a literature review to base the inquiry, a semi-structured interview format to bound (*i.e.*, establish parameters for) the data, and a structured coding strategy to interpret the data and account for subjectivity.

This research was immersive, an approach in which the researcher interacts at the site where the study participants work. Rather than maintaining a distance, the researcher became involved through firsthand knowledge. In this case study, the researcher has lived the experience of a faculty member seeking extramural NIH funding for academic biomedical research. He also worked at the study site, performing biomedical research during an academic sabbatical leave in 2006. These experiences facilitate the opportunity to interact with the study participants in a meaningful fashion during the interview process. A post-positivist approach asserts that the objectivity of the researcher can be maintained as well as independence from the study participants. In this case study, the researcher did not know the study participants personally.

1.8 Delimitations

This study was focused on a research-intensive medical center. Designed as a case study, this dissertation research was performed in the setting of a single institution. Because it ranks high among the top American research universities according to the 2015 Higher Education R&D Survey data (HERD, 2015), this institution was representative of elite status among its

peers and aspirant status among other rising institutions. The data collection for this research took place over a four-month period. Interviews were conducted in the offices of the individual faculty members who participated, to provide a familiar and non-threatening environment. However, because a compatible schedule could not be accommodated, one individual interview was carried out by Skype video call. This study was focused on a single institution located in the Southeastern United States performing biomedical research. Although each institution is unique regarding environmental factors, it may be possible to extrapolate the results of this study to similar institutions that also perform biomedical research.

Only basic science faculty members (on either tenure-track or non-tenure-track appointments) were interviewed. Basic science research or "bench" research incorporates the biomedical disciplines of biochemistry, cell biology, microbiology, physiology, and pharmacology; involves laboratory experiments; and may incorporate animal studies to determine the causal mechanisms involved in human health and disease. Once these mechanisms are understood, applied (clinical) science and translational research proceed for adoption to patient care. Basic science and translational faculty members are usually dependent on start-up funds from the institution or extramural grant funds to provide for equipment, supplies, reagents, personnel, and other costs in operating their laboratories (Dorsey et al., 2009).

This study also focused on early-career faculty members, who are defined as "those within the first seven years of appointment to a faculty position or those who have not yet been awarded tenure" (Austin, Sorcinelli, & McDaniels, 2007). This study was focused on early-career faculty members because their appointments are typically considered probationary with short-term contracts until tenure is achieved. Their appointments often are contingent on their grant funding status. Thus, these individuals represented those most likely to benefit from this

study. Interviews with 25 of these faculty members were conducted, focusing on those who have active research labs (*i.e.*, currently conducting bench experiments in a dedicated space, with or without current extramural funding) and who are pursuing NIH or other extramural grant funding. For NIH grant submissions, a New Investigator is considered an individual who has not previously competed successfully to obtain a substantial research award as an independent investigator. A New Investigator is also defined by the NIH to be an Early Stage Investigator if he or she is within ten years of completing his or her terminal research degree.

1.9 Limitations

Faculty members who have primarily clinical or teaching appointments were not interviewed. These faculty members have significant contributions to their positions beyond the scope of research. Only faculty members with terminal Ph.D. degrees were interviewed to investigate a more homogeneous group. Faculty members with M.D. degrees (or clinical appointments) were not interviewed. These faculty members have a unique perspective that is drawn from their clinical experience, which may not represent a research-centric background. Although some demographic and statistical data are presented, a quantitative research design was not used in this study. This research was also designed as a single-institutional study. However, the results of this study could be broadened in the future to develop a quantitative research instrument applicable to a multi-institutional study.

1.10 Conclusions

This study was purposefully designed as described in this chapter, to understand the focused experiences of a specific group of early-career faculty performing biomedical research in a targeted environment. However, this group is part of more than 305,000 individuals estimated to be employed in biomedical research in the U.S. (Mason et al., 2016). Although the

biomedical research workforce is heterogeneous (Mason et al., 2016), by carefully considering the research questions described above, the proposed research may provide a broader perspective for interpretation and extrapolation. In chapter two, a review of the literature is provided. The literature review includes studies involving analysis of factors influencing the productivity of early-career faculty and provides a theoretical framework for interpreting the data. As described in chapter three, the challenges that early-career faculty face can best be studied and understood through a qualitative examination of their perspectives and experiences. In chapter four, the interview data are presented as well as the major themes that emerged from the analysis of the data. Finally, in chapter five, a discussion of the data is provided in the context of the literature review and theoretical framework. A set of recommendations is also included as well as unanswered questions and suggestions for future lines of research.

CHAPTER 2

LITERATURE REVIEW AND THEORETICAL FRAMEWORKS

2.1 Introduction

Based on a random sampling, the mission statements of various universities might seem disparate at a first impression. Invariably, they include the notion of teaching, research, and service as a tripartite function in advancing knowledge. Into this environment are recruited faculty at the Assistant Professor level, who must compete for promotion and tenure (if on a tenure-track appointment) or contract continuation (if on a non-tenure-track appointment). In the field of biomedical science, however, grants have become such an essential component of these recruits that academic career productivity is linked to the ability to obtain research funding. The purpose of this chapter is to provide a background of funding for academic research in the biomedical sciences. The chapter explores how changes in this funding have affected the biomedical community. A review of the research literature is also provided to identify the factors that can influence research productivity, particularly at the Assistant Professor level.

2.2 Literature Review

Biomedical research over the last century has resulted in new drugs, medical procedures, and medical devices that have dramatically increased the health and lifespan of individuals and global populations. The United States has historically provided the majority of academic funding for biomedical research through government agencies such as the National Institutes of Health (NIH), as well as through private non-profit foundations and for-profit companies

(Dorsey et al., 2010). Those sources of financing support a mixture of academic, private, and government research laboratories.

2.2.1 Commodification of biomedical research

In his treatise on the changing culture of academic research, Hans Radder (2010) characterized the phenomenon in which academic institutions seek to commercialize the research of their faculty and results of their investigations as *commodification*. In a broader sense, commodification represents a systemic change in academic culture since the 1980s, in which academic pursuits are predominantly assessed by their economic value. This concept of commodification was similarly identified by the work of Slaughter and Rhoades (2001), who described activities dealing with market and market-like behaviors on the part of universities and faculty as Academic Capitalism. In addition to the pursuit of revenues through commercialization of research from licensing of inventions, university-industry partnerships, and investment in spin-off companies, these market-like activities also refer to institutional and faculty competition for funding from external grants and contracts (Münch, 2014).

From a federal policy perspective, the Bayh-Dole Act of 1980, which allowed academic institutions to seek patent rights for government-sponsored research, set the stage for the current focus of academic institutions on commercialization through technology transfer and licensing of inventions (National Research Council, 2010). Since the 2000s, the NIH has also changed prioritization for the funding of research infrastructure, as well as grants and contracts to emphasize translational research (Zerhouni, 2003). Translational research refers to investigations that exploit knowledge from the basic sciences to produce new approaches to prevention, diagnosis, and treatment of disease, also known as “bench-to-bedside” research. This interface between scientific discovery and clinical medicine is promoted by NIH support of

translational research into promising new treatments that can be commercialized into clinically useful products by companies. Henry Etzkowitz has coined this relationship between academic studies, government policy, and industry commercialization as a "triple helix" system that spans traditional boundaries for exploiting research discoveries for economic profit (Ertzkowitz, 2015).

2.2.2 The NIH grant review process

One of the most important pursuits during an academic career in biomedical research is applying for NIH and other extramural funding. The NIH is the world's largest funder of biomedical research and has an annual budget of approximately $33 billion for intramural and extramural

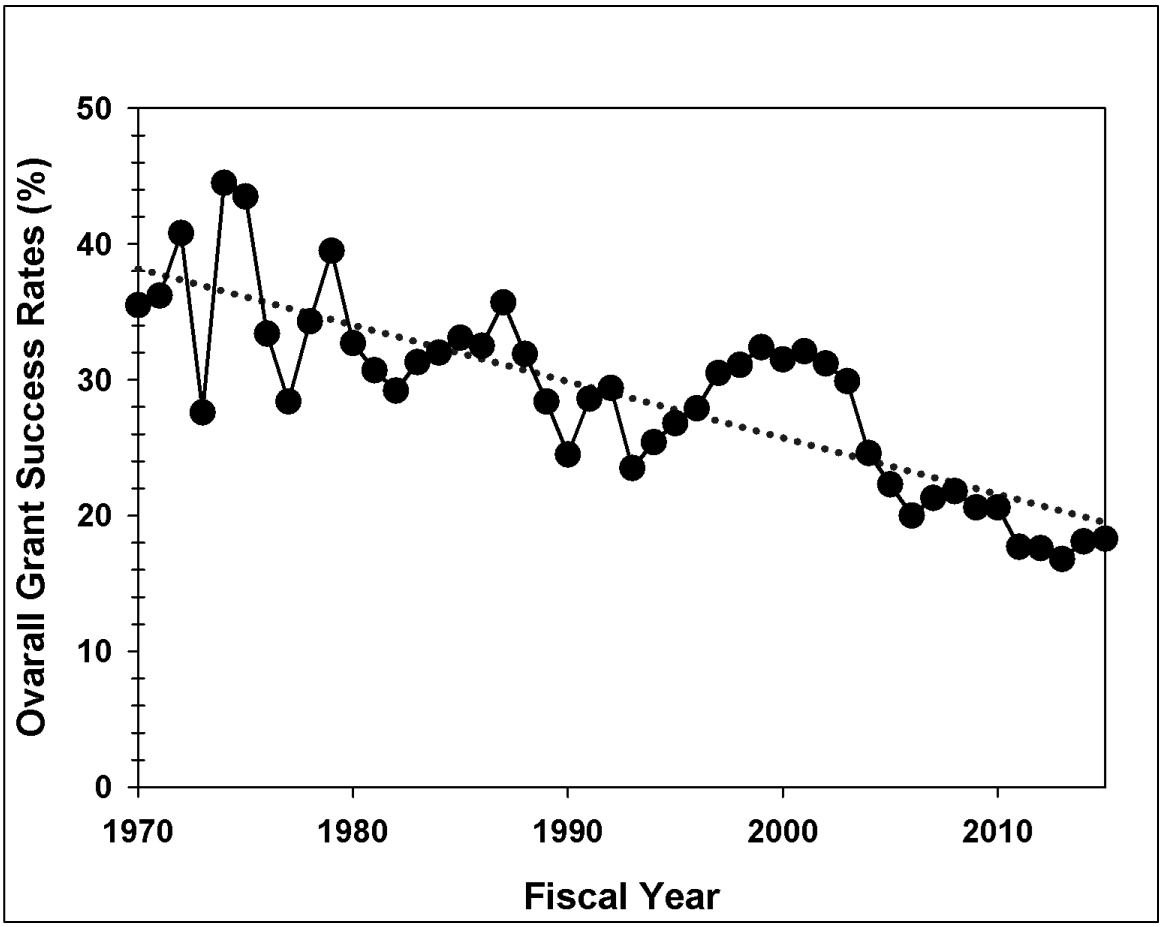

Figure 1. NIH Grant Application Success Rates. Shown above is a linear regression trend (⋯) for success rate of research project grant applications (defined as activity codes R01, R23, R29, and R37) funded by the NIH year from 1970 through 2015.

research in FY 2017 (National Institutes of Health, 2016b). In FY 2016, the NIH received 54,220 extramural research project grant applications for funding and awarded 10,372 for an overall success rate of 19.1% (National Institutes of Health, 2017b). As shown in Figure 1, data obtained from the NIH Research Portfolio Online Reporting Tools (RePORT) illustrated the success rate (defined as the ratio of the number of grants awarded to the number received) dramatically declined over the past two decades. Low success rates are not only are demoralizing to researchers, but also make it challenging to provide long-term stability for research laboratories. In 2016, $18.2 billion was awarded for extramural research project grants (RPGs), $2.6 billion for research centers, $1.8 billion for other research grants, $0.68 billion for research career awards, and $0.78 billion for Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) grants (National Institutes of Health, 2017c). The Research Project Grant Program (R01) is the most commonly used RPG mechanism awarded to independent investigators. The R01 budget typically supports a discrete, specified, and circumscribed research project; it is given for three to five years. In 2016, there were 30,106 competing R01 grant applications, of which 6,010 were awarded for a success rate of 18.9% (National Institutes of Health, 2017b). The average size of the awards was $499,221, and the total amount of NIH funding that went to R01 grants (both competing and non-competing) in 2015 was $11.1 billion (National Institutes of Health, 2017b).

Like other grant mechanisms, the R01 grants receive an initial review using standing and ad-hoc peer-review committees. The peer-review committees consist of selected members of the scientific community based on their scientific expertise and funding history. Each committee provides an overall impact score for grant applications and provides a percentile score based on the percentage of grants that received a better score in the previous year. After initial scoring,

the applications receive a secondary review by an NIH advisory council or board for programmatic priority.

Despite the possibility that peer-review committees may inappropriately score grant applications due to reviewer bias (Lee, Sugimoto, Zhang, & Cronin, 2013; Bornmann, 2011; Levitt & Levitt, 2017) and other factors such as peer reviewer expertise (Gallo et al., 2016), better peer-review scores have been associated with better research outcomes (Li & Agha, 2015). More recently, controversy regarding the NIH peer review process has centered on the possibility of racial (Ginther et al., 2011) and gender (Bornmann, Mutz, & Daniel, 2007) biases, as well as influences based on interpersonal relationships (Wessely, 2007). The peer-review process has also been criticized for encouraging conformity and discouraging innovation (Nicholson & Ioannidis, 2012). These criticisms regarding the fairness of the grant review process have led to calls for alternative systems for grant allocation, such as a modified lottery system (Fang & Casadevall, 2016) or a shift to funding investigators rather than projects (Kaiser, 2014; Germain, 2015).

In summary, the NIH grant review process has come under increased criticism as the NIH grant success rates have declined. Nonetheless, there is no clear consensus for any proposed changes to improve the situation. For example, a plan to limit the number of funded grants available to each laboratory was heavily criticized and recently tabled by the NIH. What is clear is that the trend in funding success rates is not likely to change in the near future.

2.2.3 A declining trend in U.S. funding for biomedical research

Funding for biomedical research accounts for about 60% of all extramural research revenues to universities (Zinner & Campbell, 2009), providing a substantial revenue stream. As shown in Figure 2, the inflation-adjusted NIH budget grew at an average rate of about 9% each

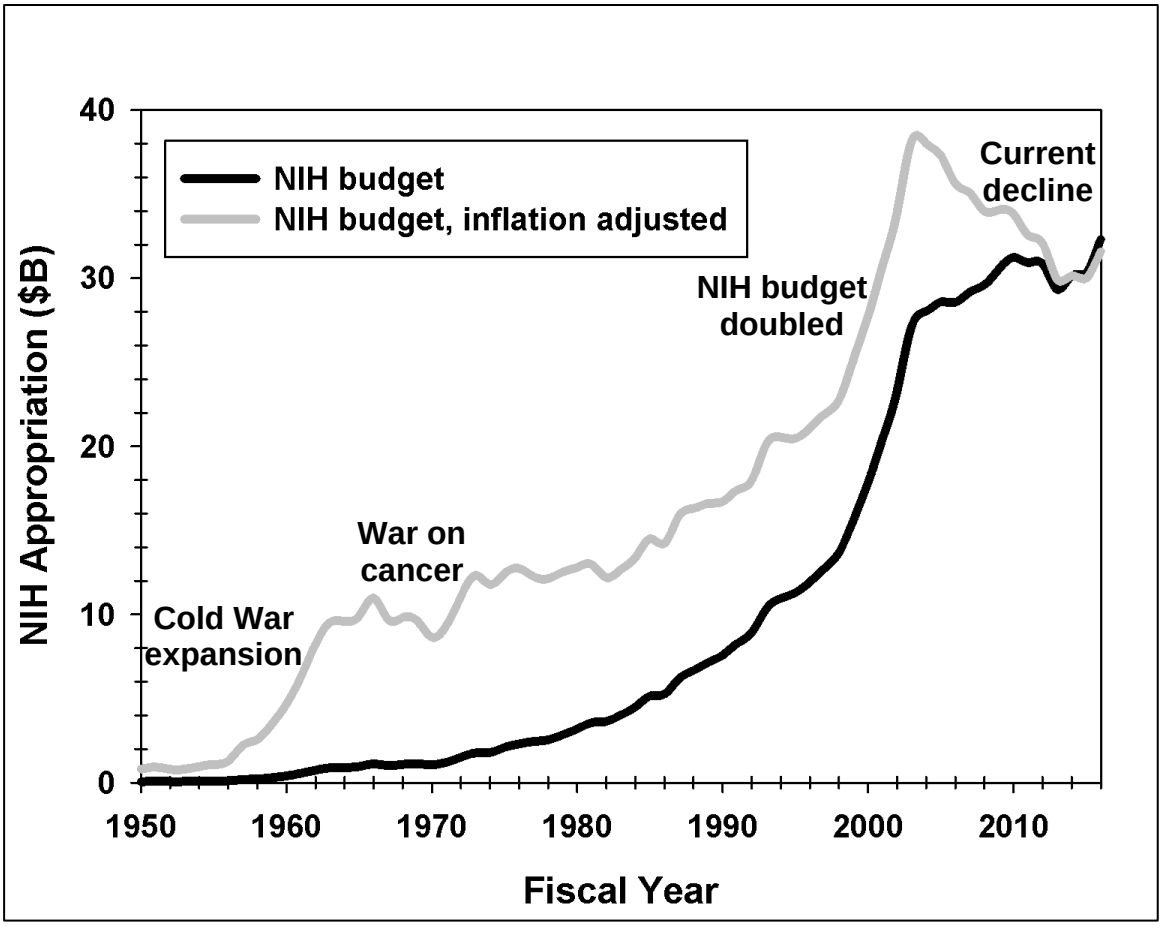

Figure 2. NIH Appropriations from 1950 to 2016. Shown in Figure 3 is the trend in appropriations by Congress each year in dollar amounts (**--**) or in real dollars adjusted for inflation (**--**).

year from 1960 to 1998. From 1998 through 2003, the National Institutes of Health (NIH) budget for biomedical research was doubled, increasing from about $13.6 billion to over $27 billion (National Institutes of Health, 2014). However, with inflation accounted for, federal funding from 2003 to 2010 for science has subsequently declined. Since 2010, federal funding has seen more than a 20% decrease in inflation-adjusted 2003 dollars to less than $22 billion (Johnson, 2013). This support has continued to decline by nearly 13% since 2011 when considering all federal funding of research and development (R&D) for higher education (Britt, 2016). Although a modest rebound in this decline was obtained in the last two years of the

Obama administration, new calls for fiscal austerity by the Trump administration threaten these gains (Reardon, Tollefson, Witze, & Ross, 2017).

Conte et al. (2017) investigated the negative consequences of a flat NIH budget on the biomedical research community over the last 15 years, by examining research publications of U.S. authors in ten top-tier clinical and basic science journals. First, the authors showed an increase in international cooperation from 26% of papers that included researchers from at least two countries in 2000 to 47% in 2015. There was also an increase in team science, as represented by a change in the number of publications with 21 or more authors from 2% in 2000 to 12.5% in 2015. Finally, the authors identified a dramatic rise in the publication output from China that paralleled an increase in government R&D expenditures relative to U.S. expenditures.

Moses et al. (2014) quantified the changes in funding (government and private sector) for biomedical research over the last 18 years and evaluated the effect on resulting outputs (measured in patents, publications, and drug and device approvals). This study examined both U.S. and international research funding as well as research output in patents and publications using publicly available data. While U.S. medical research funding increased 6% per year between 1994 and 2004, this rate declined substantially to only 0.8% per year between 2004 and 2012. In contrast, the share of total global funding for biomedical research by Asian economies (particularly China) increased by 7% between 2004 and 2012. This shift in total global funding for biomedical research resulted in a decline in the U.S. share of research by approximately 13%. Likewise, the U.S. global share of research patents decreased from 73% in 1981 to 59% in 2011. Similarly, the growth rate in the number of biomedical research articles in the U.S. (0.6% each year) from 2000 to 2009 did not keep pace with the global growth rate at 1.5% each year.

During this period, China had the most substantial growth rate in the number of biomedical research articles, at 18.7% (Moses et al., 2014).

Continued investment in biomedical research is required to obtain scientific discoveries that result in new therapies to improve health. Based on the global trends in research funding, Moses et al. (2014) concluded that the United States "will relinquish its historical international lead in the next decade unless such measures are undertaken" (p. 188). In a report to President Obama, the President's Council of Advisors on Science and Technology acknowledged a global reorganization of research (Holdren & Lander, 2012). This report noted, "Just as the United States has lost a significant portion of its manufacturing to other countries, it is now in danger of losing its advantage in invention and discovery, potentially an even greater calamity" (p. 1).

Based on the current trend in funding, Chinese spending on biomedical research and development is expected to overtake U.S. funding by the year 2022. This trend is significant because it represents a lost opportunity cost regarding individuals in the U.S. who may choose different careers outside of academic biomedical research. Although this trend is reversible, given the political climate for federal spending, it is likely that alternative revenue sources will need to be identified to increase biomedical research funding.

2.2.4 A decline in state funding for higher education

Over the last three decades, spending by state and local governments on higher education has decreased by an estimated 40% (Mortensen, 2014). Some causative factors that have contributed to this decline include budgetary constraints caused by mandatory state spending increases in retirement pensions, Medicaid costs, K-12 education, and other fixed costs (Dar & Lee, 2014). Unlike the federal government, most state constitutions prohibit deficit spending in their general operating budgets, although these restrictions can be overcome through accounting

manipulation (Costello, Petacchi, & Weber, 2014). Moreover, spending on higher education has not been viewed as a top priority by politicians based on their constituencies, particularly in times of tight budgets as was seen since the Great Recession of 2008 (Mitchell, Palacios, & Leachman, 2014). Declining state support for higher education means that most public institutions have shifted revenues by increasing reliance on tuition from students (Fowles, 2014) and increased research funding (American Academy of Arts & Sciences 2015). Currently, there are few alternatives to the decreasing trend in state support for public institutions of higher education; increasing tuition can only partially replace these losses. Public institutions have also compensated by cutting faculty positions, decreasing course offerings, and reducing student services, among other approaches (Mitchell, Leachman, & Masterson, 2016).

Many institutions have increasingly turned to hiring part-time and non-tenure-track faculty members rather than tenure-track faculty members to reduce costs and limit long-term personnel obligations (Lowman, 2010). However, the results of a study by Zhang and Ehrenberg (2010) indicated that recruiting non-tenure-track faculty members instead of tenure-track faculty members could negatively affect the overall number of extramural research dollars awarded to an institution. Non-tenure-track faculty members were shown in this study to be less competitive in obtaining grants than tenure-track faculty members. In contrast, increasing the number of part-time (and non-tenure-track) faculty members while maintaining the level of tenured and tenure-track faculty members raised the overall number of extramural research dollars awarded to an institution. It is possible that the results of this study were due to research faculty members who were freed from their teaching duties. A more recent study confirmed these findings, showing that non-tenure-track faculty members in the physics community are at a competitive disadvantage for research productivity compared to their colleagues with tenure or long-term

contracts, which may also hinder their career trajectories (Peterson, Riccaboni, Stanley, & Pammolli, 2012).

2.2.5 Institutional reliance on indirect costs

Declines in overall state support for institutions of higher education have increased financial pressures on many state university systems. In particular, state universities have paid more attention to their indirect cost returns from funded grants, resulting in a rise in the average rates (Anania, 2015). Alberts et al. (2014) argued that the reliance on indirect costs has also allowed academic institutions to expand the number of faculty members and increase research infrastructure without making a corresponding investment of resources. Since the 1960s, academic research institutions have increasingly relied on securing federal funds for research. During this time, there has also been a cost-shift to universities: the university share of funding university-based R&D rose from 8.7% in 1962 to 19.4% in 2012 (Britt, 2014). In addition, changes in federal grants over time have allowed faculty salaries and equipment to be funded by direct costs.

Indirect costs provided from grants, or F&A (facilities and administrative costs) compensate universities for expenses that are not directly associated with any single research project. Expenses included in indirect costs can include costs such as utilities, administrative costs, facilities maintenance, and building and equipment depreciation costs. Today, indirect rates at public universities range from 20% to 85% (Johnston, Desmond-Hellmann, Hauser, Vermillion, & Mia, 2015). At non-profit research institutions and private universities, these rates are even higher. High indirect costs are often an irritation to faculty members, who see them as a diversion of the NIH budget that could otherwise be spent on research (Ledford, 2014). NIH-

funded institutions contend, however, that the cost of sponsoring research has far outpaced the reimbursement provided by the NIH (Daniels, 2015).

Stephens (2014) described the economic incentive of indirect costs was to produce "high-end shopping malls," in which universities build state-of-the-art research facilities to attract productive faculty. This model encouraged universities to overbuild, and research space research increased by 30% between 2001 and 2011. Perversely, debts incurred from the construction binge created a greater reliance on researchers to obtain external funding.

2.2.6 Graduate student and postdoctoral fellow training in biomedical research

In the global infrastructure of biomedical research, graduate students, and postdoctoral fellows have become a major academic labor force (NSF, 2013). However, with the current situation of shrinking funding for biomedical research over the last decade in the United States, the training pipeline of graduate students and postdoctoral fellows is producing more research scientists than positions available in academic, government, and the private industry. Consequently, an ever-increasing supply of trainees competes for a finite amount of research funding and employment positions. As noted by a group of renowned leaders in the biomedical field, the situation creates an "unsustainable hypercompetitive system that is discouraging even the most outstanding prospective students from entering our profession – and making it difficult for seasoned investigators to produce their best work" (Alberts et al., 2014, p. 5773).

Historically, the postdoctoral fellowship position was established in the last century at elite institutions as an option for advanced specialized training undertaken after completing a doctoral degree, to hone specific scientific skills before beginning an academic research career. Over the previous 50 years or so, postdoctoral training became the mainstay at research institutions in the United States and internationally. Based on this expansion, the postdoctoral

training position is a standard prerequisite for academic employment at the tenure-track faculty level. To progress into a tenure-track academic position, postdoctoral fellows must demonstrate productivity in producing a substantial publication record, and in many cases secure independent research funding.

The postdoctoral position is at the forefront of globalization processes within higher education as more than 209,000 new United States citizens and permanent residents who completed their doctoral studies in the sciences and engineering held postdoctoral positions in 2013 (NSF, 2013). More than 100,000 additional graduates with temporary visas held postdoctoral positions in 2013, resulting in nearly 50 percent of all postdoctoral fellows working in the United States being citizens of other countries. The pattern is similar in the United Kingdom, with more than 40 percent of all postdoctoral fellows coming from overseas.

A recent study by Mason et al. (2016) showed that the supply of scientists in the biomedical research workforce continues to outstrip labor demand in jobs. The lack of faculty positions available means that postdoctoral fellows become trapped in the position, accepting multiple postdoctoral positions and staying in these posts for many years resulting in a loss of career competitiveness. One review of the situation showed that of the postdocs surveyed in 2013, almost 10% had been at that level for more than six years (Powell, 2015). In the United States, about 65% of doctoral graduates in the sciences continue into postdoctoral training, and of those, only 15 to 20% move into tenure-track academic positions (Powell, 2015). The statistics are even worse in the United Kingdom, with only about 3.5% of science doctoral graduates finding permanent research staff positions at academic institutions. A recent study by the European Science Foundation concluded, “The oversupply of Ph.D. holders in Europe is causing considerable dissatisfaction and stress for researchers on temporary contracts” (Else,

2015). This report continued the dire appraisal of the job market for postdoctoral fellows, indicating that "most of those surveyed wanted a career in academics, which is not sustainable given the rising number of Ph.D. graduates looking for work in an oversupplied employment sector."

One solution tested at a few institutions in the United Kingdom, France, and Germany has been the imposition of term limits, which restrict the number of years that researchers can remain on short-term contracts before they must be hired on permanent contracts (Powell, 2015). As an alternative approach, the number of postdoctoral positions allowed in New Zealand has been severely restricted. However, whether these regulations help is unclear; they can often be circumvented. Another approach that has been suggested is the creation of senior staff scientist positions for postdoctoral fellows who fail to progress to independent faculty positions. Many academic researchers in the United States balk at this approach, citing a lack of grant funding to support the higher salaries of senior staff scientists who could earn between $75,000 and $100,000. In comparison, the current NIH stipend ranges from $42,000 a year for a starting postdoctoral fellow with no experience, up to $55,272 for a postdoctoral fellow with seven years of experience. Academic institutions in the United States have also expanded the number of doctoral students from about 30,000 graduate students in biomedical sciences in 1979 to nearly 57,000 in 2009. Thus, a tremendous bias exists among academic researchers to use cheap labor represented by graduate students and postdoctoral fellows. However, this bias may be short-sighted when considering the likelihood that a well-trained staff scientist can be much more productive than an inexperienced trainee can.

Postdoctoral fellows have fared somewhat better in the United Kingdom. The Concordat to Support the Career Development of Researchers is an agreement signed in 2008 between the

grant agencies and academic employers, which established guiding principles for career development of postdoctoral fellows and provided for salary increases. The Concordant states that postdoctoral fellows should have "knowledge of the range of future career opportunities available to them, be aware of their training needs, have good access to training opportunities, and make full use of the recommended ten days of development activities per year" (Research Concordant, 2011). The Concordant also stresses the importance of providing graduate students career planning and support for developing alternative career options, as well as support for traditional academic careers. Nonetheless, a recent report by the Times Higher Education revealed that as many as 200 applications are received for every early-career position at top universities with permanent or open-ended contracts available (Grove, 2016).

Overproduction of doctoral graduates and postdoctoral fellows vying for a limited number of tenure-track or permanent contract positions has also contributed to a lack of career opportunities. According to one report, "the consequence is insecure employment that causes considerable dissatisfaction and stress among the postdoctoral population" (European Science Foundation, 2015). A recent study analyzing trends in the biomedical research workforce showed that the supply of doctoral graduates continues to outstrip the employment demand (Mason et al., 2017). Nonetheless, the United States Congress has directed the NIH work toward attracting and sustaining support for "diverse groups of outstanding young and new investigators" (Lauer, 2017). Without structural changes at the graduate, postdoctoral, and faculty levels to address these conditions, the research infrastructure will face an inevitable decline in productivity (Alberts, 2014).

2.2.7 Determinants of faculty research productivity

In a broad database query of the 2004 National Survey of Postsecondary Faculty, Webber (2011a) examined the input of more than 300,000 faculty members from nearly 1,200 four-year colleges and universities. The authors of this study broadly examined all academic disciplines clustered into five academic discipline groups: 1) Arts and Humanities, 2) Physical and Life Sciences, 3) Social Sciences, Education, and Agriculture, 4) Business and Legal, and 5) Others. A two-level hierarchical generalized linear model was created to identify relevant variables associated with faculty productivity. One delimitation of this study was a focus on tenured and tenure-track faculty; non-tenure-track faculty members were excluded. Furthermore, Full Professors were 38% more productive in producing refereed journal articles than other ranks. Faculty members in the Physical and Life Sciences were also more productive than other discipline groups. However, female faculty members in the Physical and Life Sciences produced 25% fewer refereed publications than their male counterparts. In addition, an adverse effect of teaching load on faculty publication productivity was found across all academic disciplines.

2.2.8 Institutional resources and faculty productivity

Startup expenses for new faculty members in the biomedical sciences are costly. Current faculty start-up investments at medical schools for research are necessary, and can often exceed available institutional resources (Joiner, 2005). It is usual to provide $400,000 to $700,000 or more in start-up funds to recruit the most qualified junior faculty (Ehrenberg, Rizzo, & Condie, 2003). One study of new faculty recruitment suggested that faculty retention for greater than ten years is critical to recoup the initial institutional start-up investment (Joiner Hiteman, Wormsley, & Germain 2007). The loss of a faculty member means that a return on much or all of this initial investment is not achieved. Institutional support of an individual faculty member's research

often ends after the start-up funds are expended; afterward, faculty members are expected to acquire extramural grants to support their research. In addition, faculty members at many institutions in "soft money" positions are increasingly expected to include a portion of their salaries on extramural grants.

When research expenditures, as well as size and type of institution, were examined, Webber (2011a) showed a positive effect on internal research expenditures by institutions on faculty productivity. For each standard deviation increase in the research funding to total funding ratio, there was a two-fold rise in the number of refereed publications produced. Thus, low institutional appropriations for research had a detrimental effect on faculty productivity. Finally, faculty members at doctoral-intensive institutions were more productive than faculty members at non-doctoral institutions were.

McGill and Settle (2012) performed a survey of faculty members in Computer Science and Information Science Departments to determine their perceptions regarding institutional resources and support for research. The data were analyzed by descriptive statistics and Pearson's correlation coefficient. The results identified an emphasis on research collaboration was perceived by most faculty members, although there was no formal definition for or understanding of this requirement. The data also showed that faculty members were not satisfied with their level of institutional support. There were also three critical areas faculty members perceived that additional support would enable them to increase their research productivity. These areas included staff support, release time, and funding for attending conferences. In addition, untenured faculty members perceived "less staff support, less funding for summer salaries, and workshops and training, and less funding for improvements to office space or facilities were available to them than their tenured colleagues" (p. 189).

One institutional approach for increasing research productivity involved strategic recruitment of new faculty members. In one study, administrators in a clinical academic department at the University of British Columbia strategized on the recruitment of research faculty "to prioritize research, develop collaborative research programs and provide a foundation for research training (Chung, Clifton, Rowe, Finley, & Warnock, 2008). The number of Ph.D. research faculty in the department increased from zero in 1994 to four in 2004. Research funding data and publication records were analyzed over this ten-year period of this strategic effort. In this study, research funding from all sources increased during the timeframe analyzed. Interestingly, the number of publications did not show a concomitant rise, although this may have been due to a time lag between receiving grant funding and acquisition of sufficient data to warrant publication. These results were supportive of using strategic recruitment as a tool to improve academic productivity.

2.2.9 Research funding and productivity

Based on the declining levels of current and projected federal funding for biomedical research, faculty research productivity is threatened. Since research productivity and funding are significant factors for promotion and tenure of faculty members in the biomedical sciences, untenured faculty members face increasing career challenges. The ability of faculty members performing biomedical research to obtain federally funded extramural grants has declined dramatically over the last decade. As the funding situation has become more tenuous, potential funding gaps may adversely affect research faculty productivity and their academic career progress. Therefore, measuring faculty productivity is important for administrators at institutions of higher education to determine which factors might contribute toward faculty success in obtaining extramural research grants.

Institutions rely on federal grants from the NIH and other agencies that are awarded to faculty members to fund research programs. While institutions vary broadly in standards established for evaluating faculty performance, Hardré and Cox (2009) found that most academic institutions prioritize research activities over teaching and service. The number of peer-reviewed publications was an important criterion used in promotion and tenure decisions. In assessing faculty productivity using the 2004 National Study of Postsecondary Faculty, Webber (2011a) showed that presentations and peer-reviewed publications were the most frequently measured outputs of productivity. In addition, there was a positive correlation between institutional apportionment of funds for research and research productivity.

Among many research institutions conducting biomedical research, grants awarded by the NIH are often strongly considered in evaluating promotion and tenure because they are subject to rigorous peer review (Ascoli, 2007). Thus, obtaining NIH grant funding indicates that a recipient is capable of research as an independent investigator. There is a perception that research productivity is predictive of the amount of funding and number of NIH grants obtained by faculty. Ali, Bhattacharyya, and Olejniczak (2010) measured faculty research productivity at the total number of federally-funded research grants awarded to faculty members and the dollar amount of each grant. These authors examined whether faculty scholarly productivity influenced the likelihood to obtain competitive research grants. The results of their study showed a positive correlation between grant funding and the number of peer-reviewed publications, although the impact of publications on funding decreased as the number of publications increased. A similar finding was obtained by Jacob and Lefgren (2011), who showed that the impact of NIH funding on the number of publications was limited, corresponding to only a 7% increase after obtaining an NIH grant. These results suggest that researchers use alternative sources of funding to

support research projects. However, NIH funding did have a greater impact on the publication productivity of researchers under the age of 45 than on senior researchers.

2.2.10 Publications and research productivity

A significant component in measuring faculty productivity is based on the output of peer-reviewed publications. As noted in Hesli and Lee (2011), the phrase "publish or perish" embodies the importance of this measure in determining faculty performance evaluations, research grant awards, and promotion and salary decisions. Despite widespread concern that individual publication rates of research scientists have increased in recent years due to evaluations based on publication records, a recent study by Fanelli and Larivière (2016) showed that the publication rate for early-career scientists has not increased over the last century when normalized to fractional and first-author productivity.

However, in a 1989 study of research productivity at the University of Nebraska College of Medicine, Ellwein, Khachab, and Waldman (1989) found that there was nearly a tenfold range between departments in publication rates per faculty member when weighted for impact factor and number of authors. While the results were unambiguous, they also illustrate the difficulty in evaluating research productivity based on the counting of publications.

Hesli and Lee (2011) examined the factors that might have contributed to publication output in the political science discipline. Using a survey of 1399 political science faculty members across U.S. institutions of higher education, a multivariate analysis was performed to identify dependent variables predictive of faculty productivity. While this study was focused on the faculty in the political science field, some general principles may be gleaned as applicable to faculty in the biomedical sciences. The results showed there were both similarities and dissimilarities in publication rates depending on faculty rank. For example, a large teaching load

had a detrimental effect on publication rates among faculty members at the Assistant and Associate Professor level. However, there was no adverse effect on Full Professors. Full Professors did show an increase in productivity correlated with the number of students advised, that was not reflected among Assistant or Associate Professors. This result could demonstrate a measurement of professional involvement with graduate students who comprise a productive research group regarding publications. One interesting finding from this study revealed that a collegial environment was unexpectedly associated with lower productivity. This finding suggested that a competitive or even a hostile environment not detract from faculty productivity but instead enhanced productivity. These results need to be studied further, particularly in the context of research grant competitiveness. In summary, teaching load and research environment are two variables that could affect productivity for faculty.

In a query of the 2004 National Survey of Postsecondary Faculty, Webber (2012) examined the demographic data to understand factors that influenced faculty productivity. An analysis of these data showed that foreign-born faculty members produced a higher number of publications than their U.S. natural-born peers produced. However, foreign-born faculty members spent more time on research and less time on undergraduate teaching than their U.S. natural-born peers, which may have contributed to higher productivity. A greater proportion of foreign-born faculty members were also at the junior faculty level, positions that demand high levels of productivity for tenure and promotion decisions. These analyses indicated there was a correlation between research productivity as measured by publications and time devoted to research.

Research publications have become a major metric for faculty productivity. The publications cited above, however, indicate that there are several factors, which could influence

individual publication rates both positively and negatively. Thus, evaluation practices (such as grant reviews) that overemphasize publication productivity could have negative consequences, putting research scientists under greater pressures to boost their publication at the potential expense of scientific quality.

2.2.11 Teaching load and research productivity

For many major medical schools, faculty teaching has been traditionally supported by research and clinical income. However, the competing demands of teaching and research and the impact on scholarship productivity have received little attention in the literature. One study by Smeltzer et al. (2016) examined the research productivity of doctoral faculty at 71 schools of nursing. Using a survey instrument, the authors determined predictors of research productivity. The strongest predictor of research productivity was the average number of hours spent on research-related activities, followed by time bought out from teaching duties. Interestingly, the authors found a correlation between productivity and the belief that engaging in research made them better teachers.

The study by Surratt, Kamal, and Wildfong (2011) surveyed faculty members at U.S. pharmacy schools to examine faculty perceptions about institutional expectations for research grant support based on teaching and administrative workloads. In addition, this study examined faculty perceptions as a function of academic rank. Among the survey respondents, a majority perceived that the amount of teaching expected was too high to be competitive as an academic researcher. A significant number of survey responders perceived that new faculty start-up funding was well below that typically found at non-pharmacy research institutions. Finally, teaching commitment was perceived by survey responders more likely to increase rather than decrease after achieving tenure.

A survey of tenure-track faculty members in colleges of agriculture at land-grant institutions by Miller, Coble, and Lusk (2013) supported the correlation described by Webber (2011a) between research productivity and time devoted to research. In this study, 378 individual faculty members responded to the survey, and their publication records from 2000 to 2009 were obtained from the different citation indexes. Using a Poisson regression model, analysis of the various variables showed that teaching appointments and extension appointments had significant effects on the number of research publications a faculty member produced. For example, the results indicated that faculty members with teaching appointments of 25% or less had a greater productivity in publications than faculty members who had larger teaching responsibilities.

The academic responsibilities of research and teaching have been a juggling act for many faculty members. However, the productivity of faculty members is often measured by the number of publications, resulting in a mixed message from universities regarding the priorities of teaching and research. Based on the studies cited above, there is a complex relationship between teaching load and research productivity, although these results could be affected by different institutional practices, such as rewarding research funding with reduced (buying-out) teaching load.

2.2.12 Collaborations and research productivity

To determine the role of research collaborations on faculty productivity, He, Geng, and Campbell-Hunt (2009) examined 65 biomedical scientists at a New Zealand university. The authors performed a longitudinal study of the publication records over 14 years from 1990 to 2003. Analysis of the data collected showed that only extramural collaborations and not intramural collaborations were correlated with future research output regarding total quantity of

publications. At the individual article level, both intramural and extramural collaborations were positively related to quality regarding impact factor. These results could provide policymakers and administrators a tool for assessing and incentivizing research productivity. However, this research was limited to a single international research institution.

The study by Peterson et al. (2011) focused on analyzing the relationship between career trajectories and research productivity among faculty members in the field of physics. The authors of this study used longitudinal data on scientific output from three sets of 100 faculty members as a career trajectory model: most cited physicists, additional highly cited physicists, and early-career Assistant Professors. The results of mathematical modeling the data demonstrated that fluctuations in productivity were quantitatively related to an academic researcher's collaboration radius and team efficiency. However, this model also identified a diminishing rate of return in productivity associated with increasing collaborative group size. In addition, the results on career productivity were consistent with incorporation of a "Matthew Effect," a phenomenon in which the rich get richer, while the poor get poorer (Merton, 1969). Among many research institutions conducting biomedical research, grants awarded by the NIH are often strongly considered in evaluating promotion and tenure (Ascoli, 2007) because they are subject to rigorous peer review. Thus, obtaining NIH grant funding indicated that a recipient was capable of research as an independent investigator.

A study by Melkers and Xiao (2012) surveyed 1,764 academic scientists and engineers at Research I universities (renamed in 2015 to Doctoral Universities – Highest research activity under the Carnegie Classification system). The authors of this study examined the relationship between faculty productivity and interdisciplinary research. In particular, the authors assessed whether or not faculty who were engaged in interdisciplinary research were more involved in

emerging technologies and more successful in funding than their colleagues who were not interdisciplinary. In the survey data, 25% of responders reported that they worked in a recognized research area of emerging technology such as nanotechnology. These positive emerging technology responders were significantly more engaged in interdisciplinary research. The resulting data illustrated that industry orientation and interdisciplinary research were predictors of funding for areas of emerging technologies. From these findings, the authors also found that women faculty who are poorly represented in fields such as engineering had greater participation in emerging technologies. Conversely, in fields such as biological sciences with better representation of women, there is less participation in emerging technologies. These results suggest that there are better opportunities for women in these areas.

The results of these studies suggest that research institutions should consider faculty development programs that emphasize research collaborations to increase research productivity. In addition, policy or funding initiatives that benefit areas such as emerging technologies may provide research growth potential for faculty where there is little competition.

2.2.13 Self-efficacy and research productivity

Self-efficacy can be defined as an individual's beliefs about his or her capabilities to perform at a defined level. In a study by Pasupathy and Siwatu (2014), research self-efficacy beliefs among faculty members at an emerging research-intensive institution in the U.S. was investigated, to understand the influence of self-efficacy on research productivity. The authors surveyed 233 tenure-track Assistant Professors and tenured or tenure-track Associate Professors in the fields of social and behavioral sciences, of whom 109 responded. Quantitative analysis of the data showed a significant but weak positive correlation between total research productivity and research self-efficacy beliefs among researchers. In support of this finding, Quimbo and

Sulabo (2015) investigated the relationship between faculty self-efficacy and productivity among 377 randomly selected faculty members at five state universities in the Philippines. Quantitative analysis of faculty members surveyed showed self-efficacy to be a positive determinant of research productivity.

The studies by Pasupathy and Siwatu (2014), as well as Quimbo and Sulabo (2015), suggested that research institutions should consider faculty development programs that cultivate self-efficacy beliefs. In another study, Pololi et al. (2015) defined the concept of vitality as "faculty satisfaction or the connection with the institution that characterizes faculty engagement." Although somewhat analogous, the authors considered self-efficacy as a consequence of vitality. In this study, the authors assessed the current faculty vitality and identified its predictive factors associated with vitality, by surveying 4,578 full-time faculty members at 26 U.S. academic health centers. Using a previously evaluated five-item scale, the strongest factors that emerged as predictors of vitality were relationships/inclusion, values alignment, work-life integration, and institutional support. Interestingly, while about 50% of those responding to the survey scored high on vitality, 25% scored low. There were no gender or underrepresented minority differences identified. These results indicated a large percentage of the faculty might lack optimal vitality in fulfilling their professional roles, and suggested that institutions be attentive to issues affecting vitality such as improving work-life integration and connectedness.

A study by Garman, Wingard, and Reznik (2001) assessed whether a formal mentoring program developed at an academic health center could have an impact on the self-efficacy of participating early-career faculty. Initially, 136 were surveyed to rank their self-confidence in professional skills. Of the responders, 39 were chosen to participate in a seven-month program,

and the other 97 were used as controls. After completing the program, the participants were re-assessed and rated themselves higher in self-confidence in all areas of professional academic skills. These results suggest that a short-term program of focused mentoring could be used to enhance faculty self-efficacy. However, this study did not link specific indices of faculty performance related to self-efficacy.

A recent study by DeCastro and Sambuca (2014) examined how the rejection of grant funding after obtaining an initial career development award from the NIH affected recipients. Using a qualitative approach, the investigators interviewed 100 awardees to understand their perceptions of a career in academic medicine. The participants described a number of factors that influenced their emotional and behavioral responses to professional rejection. A major theme from the results identified mentoring as a key element in providing the resilience to overcome career obstacles. The authors suggest that resilience can be learned adaptation. In support of these findings, McAlpine et al. (2016) studied sixty faculty members working in a range of academic disciplines, who were recruited from research-intensive universities in Europe and the United Kingdom. Using a qualitative research design, these individuals were interviewed about their experience of gaining research independence by obtaining their first grant as a principal investigator (PI). More than a third of the participants reported luck as a contributing factor in getting the grant awarded, and in other aspects of their work. The authors suggested that the perception of luck was important in maintaining participant self-efficacy through the challenges of their academic careers.

2.2.14 Entrepreneurship and research productivity

As traditional academic revenues have decreased in the last decade, research-based institutions have increasingly encouraged faculty members to engage in commercialization of

their research. In a study by Erikson, Knockaert, and Der Foo (2015), individual characteristics of research faculty members such as self-efficacy were assessed to determine the motivational factors, which may drive entrepreneurial aspirations of commercialization activities. A cohort of 924 doctoral students and postdoctoral fellows in the natural sciences departments at the University of Oslo, Norway were surveyed to assess their start-up aspirations, industry-science interaction aspirations, and patenting and licensing aspirations. Using self-efficacy theory, Erickson et al. (2015) showed that faculty members who "feel, through mastery experiences, more confident that they can handle specific tasks are more likely to have aspirations to engage in specific tasks" (p. 217). Specifically, faculty members who had previous experience in start-up companies or patent applications were correlated with entrepreneurial aspirations.

A study conducted by Lowe and Gonzalez-Brambila (2007) examined whether faculty entrepreneurs were more productive researchers than their non-entrepreneurial colleagues were. The authors defined faculty entrepreneurs as those individuals who had started a business to develop and commercialize an invention they disclosed to their institutional technology transfer office. The authors of this study sampled 150 faculty members at 15 different research institutions who founded businesses between 1990 and 1999. A control population was generated by searching for peer faculty members who obtained doctoral degrees in the same graduating cohort as the entrepreneurial faculty until a complete one-to-one random match of the academic faculty was obtained. Research productivity was calculated from journal publication data in the ISI Web of Science database (Lowe & Gonzalez-Brambila, 2007). When the authors controlled the study for other factors influencing publication rates, such as gender and graduate school, they found that entrepreneurial faculty members were more productive than their peers were before the formation of a business enterprise. Each research area examined including

medical and biomedical sciences were correlated, except for chemistry. Also, the research productivity did not decrease following the formation of a business enterprise, indicating that entrepreneurship is not detrimental to academic research.

Another study by Czarnitzki and Toole (2010) supported the relationship between entrepreneurship and productivity. The authors used information from the U.S. Small Business Innovation Research (SBIR) program to identify and evaluate academic scientists who founded or joined for-profit businesses. As a control, the authors drew from a random sample of 1,500 NIH research peers. The final sample included 447 biomedical academic scientists who received their doctoral degrees between 1965 and 1991, of whom 72 were considered entrepreneurial faculty. Publication productivity was determined using the MEDLINE database (Czarnitzki & Toole, 2010). The results of this analysis showed that entrepreneurs who eventually commercialized their research were more productive during their career as academic scientists than a randomly selected control group. However, the productivity of entrepreneurs decreased once they left academic research in favor of a for-profit business. Alternatively, entrepreneurs who only partly left or returned to academic research performed equally well as the control group of scientists.

2.2.15 Research areas and productivity

Kissin and Bradley (2013) performed an investigation to determine whether research directions or research areas among faculty members performing biomedical research were predictors of productivity. The major finding of this study was that researchers with high productivity were more likely to be represented in innovative and emerging areas of research. Using a database of 96 biomedical researchers, the authors analyzed three five-year time frames, to determine whether productivity was predictive of research in an emerging area rather than a

well-established area. Seven emerging research areas were selected, including angioplasty, coronary angiography, genomics, HIV infections, meta-analysis, statins, and stem cells. The emerging research areas were paired with the well-established area, such as drugs and infections, and productivity was defined as the number of research articles published. The results of this study showed that faculty members with higher productivity were more involved with investigating emerging areas of research than well-established areas of research. These results suggest that the most productive faculty members move to novel areas of research. However, this study was limited to a small population that may not be representative of the total biomedical research population. In addition, only a small subset of descriptors was used to define emerging areas of research.

In a study by Azoulay, Graff Zivin, and Manso (2011), the effect of different funding streams for biomedical research on productivity was examined. Most of the biomedical research at academic institutions in the U.S. is funded by the NIH, which provides grants based on specific projects. An alternative funding mechanism is provided through the Howard Hughes Medical Institute (HHMI) to fund innovative research. The HHMI provides grants based on an investigator qualification and past performance, rather than on a traditional research project submission. The authors of this study determined if the funding model for HHMI investigators resulted in productivity differences from NIH investigators. A database of curriculum vitae information, funding, and publications from public sources was used to compare 73 investigators inside the HHMI and a control group of 393 similarly accomplished NIH-funded investigators outside the HHMI. The results of this study showed that the HHMI investigators produced high-impact publications at a higher rate than the NIH-funded investigators. In addition, evidence of

HHMI investigators changes in research directions suggested there was a positive effect on productivity by exploring new lines of research.

2.2.16 Research environment and productivity

The research environment of an institution may also play a role in determining the research productivity of faculty members. Of note, an organizational trend at university-based research centers has been to create interdisciplinary structures for investigating complex scientific problems. Sabharwal and Hu (2013) used curriculum vitae data from 402 faculty members in psychology departments at academic institutions across the U.S. to examine the effect of a research center environment on productivity. The correlative analysis of the data showed that research productivity measured in research articles, books, book chapters, and research grants of faculty members affiliated with an interdisciplinary research center was higher than non-center affiliated faculty members. However, the data on research articles were not different when controlling for other factors. Finally, the results of this analysis showed that affiliation of faculty members with a research center at the Associate or Full Professor level was associated with increased productivity. However, affiliation with a research center did not positively correlate with higher productivity for junior faculty members at the Assistant Professor level.

Webber (2012) also showed that faculty members affiliated with an academic research center were more productive than faculty members were with no center affiliation. In this study, faculty members who conducted multi-institutional research in a collaborative setting had a higher productivity than faculty members who conducted research only at their home institution. Webber (2012) also showed there was no difference in productivity between faculty members at private and those at public institutions.

In a study by Louis, Holdsworth, Anderson, and Campbell (2007), 1,077 STEM graduate students and postdoctoral fellows from 150 U.S. departments of computer sciences, chemical engineering, and life sciences were surveyed to determine the relationship between the institutional structure or environment and scientific productivity. Multivariate analysis of the survey data showed that work-group size was positively associated with early productivity among these trainees. In this survey, the number of other trainees in the respondent's research laboratory defined work-group size. There was also a difference in productivity among disciplines, even within the sciences. In particular, life science trainees were more productive than other disciplines. In the life sciences, a collegial climate (willingness to work with colleagues) was negatively associated with productivity, while an open climate (willingness to share data) was positively related to productivity. Based on this data, the authors suggested that individualistic departments had more productive students than nurturing departments.

Another study by Edgar and Geare (2013) examined the cultural features within university departments at New Zealand institutions. The goal of this study was to determine distinguishing characteristics between high and low research productivity. Based on interviewing faculty members in different departments at three universities, the authors identified that "autonomy and egalitarianism, along with a strong cultural ethos supporting achievement and individualism are characteristics of high functioning departments" (Edgar and Geare, 2013; p. 774). These results seem to support the findings of Louis et al. (2007), namely that institutional culture had a significant effect on research productivity. Using a survey of 367 researchers at hospitals and research centers in the Spanish National Health System, the work of Antonio-Garcia, López-Navarro, and Rey-Rocha (2014) showed that research productivity was

also associated with satisfaction of research autonomy. There was no association with their age, seniority, or international experience.

2.2.17 Faculty diversity and research productivity

While achieving a diverse faculty in science and engineering has become a priority at many institutions of higher education, representation by women, underrepresented minorities, and persons with disabilities remains problematic (Leboy & Madden, 2012). According to the Committee on Equal Opportunities in Science and Engineering 2011-2012 biennial report to Congress (Harkavy, Cantor, & Burnett, 2015), there has been "progress, but not sufficient progress to redress the historical patterns of underrepresentation for these groups" (p. 6). In their study to identify limitations on diversity in basic science departments, Leboy and Madden (2012) noted that the lack of African-American representation was due to the low number of these individuals earning doctorates. Likewise, many women graduates with doctoral degrees may be avoiding academic careers.

To assess diversity in medical school basic science departments compared with non-medical school science departments, the authors of the study identified the number of African-American and women faculty members in basic science departments at the top 35 medical schools receiving NIH funding. The dataset was compared with the number of African-American and women faculty members at university natural science departments listed in the top 25 ranking by the National Research Council. The results of this study showed that there was a lower representation of women and African-Americans at research-intensive medical school basic science departments compared to University basic science departments. The authors of this study suggest that these results were due to differences in the working environments, such as

expectations for faculty productivity. Likewise, entrepreneurship in maintaining research grant funding was a requirement for research-intensive medical school basic science departments.

Despite the increasing proportion of women in the life sciences over the past 50 years, women and men have very different academic experiences. In a study by DesRoches, Zinner, Rao, Iezzoni, and Campbell (2010), 3080 life sciences researchers at the 50 universities whose medical schools (or medical school affiliations) received the greatest amount of extramural funding from the NIH in 2004 were surveyed. At the level of Full Professor, women reported working more hours worked per week than men did at the same rank. In addition, women at this rank reported greater administrative and professional burdens than men did. Even after controlling for professional characteristics, women also earned a lower annual salary than men did. Across all ranks, women reported a lower productivity in publications than men did. This finding may be due to differences in teaching, administrative, and professional activities between women and men that restrict the time available to conduct research.

In a limited study at eight Harvard Medical School-affiliated institutions, Waisbren et al. (2008) examined the research productivity in obtaining research grants between male and female faculty members. In this study, the number and funding outcomes of all grant applications from 2001 to 2003 were examined. Among the 2480 faculty applicants, there were gender differences in the following statistics. Women had fewer funding years requested than men (3.1 versus 3.4). Also, the median annual amount sought by women was lower than men ($115,325 versus $150,000); the mean number of years awarded to women was fewer than men (2.9 versus 3.2), and the median annual amount awarded to women was lower than men ($98,094 versus $125,000). However, when controlled at the level of academic rank, the success rate of grant applications was not different between genders. In addition, at the lower academic ranks,

women submitted fewer applications to the NIH than men did, resulting in less grant funding awarded at the Instructor and Associate Professor levels.

2.2.18 Promotion and tenure and research productivity

Most academic research institutions view faculty productivity regarding three areas: teaching, research, and service (Webber, 2011b). However, the distribution and emphasis of teaching, research, and service are dependent upon the institutional type and mission. For example, research may play a greater role among faculty at a research-intensive medical school while teaching and service may be emphasized among faculty at a liberal arts college. Even among institutions of similar scope, there can be considerable heterogeneity in evaluating faculty performance. In a qualitative study of 62 academic departments at 23 research universities in 13 states, Hardré and Cox (2009) reviewed departmental documents for defining criteria in the annual assessment of faculty productivity and evaluation of tenure and promotion. The results of this study showed that evaluation standards differed among departments, even from the same institution.

Academic tenure can be defined as a contractual right to hold a faculty position without termination except for just cause and is primarily awarded at the time of promotion to a more senior position. Tenure arose in the early twentieth century as a means to ensure academic freedom for faculty, particularly in protecting from external criticism or political repercussion when their research or teaching conflicted with the prevailing dogma (Walker, 1983). The modern tenure system is based on recommendations made by the American Association of University Professors in 1940 in which the probationary period for tenure would be seven years, and that tenured faculty members would be protected from arbitrary dismissal (Spellman & Meiklejohn, 1977). These tenets are still accepted by most major academic research institutions.

This tenure policy sets the sixth “up-or-out” year of faculty appointment as the period for mandatory tenure review; it effectively constricts the first five years as a window for new faculty to distinguish themselves as scholars and teachers. If the tenure and promotion committee and the institution do not grant tenure, then the faculty member is provided a one-year notice of non-reappointment. Unfortunately, while institutional expectations of faculty performance and achievement that justify the granting of tenure have not changed, a rapidly evolving research environment in the field of biomedical science has made it far more difficult to meet these expectations.

Gardner and Veliz (2014) examined the experiences of university faculty on the tenure-track at a striving institution during a mission change from a teaching focus to a research focus. Their study used an inductive technique to compare tenure and promotion documents from 30 academic units during a period between 1980 and 2012. Gardner and Veliz (2014) found that “shifts in environment and strategy could be seen as being reflected in the ratcheted-up expectations for faculty members, particularly as they related to a transition from teaching excellence to excellence in all areas, with a specific emphasis on scholarship" (p. 123). Both faculty and administrators were responsible for the increased criteria for promotion and tenure during this period.

The additional time devoted to seeking grant funding is often taken at the expense of publishing papers and generating the research data needed to establish a nationally competitive program (von Hippel & von Hippel, 2015). Therefore, the constrained and unpredictable funding environment makes it far more difficult for junior faculty members to develop a strong bid for tenure during their sixth year (Daniels, 2015). In addition, the traditional tenure clock renders the institution vulnerable to making lifelong career decisions about its faculty with

inadequate information about their potential for long-term success and before it can recover the large initial investment in expensive start-up packages (Burr et al., 2008).

2.2.19 The tenure clock and research productivity

These issues in the promotion and tenure process have led some major medical schools to re-examine the seven-year tenure clock. A survey by the Association of American Medical Colleges (AAMC) has revealed a national trend by medical schools to adopt longer and more flexible tenure probationary periods. Indeed, nearly half of U.S. medical schools have extended the tenure clock to eight or more years for both clinical and basic science faculty (Burton & Corrice, 2011). Many institutions have adopted a policy to stop the tenure clock for faculty members, if necessary, to allow time for circumstances such as health or family issues without being penalized (Bunton & Corrice, 2011).

The ten-year attrition rates among junior faculty at medical schools were reported by the Association of American Medical Colleges to be higher for women and minorities than white men (Alexander & Lange, 2008). To further understand the factors associated with the departure of junior faculty members from research-intensive medical schools, Speck et al. (2012) studied 901 newly hired Assistant Professors between 1999 and 2007 at the Perelman School of Medicine at the University of Pennsylvania. Demographic and statistical data on junior faculty members on tenure, research, and clinical educator tracks were obtained from the institutional faculty affairs database at the University of Pennsylvania and de-identified. Faculty members appointed to academic clinician track were not included. Analysis of the data showed that 26.7% of these junior faculty members departed from their initial appointments. Faculty members appointed to clinician-educator or research track were more likely to depart than faculty members on the tenure-track. Also, women on the clinician-educator track were more likely to

depart than men were. However, faculty members on all appointments who took a stop-the-clock or extension of their probationary were at a decreased rate of departure by the tenth year.

Stopping the tenure clock policies for family reasons was expanded at many institutions of higher education to include eligibility of both genders, providing an equalizing factor for faculty in life events that might result in decreased productivity. In a study by Manchester, Leslie, and Kramer (2013), 334 tenure-track faculty members at a doctoral granting institution of very high research activity were examined. These individuals were selected in five yearly cohorts between 1998 and 2002; 283 were faculty members who did not use a stop-the-clock policy while 51 were faculty members who did. Consistent with concern that those taking advantage of a stop-the-clock policy for family reasons are not as committed to the organization, there was an adverse effect observed on salary attainment. There was no difference in faculty productivity of publications between the two groups. Importantly, similar to Speck et al. (2012), faculty members who used a stop-the-clock policy were also more likely to achieve promotion and tenure.

Despite the potential benefits for young faculty on tenure-track, extending the tenure clock has been criticized because it extends the period of uncertain job security and lower salaries. In 2011, despite the support of the medical school faculty, the faculty senate at the University of Michigan voted against proposals to extend the tenure clock from 8 years to 10 years (Bennett, 2011). It was argued that such an extension could leave faculty members of other colleges and schools within the system with fewer career options if denied tenure after waiting up to 10 years. For most institutions, extending the tenure clock affords some flexibility to faculty for dealing with the granting of tenure when conditions exist (e.g., poor research funding environment, increasing clinical obligations) that impede normal progress toward tenure.

Maintaining the traditional probationary period for tenure review rewards those faculty who continue to excel despite the changing environment. The long-term benefit to the institution would be the retention of talented faculty and the recovery of substantial initial investments in

2.2.20 Faculty retention and productivity

Attracting and retaining the best and most talented faculty is difficult for both individuals and biomedical research institutions. For faculty, securing grant funding and maintaining a productive publication record can be barriers to academic success. For institutions, the cost of initial recruitment investment and replacement cost for faculty who leave prematurely can be expensive. Based on survey data from the Association of American Medical Colleges, the ten-year retention rate of first-time Assistant Professors hired from 1981 to 1997 was 43% (Alexander & Lange, 2008). In addition, there was a disproportionately higher rate existed for both women and non-white faculty members in leaving academic medicine.

Mentoring early-career faculty can have a positive effect on their future success. In a study by Ries et al. (2012), new Assistant Professors hired in health sciences disciplines at the University of California, San Diego between 1988 and 2005 were offered the opportunity to participate in a seven-month, faculty development program. Overall, 113 faculty members participated in the program, and 202 non-participating faculty members were included as matched controls. Afterward, the academic productivity of participants and non-participants was measured. Determinants for productivity measurement included: leadership and professional activities, honors and awards, research grants, teaching and mentoring/advising activities, and publications. The results of this study showed that retention of participants was greater than non-participants were (67% versus 56%). In addition, the academic productivity of faculty participants was higher in all measurements compared to matched non-participants.

Another study by Bucklin et al. (2014) supported these results. This study examined factors correlated with the attrition of newly hired faculty from the University of Colorado School of Medicine at five years after their hire date. Some of the factors associated with attrition included perceived negative academic climate from the department chair and lack of professional development. The results of the studies support the notion that institutions must develop active strategies for faculty retention, through faculty development programs.

A recent review by Geraci and Thigpin (2017) summarized the research literature on mentoring of early-career faculty in academic medicine. Among the different mentoring studies published, there has been no clear definition of mentoring characteristics, resulting in a number of different mentoring models tested. However, each of the models was intended to meet the professional and personal needs of the early-career faculty, but none was superior to another across institutions and mentees. Nonetheless, there was cumulative evidence presented that mentorship process could produce a significant benefit to mentees, as well as mentors and their institutions.

Sensemaking is a process by which individuals give meaning to their experiences. O'Meara, Lounder, and Campbell (2014) used the theory of sensemaking in a qualitative study to understand the causes of faculty attrition. In this study, the authors sought to identify the explanations for faculty departure from a large research-intensive university in the U.S. At this anonymous institution of approximately 38,000 students, 238 faculty members were lost due to resignation between 2005 and 2010 (an average of about 2.6% of the entire faculty each year). Using semi-structured interviews and focus groups, the authors queried 13 early-career faculty members who left the university, as well as administrators involved in retention of faculty and senior colleagues of the departing faculty. The dominant explanations for departure revealed by

this study included better opportunities, a likelihood the faculty member would not achieve tenure, family, geographic reasons, and work environment and fit. An analysis of sensemaking by the faculty who left the University showed that their explanations for departure were influenced by status expectations and proximity to the individual who was leaving. O'Meara et al. (2014) noted, "Both colleagues and leavers were influenced by their role in the story of departure and a desire to avoid a negative depiction of their actions or lack thereof" (p. 627). Overall, the authors suggested an institution could utilize sensemaking to help understand its strengths and weaknesses regarding faculty retention and departure.

2.2.21 Faculty satisfaction and productivity

Faculty satisfaction is an important factor in considering institutional retention rates. After successful recruitment, faculty turnover rates that are too high can be problematic for a number of reasons. First, future contributions of highly qualified faculty are lost. The cost of start-up packages can also be considerable, particularly for biomedical scientists who require expensive specialized equipment. Finally, new faculty search processes can be costly regarding time and resources.

A study by Ryan, Healy, and Sullivan (2012) examined the reasons faculty members gave for their intent in leaving an institution to understand better the factors associated with departing. The authors of the study surveyed 587 tenured and tenure-track faculty members at a large, public research university in the midwestern United States. The results of a statistical model to correlate predictors of faculty having considered leaving for another institution showed that key predictors of faculty in the ''hard-applied'' disciplines included the following reasons: not having a spouse or partner, a perceived lack of support, a perceived lack of fit, stress of

raising a family, and dissatisfaction with certain aspects of the ‘‘faculty job.’’ The results of this study could help administrators develop policies and programs to enhance faculty retention.

A recent study by Stoykov et al. (2017) surveyed junior faculty at Rush University in the Colleges of Health Science, Nursing, and Medicine about whether they had considered quitting research in the previous year. The authors examined different factors from the survey that were correlated with those who were considering quitting research. Those factors that were associated with thinking about quitting included the following: a lower confidence in their research capabilities, decreased job satisfaction, and higher levels of job burnout than those who were not. The results of this study suggest that additional institutional resources, such as career development and faculty support may be necessary to enhance faculty retention.

As a note of caution, a qualitative study by Ambrose, Huston, and Norman (2005) used semi-structured interviews to understand why some faculty members leave and others stay revealed unforeseen issues that strongly influenced faculty satisfaction. For example, the surrounding city and the interdisciplinary nature of the university were identified as critical factors that affected personal satisfaction. These results suggest that results from one institution may not apply to another, and indicate that institution-specific studies need to be conducted.

2.3 Gaps in the Research Literature

As shown in Figure 2, after adjusting for inflation the NIH budget for 2013 was approximately 22% below the funding level in 2003 (Hourihan, 2015), and the NIH budget is likely to remain uncertain for the foreseeable future. The funding situation for research faculty is a relatively recent phenomenon that needs to be investigated. While the decline in research funding growth has been ongoing for the last decade, the effect on the careers of faculty has become evident only in the last few years. Thus, the current research literature is small but

expanding. Many studies have focused on different determinants of faculty productivity, including teaching load, research collaborations, individual self-efficacy, entrepreneurship, and research environment. Most of the citations available have focused on specific academic departments or institutional types. For example, one study focused on academic urology departments showed that NIH-funded faculty members had statistically higher research productivity than unfunded faculty (Coleco, 2013). This study was a quantitative analysis that compared the number of grants and publications using information available in public databases. Not surprisingly, senior faculty had higher NIH funding awards than junior faculty with less experience and productivity record. However, no studies were available that focused on faculty perceptions as applied to seeking extramural grant funding.

2.4 Theoretical Frameworks

The goal of a theoretical framework is to provide a simple explanation of an observed phenomenon, to relate an observation to established knowledge, to allow for verification and revision, and to stimulate further investigation (McMillan & Schumacher, 2014). In studying faculty who seek extramural research grants and experience limited funding opportunities, several theoretical frameworks might be used to understand their perceptions.

2.4.1 Motivational theories

One example is the context of motivational theories that consider what prompts individuals to act in a certain way. For example, Maslow's Theory of Motivation (1943) describes how a hierarchy of unsatisfied needs motivates people: lower demands must be satisfied before higher elements can be met. This theory could explain why a faculty member would be motivated to seek job security over job satisfaction. Alternatively, Rational Choice Theory (Zey, 1997) describes how individuals are driven by maximizing rewards and

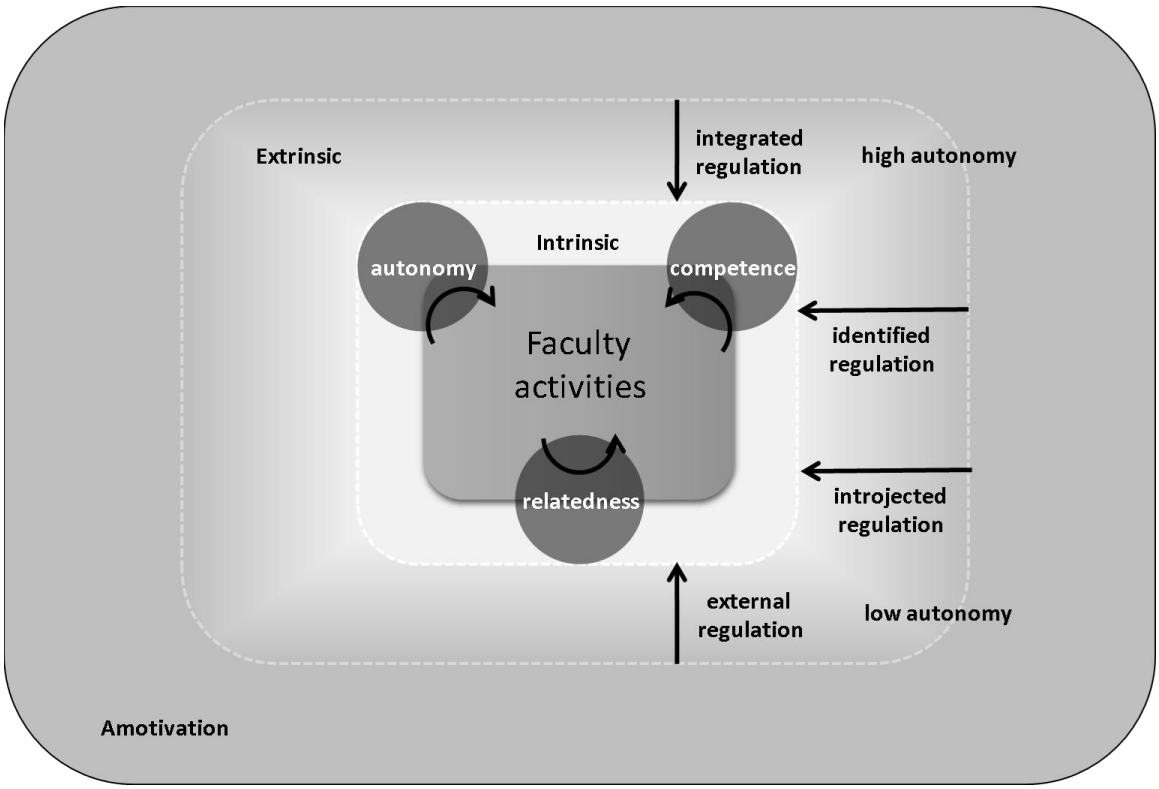

Figure 3. Self-Determination Theory. Shown are the different types of intrinsic and extrinsic motivations as described by Self-Determination Theory.

minimizing costs. This theory has its origins in the late 18th century by Cesare Beccaria, who described the control of destiny by reason and knowledge; he applied his ideas to the field of criminology (Cornish & Clarke, 1987). Rational Choice Theory was subsequently used economists to describe the choices that individuals make and sociologists for explaining social behavior (Hechter & Kanazawa, 1997). Rational Choice Theory could be used to describe social exchanges and explain why a faculty member does or does not respond to institutional incentives for obtaining extramural research grants. Likewise, this theory could explain why faculty members are motivated to seek grant funding instead of performing other academic work.

One key theory that has been used to understand faculty performance is self-determination theory (Ryan & Deci, 2000). Under Self-Determination Theory (Figure 3),

individuals are motivated to act through a continuum of intrinsic and extrinsic factors. Intrinsic factors are characterized by the inherent satisfaction of performing an activity. Intrinsic motivation occurs when three psychological needs are satisfied: autonomy, competence, and relatedness. The need for autonomy describes the actions of an individual made of their own volition rather than from pressure by an external source. The need for competence refers to the yearning for mastery or a belief that wanted outcomes will be products of one's actions and not merely those of chance. The need for relatedness describes the desire to be meaningfully connected to a group.

If these intrinsic needs are not entirely satisfied, individuals may still be motivated by four extrinsic factors, including integrated, identified, introjected, and external regulation (Ryan & Deci, 2000). Integrated regulation describes engagement in behavior that is consistent with one's internal needs and values. When an individual behaves in a manner that may not be consistent with their values, but are nonetheless considered important, he or she is said to be acting out of identified regulation. Introjected regulation describes the self-imposed pressure to engage in an activity (*i.e.*, through feelings of guilt or anxiety). When the source of pressure to engage in an action becomes external, such as public recognition or shame, the associated motivation is considered to be external regulation. Finally, the complete absence of motivation at any level is characteristic of amotivation.

In summary, Self-Determination Theory may be useful in helping to sketch out a meaningful framework in which to examine the experience of early-career faculty who seek out NIH grant funding in a highly competitive environment. Although Self-Determination Theory has not been applied to understand the action of grant submission, other faculty activities have been studied in this context. For example, Self-Determination Theory has been useful for

understanding faculty motivation to engage in research activities (Lechuga & Lechuga, 2012). Likewise, in a study of 781 faculty members, Hardré et al. (2011) showed intrinsic motivation for research had a positive effect on the perceived value of conducting research, which predicted productivity. Another study suggested that intrinsic motivation was a key factor for performing teaching duties at a university medical center (Van den Berg et al., 2013). Similarly, Wiebke et al. (2016) showed competence to play a significant role in motivating 534 junior faculty members at German universities to perform their teaching duties.

2.4.2 Academic Capitalism

Beyond individual responses to different phenomenological factors, it is important to consider individual faculty members within the context of larger economic, political, and social issues. To this end, a theoretical framework should account for the wider environment in which faculty members are embedded. This framework should provide a connection between the individual faculty member and their role within the organization and larger environment.

Academic Capitalism is a theory developed by Slaughter and Leslie (1997) to describe the market-like behavior of higher education institutions and their faculty. This theory can be specifically used to explain the process by which academic institutions have become more focused on supporting applied research and entrepreneurial activities of their faculty, rather than basic or theoretical research.

In the context of Academic Capitalism, the acquisition of facilities and administrative (F&A) costs that are associated with research grants have become an important revenue stream for many research-intensive institutions to finance their research enterprises (Goldman & Williams, 2000). These F&A costs have increased significantly as a proportion of federal research grant expenditures and have been asserted to be responsible for unsustainable growth in

research faculty and facilities (Ledford, 2014). F&A reimbursements do not cover the research costs incurred by universities based on increased federal regulations (Goldman & Williams, 2000). Thus, a decline in the number of sponsored research grant and patent revenues awarded to an institution would not only negatively affect the productivity of individual faculty members but could also adversely affect an already strained research infrastructure.

Many institutions have established technology transfer divisions to reward entrepreneurial faculty and promote compliance as well as to protect and exploit their intellectual property (Siegel & Wright, 2015). Some institutions have advocated entrepreneurial activities by faculty members as an important measure in consideration of academic promotion and tenure (Sandberg et al., 2014). There is also evidence from Mendoza and Berger (2008) to suggest that faculty perception of Academic Capitalism is a positive force that enhances the quality of teaching and scientific research. In contrast, Henry Giroux (2002) has argued that the social and cultural values of academics have been eroded in the current environment of Academic Capitalism.

A recent case study by McClure (2016) suggests that institutional prioritization of Academic Capitalism (as exemplified by entrepreneurship) is an administrative-driven process. Five administrative roles were identified in the process of advancing entrepreneurship, including "building infrastructure, creating new programs, cultivating donors and raising funds, setting a vision around entrepreneurship, and changing policies" (McClure, 2016; p. 516). This work also indicated the potential for conflict between faculty and administrators from initiatives to promote entrepreneurial activities.

In addition to understanding the process of entrepreneurial activities, other faculty activities were studied in this context of Academic Capitalism. For example, Gonzales,

Martinez, and Ordu (2015) used the theoretical framework of Academic Capitalism to explore the experiences of faculty who work in the context of a striving university. This research defined those universities with aspirations to become more like those institutions above them in the prestige hierarchy as striving universities. The institution studied by Gonzales (2014) aspired to become a Tier One research university. Although there is no precise definition of Tier One status, it is accepted that these institutions are R1 (Doctoral Universities with Highest Research Activity) under the Carnegie Classification. Another accepted definition is membership in the American Association of Universities, whose criteria emphasize the amount of research funding awarded, among other metrics.

Through the lens of Academic Capitalism, striving can be viewed as a particular manifestation of institutional strategies in response to market forces that are geared to enhance academic reputation as a means to increase market value. An overarching theme identified by Gonzales et al. (2014) was the institutional pressure that faculty members described regarding their work in a striving environment. Specifically, Gonzales et al. (2014) found that this pressure was manifest through faculty perceptions "that their careers were without boundaries…of the need to constantly manage or outsmart time…[and] of heightened surveillance" (p. 1105). Thus, performance pressures induced through the effect of Academic Capitalism led to negative faculty experiences. In sum, the theory of Academic Capitalism exploited by Gonzales et al. (2014) may be useful in the proposed study, to help sketch out a meaningful framework in which to place the context of experiences of early-career faculty members who seek out NIH grant funding in a highly competitive environment.

2.4.3 Biomedical research in the context of Pierre Bourdieu

A sociologist and philosopher, Pierre Bourdieu worked to understand the relationship between social structures and individual practices. His concepts of field, capital, and habitus, which he defined in his Theory of Practice (Bourdieu, 1977), can be used to interpret scientific practice. For example, Bourdieu's Theory can be used to describe the scientific field as a collective of institutions, rules, and norms that constitute an objective authority and produces research activities. According to Bourdieu (1975), the scientific field can be described as a "competitive struggle, in which the specific issue at stake is the monopoly of scientific authority, defined inseparably as technical capacity and social power" (p. 19). Imposing itself upon the faculty members (who perform research to produce scientific capital) are power structures of scientific authority, such as administrators, funding agencies, and evaluation bodies who limit the exercise of autonomy. At stake in the competitive struggle for power are resources, regarding economic, social, and cultural capital from administrators and symbolic capital from evaluators and funding agencies. Based on Bourdieu's rationalization, scientific practice is not merely a search for knowledge but is marked by the exchange of capital among faculty, administrators, and evaluators.

2.4.4 Bourdieu's Theory of Practice

The dynamic interactions between faculty and institutional administration in the context of Academic Capitalism can also be expanded using Pierre Bourdieu's concepts of field, capital, and habitus, which he defined in his Theory of Practice (Bourdieu, 1977). Agency is the ability of individuals to act independently and make free choices. However, Bourdieu's theory explains that individuals do not choose without input, but rather in the context of pre-existing social contexts or scripts, or habitus (Bourdieu, 1977). Individual social interactions are influenced by

the filter of historical experiences and by socialized tendencies, which create a foundation for future behavior. Bourdieu's theory explains that agency occurs in social or structural arenas or fields in which different kinds of capital (economic, cultural, and social) are exchanged. Bourdieu (1977) used the concept of field to describe the social and structural setting in which agents interact and compete to establish their legitimacy.

As shown in Figure 4, faculty members seeking research funding are agents bound by the scientific field and the structural conditions of Academic Capitalism established by funding organizations and academic institutions. Within this field, faculty members compete for

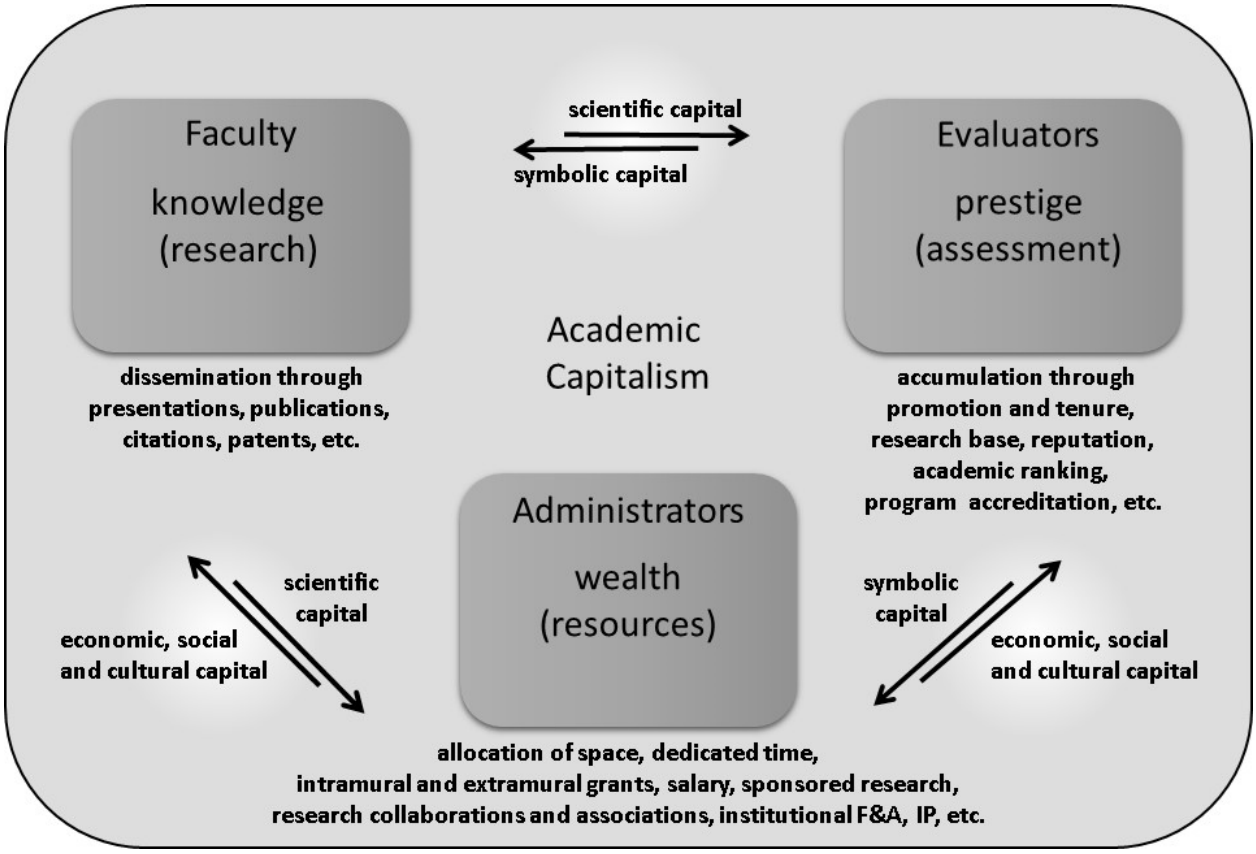

Figure 4. The Field of Academic Biomedical Research. Shown above is a depiction of the academic relationship between the activities of research, resource allocation, and assessment in the context of Academic Capitalism. F&A – facilities and administrative costs; IP – intellectual property. Adapted from *Academic Capitalism: Universities in the Global Struggle for Excellence* by Richard Münch, Figure 4.4, p. 123. Copyright (© 2014). Reproduced by permission of Taylor and Francis Group, LLC, a division of Informa plc (Appendix E).

economic, cultural, and social capital (*i.e.*, institutional resources and professional legitimacy) from administrators in exchange for their scientific capital (*i.e.*, grant-driven research productivity as measured by publications and citations). Faculty also compete for symbolic power (*i.e.*, prestige and scientific reputation) from evaluators such as grant and journal reviewers in exchange for their scientific capital (*i.e.*, research productivity). The ability of individual faculty members to exert an effect on their field (the scientific community) and the amount that their research autonomy is either restricted or expanded with resources available is dependent on the amount of scientific capital they hold. Administrators compete for symbolic power (*i.e.*, institutional reputation) from evaluators such as accrediting agencies and governing boards in exchange for social and cultural capital (*i.e.*, professional relationships and legitimacy).

Through the lens of Academic Capitalism, Bourdieu's Theory can help to describe the capital exchanges involved when faculty members must attempt to make their research viable in organizations that prioritize revenue-generating and other activities to increase academic status. In this regard, the current strategic plan at the study site prioritizes activities that attract and generate revenue, with a specific target of improving NIH ranking in the number of grants received to become top 20 in national ranking and increasing philanthropic support to $650 million (SSU-Central Strategic Plan, 2015).

In the context of Bourdieu's theory, Mendoza, Kuntz, and Berger (2016) argued that economic capital has become increasingly valued over the cultural and social capital as commercialization and grant revenues have become academic priorities for many public institutions. Rosinger, Taylor, Coco, and Slaughter (2016) extended this concept to argue that institutional revenues generated from research are preferred to other income sources, such as from tuition or teaching. This revenue preference establishes a hierarchy in cultural capital that

confers segmentation in status among academic units that are research-intensive over units that are teaching-intensive. Consistent with this segmentation, Mendoza et al. (2012) argued that elite academic departments accumulate economic, cultural, and social capital from obtaining substantial revenues from large research grants.

Gonzalez (2014) examined the how faculty members responded to the striving aspiration of their university to attain top-tier status. The results of the study by Gonzales (2014) suggest that faculty are capable of playing an important role (both positive and negative) as agents in a striving environment. A major finding was that pre-existing social contexts (or habitus) were an important factor in faculty reactions. By this research, Gonzales (2014) indicated potential conflicts could occur in the setting of a striving university among the faculty, categorized regarding operationalizing, negotiating, and resisting agency.

2.5 Conclusions

This dissertation is intended to be a study about the process of seeking research funding and what this means in the experiences of faculty members. In this chapter, a review of the literature consisting of an overview of research funding for biomedical research and the structure of NIH grant review process was provided. The literature review included descriptions of studies that apply qualitative and quantitative treatments covering the issues of research funding in higher education. Themes emerging from the literature indicate the significance of research funding for faculty members in the context of productivity and career development and progression. Finally, gaps in the literature were identified. Following the literature review, several theoretical frameworks were discussed.

The goal of this dissertation research is to understand the interface between faculty and administrators as well as funding agencies at a research-intensive university, and the emphasis

placed on faculty to obtain extramural research funding in an increasingly competitive environment. An initial theoretical framework considered the application of motivational theory to provide an understanding of this phenomenon. However, while motivational theories are useful in describing intrinsic and extrinsic factors involved in individual behaviors, they do not provide a greater context of economic, political, and social issues. In contrast, Bourdieu's Theory can provide a valuable tool to evaluate habitus and the process of agency in faculty members inside the scientific research setting. In particular, the capital exchange characterized by Bourdieu is appropriate given the importance that economics plays in the current structure of biomedical research. Finally, Academic Capitalism can provide a theoretical framework to establish the context of faculty in the complex interaction between academic institutions, government, and industry. In her study involving the experiences of faculty who work in a striving University, Gonzales (2014) noted that "Academic Capitalism shines a light on the transformation of faculty members into managed professionals who labor for the knowledge economy" (p. 1111). Thus, Academic Capitalism can be used as a theoretical framework to consider how faculty members position themselves as competitors in a scientific marketplace.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This research was a case study designed to understand the individual perceptions of faculty who seek extramural research funding. The environment of a single research-intensive medical center at a major urban public institution bound these experiences. The individual faculty members who participated in the study were the primary instruments used to provide this understanding.

3.2 Restatement of the Research Questions

The purpose of this research study was to understand the individual perceptions of faculty who seek to obtain extramural research funding. The following research questions were addressed using a qualitative research design:

1) What were the backgrounds that early-career faculty members drew upon in seeking grant funding for their research?
2) What did grant-seeking look like from the faculty perspective, and how have their grant-seeking experiences affected them professionally and personally?
3) What reflections did early-career faculty have on the meaning of their grant-seeking experiences?

These questions were incorporated into an open-ended interview instrument, in which faculty members were given the opportunity to explore and explain what grant-seeking meant to them and their work. Ultimately, this study was intended to be a story about what the challenges in

academic funding of research looked like and meant to faculty members at the early stages of their careers.

3.3 Setting of the Research

An academic medical center is a tertiary educational institution that teaches medicine and awards professional medical degrees, as well as advanced clinical degrees in allied health sciences and graduate degrees in biomedical sciences. Academic medical centers also provide medical care to the community by operating clinics and hospitals, as well as residency training programs (Hignite, 2015). Associated with academic medical centers is biomedical research into the broad areas of basic and applied investigation of normal biological processes as well as causes and treatment of human disease (American Association of Medical Colleges, 2015).

There is a large discrepancy in academic medical centers, based on research areas, funding levels, faculty size, and other parameters; thus, there is no "typical institution." Thus, choosing any of the regional public or private institutions in the southeastern United States with significant biomedical research programs was considered to be appropriate. Some examples include the following: Augusta University, Emory University, Medical University of South Carolina, University of Alabama at Birmingham, University of Florida, University of Kentucky, University of Louisville, University of Miami, University of North Carolina – Chapel Hill, University of South Florida, University of Tennessee Health Science Center, University of Virginia, Vanderbilt University, Virginia Commonwealth University, and Wake Forest University.

The site selected for this study was referred to as Southeastern State University – Central[1] (SSU-Central). SSU-Central was chosen because of its logistical accessibility in performing the

[1] The names of the faculty, administrators, and university were altered to provide confidentiality.

study. Within the Southeastern State University System, three public universities campuses operate independently, including Southeastern State University – East (SSU-East), Southeastern State University – Central (SSU-Central), and Southeastern State University – North (SSU-North). Southeastern State – Central (SSU-Central) is a comprehensive urban university and classified as R1; Doctoral Universities – Highest research activity (Carnegie Classification of Institutions of Higher Education, 2016). The institution had a total enrollment of approximately 18,000 in 2015, with about 11,000 undergraduate students, 6,000 graduate students, and 1000 medical students. SSU-Central is composed of the College of Arts and Sciences, nine schools (Business, Dentistry, Education, Engineering, Health Professions, Medicine, Nursing, Optometry, and Public Health), the Graduate School, and the Division of General Studies. Together, these academic units offer 51 bachelor's degree programs, 46 master's degree programs, and 36 doctoral programs. The SSU-Central School of Medicine is made up of about 1000 medical students, more than 900 residents, and 1,400 full-time faculty members in 26 academic departments. The School of Medicine maintains a multidisciplinary adult outpatient clinical facility, a university hospital (one of the largest academic hospitals in the U.S.), and a children's hospital. The US News and World Report has highly ranked the SSU-Central School of Medicine among the best medical schools for research (SSU-Central Annual Report, 2014).

In 2014, SSU-Central received approximately $323 million in grants and contracts revenues primarily from the NIH for sponsored research, which came with another $75 million of F&A cost recovery (SSU-Central Financial Report, 2014). Despite constraints in the federal budget for NIH extramural grants, the number of grant dollars awarded to SSU-Central in 2014 showed a 20% increase over the previous year, due in part to institutional investments in infrastructure and spending priorities (SSU-Central Financial Report, 2014). This financial

record for SSU-Central supports the relevance of Academic Capitalism in interpreting its institutional priorities. In 2013, SSU-Central also developed an Institute for Innovation and Entrepreneurship designed to facilitate entrepreneurship and commercialization on campus.

As a single site, the SSU-Central School of Medicine was considered an appropriate location to study the perceptions of faculty in the performing biomedical research, because of the amount of NIH revenues from research project grants. As shown in Figure 5, NIH funding for research project grants awarded to SSU-Central reached a high of $193 million in 2003 but fell to $120 million in 2013. Recently, SSU-Central has increased research support for three newly formed research institutes in genomic medicine, personalized medicine, and informatics (citation

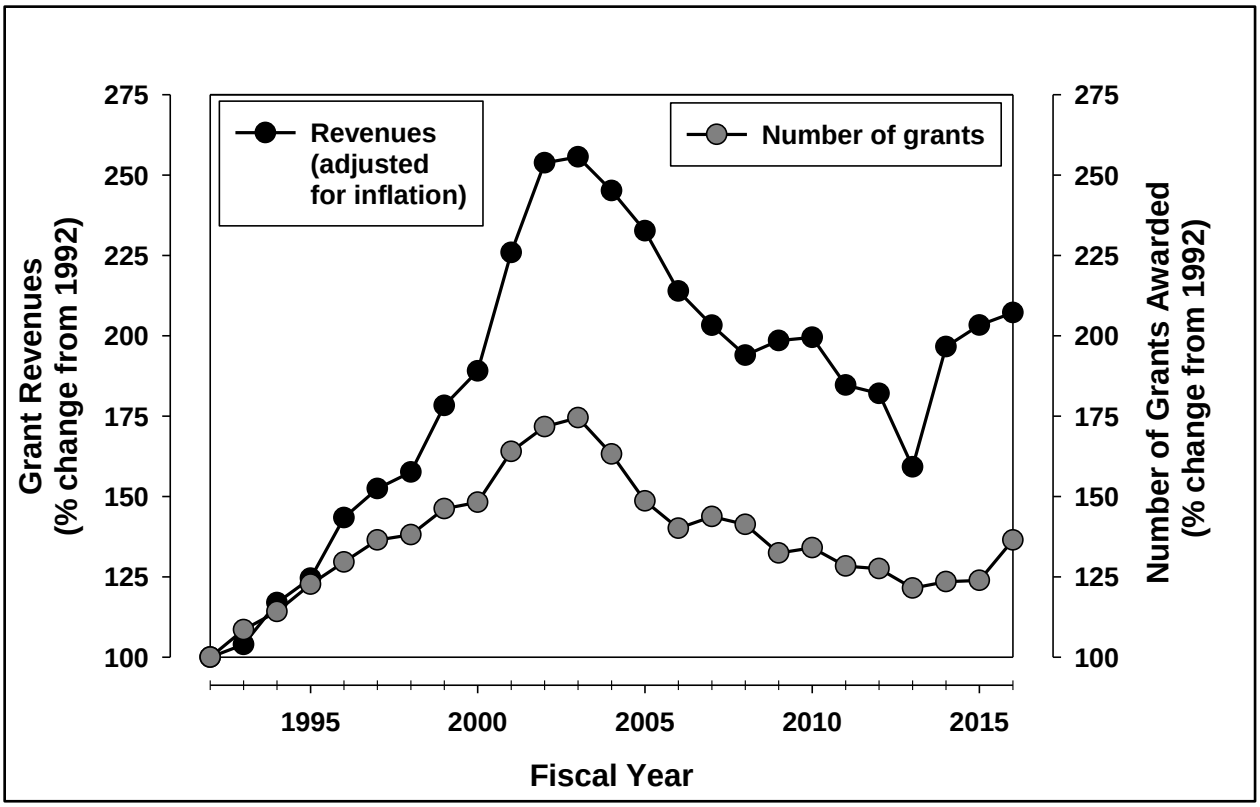

Figure 5. NIH Research Project Grants to SSU-Central. Shown is the trend number of grants (●) and award dollars (●) for research project grants (defined as activity codes R01, R23, R29, and R37) funded by the NIH each year to SSU-Central from 1992 through 2016).

redacted). This effort has bolstered NIH research funding to $156 million in 2016, placing SSU-Central 10th in NIH funding among public universities.

3.4 Methods

The previous literature review primarily cited quantitative studies as an appropriate means to understand the relationship between faculty productivity and research funding levels. However, these studies did not provide individual faculty perceptions about their situation nor identify individual factors that sustained their academic endeavors. In addition, the myriad of strategic approaches considered by individual faculty for career options was potentially lost in quantitative studies. Compared to quantitative research, this qualitative study on early-career faculty seeking research funding was designed to capture effectively these personal insights in detail.

This research was an exploratory case study, which involved understanding the substance of a particular individual, group or phenomenon, by providing a comprehensive description of a given situation, and performing a thorough analysis (Creswell, 2105). In this study, the research involved detailed interviews with individual faculty members who have experienced the effort to obtain extramural grant funding from the NIH. Afterward, the interviews were examined for patterns that could be used to explain and interpret the shared experience. A major strength of this approach was that it provided an in-depth, detailed description of the phenomenon. In addition, this approach was emergent, in which open-ended interview questions did not impose a rigid structure that survey questions do. However, the study was potentially limited by the subjectivity imposed from the interviews that presented difficulty in establishing the reliability of the information. Also, researcher bias was difficult to avoid. To assure research quality, an abundance of interviews provided overlapping data.

Case studies are bound by choosing a particular individual, organization, or event (Creswell, 2015); SSU-Central was selected as the organization to be examined. This case study was instrumental, in which an individual situation was used to illustrate a more general phenomenon. Experiences of the early-career faculty at SSU-Central were used to illustrate the experiences of faculty seeking grant funding for their research at other institutions. Case studies can provide a capability of data collection that would not normally be easily obtained by broader methods. The data collected can also be richer and of greater depth by focusing on the specific issues of a bounded case. However, a major limitation of the case study was that it might not be able to be generalized to the wider population experience. Faculty at other academic medical centers may have unique experiences different from those at SSU-Central. For example, faculty at some institutions have salary support primarily through dedicated funding streams ("hard money" positions) while others like those at SSU-Central are expected to support the majority their salaries from grant funding ("soft money" positions).

3.5 Participant Selection

For this study, all procedures involving human subjects were conducted using a protocol approved by the Institutional Review Board (IRB) of The University of Alabama. Twenty-five interviews of faculty members were undertaken to ensure that a thorough evaluation of the research question was obtained (*i.e.*, that there was saturation in the information gathered). For qualitative studies, estimating a sampling size to reach saturation has proven to be difficult, and citations in the literature (Mason, 2010) recommend anywhere from 15 to 50 participants. In an analysis of 560 doctoral dissertations using qualitative studies, Mason (2010) found the median and mean of participants were 28 and 31, respectively.

Guest et al. (2006) suggested that between six and 12 interviews may be sufficient in the context of purposeful sampling of a group of relatively similar individuals. However, that number would need to be larger if the selected group was heterogeneous, or if the variation between distinct groups or correlation among variables were to be assessed. Creswell (2013) has suggested a range of between 20 and 30 participants for grounded theory studies. Having 25 interviews completed allowed for these contingencies and permitted a greater validation of the results. In addition, an abundance of interviews provided research quality, such that multiple data sources supported the themes identified.

To select participants, faculty with similar educational backgrounds were identified. This selection meant, for example, focusing on basic research scientists with Ph.D. degrees, and excluding clinician scientists with M.D. degrees, who may have had a different career perspective. Also, faculty members whose primary appointments were teaching were excluded from the study, since they would not likely have been involved in applying for research grant funding. Participant candidates were initially identified through departmental websites, and through contacts with department chairs and other administrators. Funding statistics from the NIH were readily available through public databases.

This study included both tenure-track and research (non-tenure) track faculty at the Assistant Professor rank in a Combined Health Sciences Program at SSU-Central. These faculty members were selected from the seven departments in the School of Medicine (Biochemistry and Molecular Genetics; Cell, Developmental and Integrative Biology; Genetics; Microbiology; Neurobiology; Pathology; Pharmacology and Toxicology), who participated in an interdisciplinary graduate program that allows graduate students to explore a curriculum across scientific disciplines). In addition, faculty members from five clinical departments in the School

of Medicine and School of Health Professions (Dermatology, Medicine, Nutrition Sciences, Physical Medicine and Rehabilitation, and Urology) whose primary duties involved biomedical research were included in the study. Because Ph.D. faculty members in clinical departments contribute substantially to the research mission of their departments (Fand and Meyer, 2003), their experiences were relevant to the study. These faculty members were selected based on their common characteristic of running a research laboratory.

Copies of their current curriculum vitae (CV) were obtained from each participant to correlate position and rank, and to assess productivity in grants submitted and funded, as well as in publication quantity and quality. The contributions to teaching and service were also compared among participants. This material provided a richer context in which to evaluate individual responses to interview questions.

3.6 Sampling Approach

Sampling was purposeful as described by Creswell (2013); the participants were deliberately selected to provide the most information-rich data possible (pp. 154-157). Sampling was also criterion-based. Specific criteria (*i.e.*, people who have experienced a particular phenomenon, age, demographics) were used based on the questions guiding the research. As shown in Table 1, 29.4% of the total faculty participating in the Combined Health Sciences Program were eligible to participate as Assistant Professors. Each of the 72 eligible faculty was emailed (Appendix B) to inquire about their interest in participating in the study. Forty additional Ph.D. faculty members at the rank of Assistant Professors and identified as performing biomedical research in other clinical departments were also emailed a request.

From 112 emails sent, there were 11 negative responders, 14 positive responders, and 87 non-responders. Selected department heads were also approached in the School of Medicine to

Table 1. Faculty at SSU-Central by Rank, Gender, and Tenure Status. Shown are Fall 2015 data.

Rank	Men		Women		Total	
	Number (% Total)	Tenured (% Total)	Number (% Total)	Tenured (% Total)	Number (% Total)	Tenured (% Total)
	Combined Health Sciences Program					
Professor	31.0	53.4	9.8	17.6	40.8	71.0
Assoc. Professor	14.7	19.8	9.8	9.2	24.5	29.0
Asst. Professor	19.6	0.0	9.8	0.0	29.4	0.0
Instructor	4.9	0.0	0.4	0.0	5.3	0.0
Total	70.2	73.3	29.8	26.7	100.0	100.0
	School of Medicine					
Professor	22.7	63.0	7.3	18.2	30.1	81.2
Assoc. Professor	15.7	13.3	8.6	5.5	24.4	18.8
Asst. Professor	21.7	0.0	15.9	0.0	37.6	0.0
Instructor	4.0	0.0	4.0	0.0	8.0	0.0
Total	64.1	76.3	35.9	23.7	100.0	100.0
	School of Public Health					
Professor	22.4	37.1	13.4	22.9	35.8	60.0
Assoc. Professor	14.9	20.0	16.4	20.0	31.3	40.0
Asst. Professor	9.0	0.0	22.4	0.0	31.3	0.0
Instructor	0.0	0.0	1.5	0.0	1.5	0.0
Total	46.3	57.1	53.7	42.9	100.0	100.0

suggest names of Assistant Professors with Ph.D. degrees who were performing biomedical research. These individuals were forwarded a second email request. To reach the goal of 25 candidates for the interview pool, a snowballing approach was used, in which positive responders were asked to identify additional colleagues who might be willing to participate. These additional individuals were contacted by email.

For this study, data collection consisted of recorded interviews, research investigator notes taken during each interview, and observational notes and summaries taken immediately after each interview (Kvale & Brinkmann, 2009). Each interview consisted of three parts. First, the faculty members were asked to describe their entry into biomedical research. Then, the

faculty members were asked to describe the kinds of experiences they had in seeking funding for biomedical research. Finally, the faculty members were asked to articulate how these experiences have affected them both personally and professionally. All interviews were transcribed and provided to the participants for information checking. The notes and summaries were used to validate the authenticity of the interviews and to assist in the data analysis.

Initial interviews were conducted using a series of open-ended questions in a semi-structured format (Kvale & Brinkmann, 2009) as indicated in Appendix C. In developing the interview instrument that reflected the academic careers of faculty and their experiences in seeking grant funding, the questions were based on the influence of Academic Capitalism and Self-Determination Theory. In the context of Academic Capitalism, Feldman (2012) proposed that scientific research has become more about money, in which "[p]ublish or perish has been replaced by fund or famish," especially in the biomedical sciences (p. 1171). Thus, the interview questions were composed to gauge how faculty members perceive their experience of grant generation about the institutional research enterprise. For example, some questions addressed the institutional incentives and expectations that faculty experienced in grant writing (Appendix C, Interview Instrument Question 6). In the context of motivational theories, Stupnisky et al. (2017) recently drew upon Self-Determination Theory to predict the success of pre-tenure faculty. Self-determination theory identifies human motivation as a continuum from extrinsic to intrinsic, with intrinsic motivation as ideally mediated through a sense of autonomy, competence, and relatedness. Thus, the interview questions were also composed to understand their motivations. For example, some questions addressed the strategies faculty used in seeking grant funding and their motivations to continue the process.

After completion of the initial interviews and transcription of the data, the research investigator reviewed each response to determine whether the questions were being answered. Follow-up interviews of each participant were conducted, in some cases, to clarify answers from specific questions or to explore particular experiences in greater depth. The process of interviewing faculty members continued until the assessment of emerging saturation in the data collection process (Creswell, 2015; p. 280). Once saturation occurred (*i.e.*, when obtaining new information diminishes, and redundancy became apparent) no additional interviews were scheduled to be collected beyond the 25.

There are five common steps related to qualitative data collection (Creswell, 2013; pp. 139-171). First, the data collection sites and participants are identified that can best address the research question. Next, access was gained to those sites and participants selected to best address the research question to be examined. Afterward, the type of information to be collected was determined. Specific research instruments are developed for gathering and recording the data. Finally, the data collection was administered under ethical guidelines considered in the design and access steps.

For a study of early-career faculty members seeking NIH funding for biomedical research, academic medical centers were the logical choice for collection sites, since NIH funding provides the majority of research investment at these institutions. There were several advantages to choosing a single institution as a site to perform the study. Because the literature review showed that different institutional factors were significant predictors of faculty productivity, limiting the study to a single institution eliminated this variable. In addition, seeking Institutional Review Board for site access was more manageable when restricted to a single institution.

A series of open-ended questions (Appendix C) were used to document the experiences of the participants, to help preclude subjecting the study to biases of the research investigator. In this context, the researcher reviewed the interview questions with the dissertation committee for appropriateness. During the interviews, the participants were asked the same predetermined questions in the same order.

Although one-on-one and telephone/Skype interviews were the most time-consuming instrument of data collection, they were also ideal for obtaining individual perspectives as opposed to shared perspectives that emerge during focus group interviews. In addition, it was possible to obtain responses that were more candid than focus groups. Likewise, focus groups were potentially harder to schedule among busy faculty members. Throughout the interview process, the same interview protocol was used with each participant to assure that each interview was consistent and comprehensive. Before initiating each interview, a signed IRB consent form (Appendix D) was obtained from each participant. In addition to an audiotape recording of each interview, brief notes were taken to document the process.

3.7 Data Analysis

The goal of the semi-structured interview protocol (Appendix C) was to use an open-ended question format that provides focus to the study (Harrell & Bradley, 2009). The instrument had three parts. First, the faculty members were asked to describe their entrance into the research profession. Next, the faculty members were asked to describe the kinds of funding expectations with which they approached their career and their actual experiences (awareness) with the current NIH funding environment. Finally, the faculty members were asked to articulate how these experiences have affected them. Each interview took about 60 minutes, which

allowed for in-depth answers and follow-up questions. All interviews were recorded, transcribed, and provided to participants for accuracy checking.

To focus the data analysis on the research questions, key issues identified from the literature review were used as the structural basis to guide the analysis of the study. For example, the concepts of tenure and promotion, the tenure clock, and appointments in the context of seeking grant funding were explored as possible themes in the interviews. Likewise, the contributions of the research environment to grant funding, including collaborations and entrepreneurship were examined.

From the theoretical frameworks, the analysis was guided by the conceptualization of universities and faculty engaged in biomedical research as market participants and competitors for the accumulation of economic gain. Interpreting the data through the lens of Academic Capitalism, some questions that were used for data coding and analysis included the following.

- How did faculty describe the economic expectations of their institution related to seeking and obtaining extramural grants?
- How did faculty describe the economic resources of their institution in relation to seeking and obtaining extramural grants?
- How did faculty describe their grant-seeking efforts regarding their personal economic gain or loss?
- How did faculty perceive their research in the context of a business?

Classifying different types of motivation is important when seeking to understand individual actions, and can provide unique insights into faculty performance in the higher education setting. Interpreting the data through the lens of Self-Dependency Theory, some questions that were used for data coding and analysis included the following.

- How did faculty experiences in seeking extramural grants relate to the principles of intrinsic motivation, comprised of autonomy, competence, and relatedness?
- How did faculty experiences in seeking extramural grants relate to the principles of intrinsic motivation, consisting of integrated, identified, introjected, and external regulation?

Bourdieu's Theory of Practice can be helpful to characterize the struggles of early-career faculty in the field of an academic setting. His theory explains the struggle of individuals as they insert themselves into a setting, to claim or maintain a space of legitimacy. Thus, seeking and obtaining extramural grants can be looked at as the capital that faculty use in negotiation their positions with the institution. Interpreting the data through the lens of Bourdieu's Theory of Practice, some questions that were used for data coding and analysis included the following.

- What were the faculty perceptions regarding their productivity as an exchange of scientific capital?
- What were the faculty perceptions regarding institutional support as an exchange of economic, social and cultural capital?
- What were the faculty perceptions regarding their evaluation from reviewers as an exchange of symbolic capital?

While the data were collected, each interview was transcribed as soon as possible after being obtained; this allowed simultaneous data analysis and data collection to identify major themes.

Once transcribed, text files of each interview were imported into a qualitative data analysis program (nVivo v. 11, QSR International Pty Ltd., Australia). The program was used to help store, organize, and manage the data. The program was also used to minimize research investigator errors (such as missed or incompletely coded data) in working through the analysis.

There were also tools available within the software that made coding more efficient and reliable, such as text search capability. After an initial exploratory analysis using nVivo, the research investigator manually coded the transcribed interview text files to make sense of the information. The text was subdivided into segments, examined for overlap and redundancy, and condensed into themes. Initial coding was performed as an open-ended approach to identify first impression words or phrases in response to examining the transcribed interviews (Saldaña, 2015). Subsequently, in vivo coding was performed, in which codes were taken directly from the data (Saldaña, 2015).

Once the coding was complete, categorizing was performed to group similarly coded data. Because of coding and categorization, an analytical reflection of the data was performed to identify emergent themes. These themes included ordinary, unexpected, and hard-to-classify, representative of both major and minor ideas. In addition, contrary evidence was identified. After analyzing all of the interviews for themes, interconnections and layers were determined, and the resulting analysis was represented in figures, tables, and a narrative summary.

3.8 A Timeline for the Study

Based on a timeline for the study as shown in Table 2, in which each of the following processes (proposal defense, IRB submission, data collection, data analysis, writing the results,

Table 2. A Timeline for the Study.

	Month												
Process	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
proposal defense	X												
IRB approval		X	X										
data collection				X	X	X	X						
data analysis						X	X	X	X				
writing the results										X	X	X	
dissertation defense													X

and dissertation defense) took a one- to four-month time frame to complete, the overall length of the proposed research was approximately 12 months.

3.9 Ethical Considerations

The major ethical consideration for this study was confidentiality. Participants in this study were assured confidentiality to allow for providing frank and open interviews about themselves, their administrators, and their institution. To maintain privacy, the research investigator coded all identifying information, and any key identifying information was kept in a secure location. Original data (such as IRB documents, interview recordings, and field notes) were maintained in a locked file cabinet in the research investigator's office to maintain a chain of custody and to limit unauthorized access. Transcripts of the interviews were encrypted and stored on a password-protected hard drive. No identifying information was included in the dissertation manuscript that resulted from this work, and pseudonyms were used in quoting specific interview conversations. An institutional pseudonym for the research site was also used. These measures made it more difficult for participants to be identified with any certainty.

3.10 Researcher Positionality

The research investigator had no current relationship with the subject institution to be studied nor a stake in any specific findings during the study. However, the research investigator performed sabbatical research over the course of a year in 2006. While this experience has provided some institutional familiarity, there have been no professional collaborations with SSU-Central faculty for more than five years. The research investigator is a scientist in the field of biomedical research, similar to the participants in the study. This background and shared experience in applying for grants could have resulted in investigator bias to overlook important themes or viewpoints that are different. Therefore, care was taken during the interview process

to allow the subjects to tell their stories. The research investigator is also a senior faculty member with tenure and holds an administrative position (department head) at a biomedical research institution. This background could create an unintended preconception of early-career faculty members during the interviews. Thus, care was also taken to obtain an unbiased view of subject experiences, by using a semi-structured interview format.

3.11 Validity of the Study

To ensure goodness, trustworthiness, and rigor, the research investigator used well-established practices in qualitative research (Creswell, 2013). For example, it was important to obtain a range of types of evidence and multiple data sources. To achieve a variety of evidence, participant observations and notes taken during each interview were obtained to supplement the interview transcript. Transcripts were provided to each participant so that they had an opportunity to check the accuracy of the transcript and the information provided, and to add additional comments, if necessary. To ensure trustworthiness, the research investigator engaged the dissertation committee chair in discussing the emerging data analysis. Colleagues in the biomedical research field who were not familiar with the research project (and not associated with SSU-Central) were asked to review the analysis and offer alternatives. Detailed notes were maintained to help account for objective observations and subjective bias. Finally, multiple data sources (interviews, participant reviews of transcripts, observation/field notes and summaries, and peer reviews) were compared to assess the data.

3.12 Conclusions

This section has presented the methodology employed in this study. The steps of the research study were detailed, including a consideration of the setting, qualitative design, and participant selection. A description of the semi-structured interview protocol was also included.

Finally, a systematic process of data analysis was outlined, particularly considering researcher positionality and data validation.

CHAPTER 4

RESULTS – INCREASED EXPECTATIONS AND DECREASED FUNDING

4.1 Introduction

The goal of this study was to better understand the experiences of early-career faculty in seeking federal grant funding for biomedical research. The trend in biomedical research that has resulted in the demand for federal funding exceeding availability is a recent phenomenon, which has been exacerbated by the 2008 recession and federal budget sequestration in 2013 (Alberts, Kirschner, Tilghman, & Varmus, 2014). Early-career faculty members in the biomedical sciences face many challenges in obtaining grants because NIH grant funding for biomedical research has decreased dramatically over the past decade (Daniels, 2013). Given the current emphasis on getting extramural grants for favorable tenure decisions, the retention of early-career faculty is correlated with success in grant funding (McGroarty et al., 2014). Thus, this investigation provided insights into their professional career development and directions. The presentation of the results of this study follows the description of participant demographics. Interviews with 25 participants provided the necessary data to answer the following research questions that guided this case study:

1) What were the backgrounds that early-career faculty members draw upon in seeking grant funding for their research?
2) What did grant-seeking look like from the faculty perspective, and how have their grant-seeking experiences affected them professionally and personally?

3) What reflections did early-career faculty have on the meaning of their grant-seeking experiences?

4.2 Results

4.2.1 Participant demographics

As shown in Figure 6 and summarized in Table 3, 25 faculty members at SSU-Central participated in this study; 15 were from basic science departments in the School of Medicine

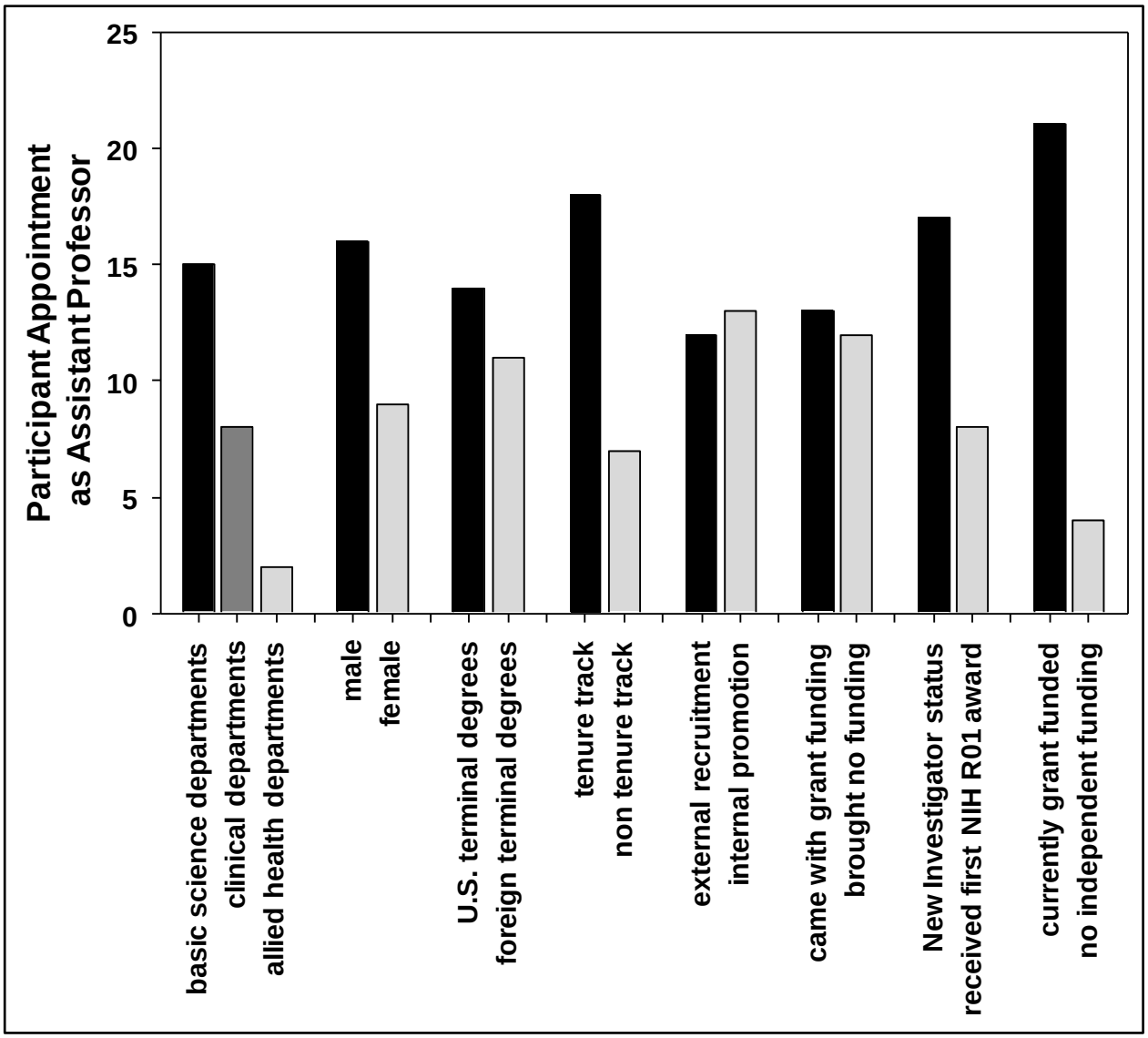

Figure 6. Demographic Data on Faculty Participants. Shown is the distribution of faculty participants in the study based on demographic data.

Table 3. Participant Demographics.

Participant	Gender	Age	Ph.D. Graduate	Tenure Track	Years in Position	Recruited	Funding Status
1	F	43	U.S. – G	Yes	6 – I	Internal	CF, 2018
2	F	46	Foreign	No	3 – I	Internal	CF, 2018
3	F	42	U.S.	Yes	4	External	NF, 2017
4	M	45	U.S.	No	6 – I	Internal	NR
5	M	54	Foreign	No	6 – I	Internal	NF, 2018
6	M	39	U.S.	Yes	4 – I	External	CF, 2019
7	M	54	Foreign	Yes	6 – I	External	NS
8	M	42	Foreign	No	5	External	CF, 2021
9	M	38	Foreign	No	6	Internal	CF, 2019
10	M	47	U.S.	Yes	7 – I	Internal	CF, 2017
11	M	36	U.S.	Yes	3	Internal	NF, 2020
12	M	51	U.S. – G	No	10 – I	Internal	NR
13	M	46	Foreign	Yes	4	External	CF, 2018
14	M	49	U.S.	Yes	8	Internal	CF, 2017
15	M	40	U.S.	Yes	1 – I, E	External	CF, 2017
16	F	45	Foreign	Yes	8	Internal	CSF, 2021
17	F	34	U.S.	Yes	2 – I, E	Internal	CF, 2021
18	F	49	U.S. – G	No/Yes	1 – I	Internal	CF, 2018
19	M	46	Foreign	No	5 – I	External	NF, 2017
20	F	56	Foreign	No/Yes	3 – I	Internal	CF, 2018
21	M	41	U.S.	Yes	5	External	NF, 2020
22	M	39	U.S.	Yes	5 – I	External	NS
23	M	42	Foreign	Yes	4 – I	External	CF, 2019
24	F	40	U.S.	Yes	6	External	NF 2017
25	F	40	Foreign	Yes	5 – I	External	NF 2017

Note. M – male; F – female; G – graduate of SSU-Central; I – NIH New Investigator status (no previous substantial award as PI); E – NIH Early Career status (within ten years of completing a terminal research degree); C – came to current position with extramural grant funding; N – came to current position with no extramural grant funding; F – currently funded and year of funding completion is provided; R – funded through a research group; U – currently unfunded; S – current start-up funding remaining

and eight were from clinical departments. Two participants were from the School of Allied Health. Of the faculty who participated, the range of time from initial appointment as Assistant Professor was between one and ten years, with an average value of five years. An analysis of the distribution of faculty participants in the study by gender showed that 16 of the

participants were men and nine were women. This distribution was similar to the overall gender (approximately 70% men and 30% women) at SSU-Central.

Fourteen of the 25 participants obtained their Ph.D. degrees from U.S. institutions of higher education. Three of those participants received their Ph.D. degrees from SSU-Central. Higher education institutions representing the 11 foreign-graduated faculty members were African, Canadian, Chinese, European, Indian, and Mediterranean. Of the 25 participants, 18 were tenure-track faculty, and seven were not on tenure-track. Twelve participants were recruited to their positions from outside SSU-Central, and 13 participants were promoted to Assistant Professor from more junior positions such as Instructor, Postdoctoral Fellow, or Research Associate. Two of the internal recruits were promoted from a non-tenure-track position to a tenure-track position. Five of the seven faculty members not on tenure-track were internal promotions. In many cases, the internal promotions were associated with obtaining a major extramural grant from the NIH or other funding agency.

Of the 25 participants, 17 were New Investigators, which meant that they have not yet obtained an NIH R01 grant in the role of Principal Investigator. Four participants were unfunded

Table 4. Participant Pseudonyms.

Participant	Name (Pseudonym)	Participant	Name (Pseudonym)
1	Amanda Crowley	14	Matthew Sealy
2	Kathryn Cresson	15	James Gallatin
3	Patricia Hewitt	16	Suvana Yorktown
4	Daniel Goodrich	17	Gloria Yoakum
5	Roger Bedias	18	Teresa Kirby
6	Charles Wilson	19	Prem Bremond
7	Deming Huan	20	Kala Socorro
8	Frederick Kaufman	21	Brian Gordon
9	Jeff Wharton	22	Alan Pharr
10	John Higgins	23	Mandar Nash
11	Michael Driscoll	24	Carol Kempner
12	Ken Zang	25	Elona Moran
13	Joseph Niederwald		

by any extramural grants, although two of these had start-up funds to operate their laboratories. The other two were funded as part of larger research groups. For the analysis and presentation of the interview data, pseudonyms were assigned to each of the participants, as shown in Table 4.

4.2.2 Major themes

After coming to SSU-Central in 2013, the new Senior Vice President and Dean of the School of Medicine announced to the general faculty an ambitious plan to grow the research enterprise of the institution, acknowledging a difficult funding environment. He indicated that where he thought the School "needed to go was really into the top 20 [in NIH funding], which would put…[SSU-Central]…in the top ten of all public-funded schools" (Dean's speech, 2015). In constant dollars, he calculated that this move would require about a 65% increase in grant revenues from the NIH. The Dean admitted, however, that his plan was challenging.

> This, however, is like…[going up]…on a down escalator. The moment you stop walking…[you go]…backwards. That's clearly the same for us. We stop either funding, supporting, or growing, we will not continue to grow. The environment is not in our favor. It's a counter-productive environment for growth. (Dean's speech, 2015).

As shown in Figure 5, SSU-Central has been successful in increasing NIH funding by 30% since 2013 from $120M to $156M. Realizing that the NIH budget has not grown appreciably in recent years, the Dean acknowledged that their increase came at the expense of other schools. He indicated, "That's a lot of money to take away from other schools. The money hadn't grown. We just took a bigger part of the pie" (Dean's speech, 2015).

In this setting of increased institutional expectation to bring in grant revenues, the early-career faculty members were asked to participate in this study. First, the faculty explained their personal and professional experiences that brought them to SSU-Central and kept them motivated in their careers. Second, the faculty spoke at length on the theme of mentoring both regarding being mentored as well as providing mentoring in their careers. Third, the faculty

incorporated the previous two themes to contextualize their grant-writing experiences. From the interview data, three major themes emerged. These overarching themes describe their role and actions in light of their goal to fund their research laboratories.

4.2.3 Personal and professional experiences

The theme of Personal and Professional Experiences encompasses participant experiences in both their personal and their professional lives as early-career faculty members of a university. These experiences also connected with their personal and professional thoughts about seeking grant funding for biomedical research. Participants spoke to three essential aspects of their personal and professional experiences: (1) the path they took to academics, (2) the realities of academics, and (3) the passion and motivation they had regarding an academic career. Figure 7 outlines the relationship these three sub-themes had to the central theme of personal and *professional experiences.*

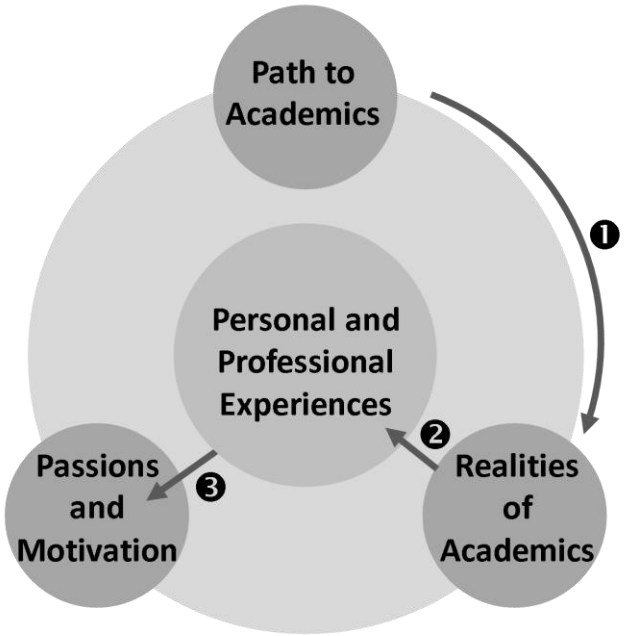

Figure 7. Relationship Between Theme and Sub-Themes of Personal and Professional Experiences.

4.2.3.1 Path to academics

Participants talked about the multitude of reasons why they pursued a career in academic research. Some of the participants were initially not interested in a career in academics, while others actively pursued a career in the field. One participant talked about her reluctance to continue in academics because of her personal experiences at a highly competitive university. Dr. Kathryn Cresson (Participant 2) is a non-tenure-track researcher at SSU-Central with a funded laboratory investigating cancer biology. She explained that at that time, she believed that she would "either go to industry or a hospital or some different kind of setting." Dr. Cresson shared that she "was very disappointed in [the] academic environment" and "didn't like what I saw" during her postdoctoral training. Instead, she decided to focus on the research aspect of science when a Principal Investigator (PI) recruited her to work in a research hospital setting. After this appointment, her PI was offered a position at SSU-Central to continue the research, which left her in a position of deciding what she wanted to do. Dr. Cresson explained that she "really liked her [the PI's] research, but then it's going back to academics, which I didn't want." Ultimately, she decided to follow her PI to SSU-Central and work with her as a Research Associate "because I didn't want to be faculty" (Cresson, interview 2). For Dr. Cresson, it was not until she applied for an internal grant meant for faculty members that she was given the prospect of a faculty position. If her grant were selected, she would "be promoted to instructor" to fulfill the eligibility requirements (Cresson, interview 2). She was awarded the grant, and by default, SSU-Central offered her a faculty position.

Dr. Alan Pharr's (Participant 22) experience was completely different; from an early age, he realized that he wanted to be a scientist. His stepfather recognized how intelligent he was and pushed him towards a stable career as a physician. Dr. Pharr acknowledged, "I was really

pushing for med[ical] school for him, not for me" and on "one fateful night, I missed the MCAT deadline." It was that experience that made him start pursuing his dream and exploring what he wanted to do. He knew he loved science and enjoyed laboratory coursework as an undergraduate student. When one of his Professors asked the students with interest in research to speak to him after class, Dr. Pharr took the opportunity. He was able to do experiments alongside the Professor, but the real answer to his question of career choice came about in a conversation with his grandmother. Dr. Pharr explained that he would sit at the table, just he and his grandmother. He recalled that she would "fix me food like any good Cajun grandmother," and she would talk to him about what he wanted to do in life. Dr. Pharr shared that he told his grandmother, "Well, I could help one person at a time, or maybe I could do research and help millions of people at a time" (Pharr, interview 22). He acknowledged that his grandmother "helped me realize" which was the better choice for him to pursue (Pharr, interview 22). At SSU-Central, Dr. Pharr is a tenure-track researcher with a start-up funded laboratory investigating infectious diseases.

Many participants talked about their experiences growing up, some in the United States and several in foreign countries. Dr. John Higgins (Participant 10) is a tenure-track researcher with a grant-funded laboratory investigating cancer biology. He talked about growing up in a small town in Pennsylvania and being the first generation in his family to go to college. He spoke about his experience in the Navy and his decision to pursue an education after he was discharged from the military. Dr. Higgins shared that as an undergraduate student, he pursued a research position with a Professor. He detailed, "I just walked up and said 'I want to do research.' And it took about a month of long weekly meetings before he offered me a position in his lab" (Higgins, interview 10). By the time he graduated, Dr. Higgins had published ten papers

and had begun looking for graduate opportunities that revolved around being an academic researcher.

Dr. Ken Zang (Participant 12) described how he knew from a young age that he was "interested in science" and that he wanted to "stay in science" to "do experiments" for a living. He was born in China and became interested in science because of his father (a scientist), who pioneered a "super rice" that looked similar to "wheat" (Zang, interview 12). He talked about how he did not pursue a postdoctoral position after graduating with his Ph.D. from SSU-Central. Although offered a postdoctoral position at Cold Spring Harbor Laboratory, he stayed at SSU-Central and became a Research Associate for another PI. A few years later, he was promoted within the research group to an Associate Professor position. Dr. Zang was able to accomplish his career goal to conduct research but without having to worry about grant submissions. As a non-native English writer, Dr. Zhang noted, "Submitting grants is…kind of hard for us…we basically just provide data for the PI" (Zang, interview 12). Dr. Zang is a non-tenure-track researcher in a grant-funded research group investigating genetic diseases.

Participants talked about their introduction to SSU-Central, whether as a postdoctoral trainees offered jobs after completing their fellowships or as prospective faculty members. For Dr. Teresa Kirby (Participant 18), outside factors heavily influenced her decision to stay at SSU-Central following her postdoctoral fellowship. She even admitted, "I discourage people from doing it the way I did because of it kind of – it has held my career back" (Kirby, interview 18). Her mother was diagnosed with cancer when Dr. Kirby was a postdoctoral trainee, which made her want to stay close by because her mother was also a widow. As a result, this limited her choices in finding a faculty position since she wanted to remain at SSU-Central. She decided to continue her postdoctoral fellowship and remain in the area to be a support for her mother as she

was “going through this” (Kirby, interview 18). After completing her postdoctoral fellowship, Dr. Kirby’s PI helped her get a position as an instructor at SSU-Central. She acknowledged that while “it’s highly discouraged [*sic*] to stay with the same group that you did your training with,” she “enjoyed the project that she was working on” and “didn’t want to abandon the project either” (Kirby, interview 18). Dr. Kirby is a tenure-track researcher with a grant-funded laboratory investigating genetic diseases.

For Dr. Brian Gordon (Participant 21), networking helped him secure his position as an early-career faculty member. He shared that when he was a postdoctoral trainee, his PI was invited to give a symposium talk about the research they were conducting. However, his PI told the event organizer that Dr. Gordon was the one who “came up with the idea and everything” and told the organizer to invite him instead. Dr. Gordon described that after giving the talk, he was invited out to dinner by another symposium attendee who was from SSU-Central, and he told the attendee about his career search. Dr. Gordon related to the attendee that he applied for a position at SSU-Central, after which the attendee asked whether he had received any feedback about his application. Dr. Gordon told the attendee that he had not hear back from SSU-Central, after that the attendee advised “to let [him] know next week if [I] haven’t heard anything.” He continued, “Two days later, the chair of Pharmacology says ‘Hey, we just read your application, and we want to invite you down for an interview’ [laughter]” (Gordon, interview 21). Dr. Gordon is now a tenure-track researcher with a grant-funded laboratory involved in developmental biology.

These personal connections occurred not only within the United States but also in other countries. Dr. Joseph Niederwald (Participant 13) grew up and was educated in Europe. After completing his doctorate, he was recruited by a Professor from the United States who was

visiting his country at the time. Dr. Niederwald described the first time they met. The Professor advised him to investigate coming to the United States to do his postdoctoral training. After his first meeting with this Professor, he published a significant paper with his doctoral mentor that resulted in the opportunity to "pick a conference and go to the conference whenever [I] want" (Niederwald, interview 13). Dr. Niederwald chose a conference organized by the Professor who wanted him to do his postdoctoral training in the United States so they could meet again. He shared, "We talked again. The Professor said, 'Well, whenever you graduate, I'll call you every six months. And whenever you're ready, just come over'" (Niederwald, interview 13). Six days after he graduated with his Ph.D., he was on a plane to the United States to become a postdoctoral fellow working for the Professor. Dr. Niederwald worked alongside the Professor until the Professor's retirement. Afterwards, he was promoted to a non-tenure-track Assistant Professor position and stayed until his recruitment to SSU-Central. At SSU-Central, Dr. Niederwald is now a researcher with a grant-funded laboratory investigating genetic diseases.

Table 5. Summary of Participant Dialog in the Path to Academics Sub-Theme.

Code	Participant Dialog	Dialog Summary
career	"didn't want to be faculty"	– academic research was a default (unplanned) career pathway
career	"help millions at a time"	– academic research was a rational career choice
career	"I want to do research"	– t undergraduate exposure to research led to an academic career
career	"interested in science"	– a lifelong dream to attain a research career was fulfilled
postdoc	"it held my career back"	– staying at the same institution as postdoctoral training was a disadvantage
postdoc	"didn't want to abandon the project"	– rationale for staying at the same institution as postdoctoral training
interview	"we want to invite you"	– networking led to an interview for a faculty position
interview	"whenever you're ready"	– networking led to an interview for a postdoctoral position

Table 5 provides a summary of the participant dialog and major findings regarding their path to academics. Participants described in detail how they entered the field of biomedical research and some of their experiences in coming to a university setting at SSU-Central.

4.2.3.2 Realities of academics

Participants spoke about the realities of working in an academic career, such as long work days and having to subsidize a percentage of one's salary with grant revenues. Participants also talked about the funding aspect of academics and its connection to keeping their jobs and getting tenure. To one participant, "the most important criteria [to getting tenure] on this campus is money" because that is how they subsidize a significant percentage of their salary cost (Niederwald, interview 13).

When Dr. Mandar Nash (Participant 23) was first recruited to SSU-Central, he had a grant that covered 40% of his salary for three years, and SSU-Central supported the other 60% during that time. He explained that in his initial contract, "they're going to support my salary for the first three years to get me on my feet" and "after three years, I have to cover 70% of my salary" with grants (Nash, interview 23). By covering such a large portion of his salary, he indicated the need for two or more grants "to cover my salary and run my lab," which he has struggled to do (Nash, interview 23). Dr. Nash is a tenure-track researcher with a grant-funded laboratory involved in cardiovascular disease. Although faculty members "can get bridge funding" for short periods of time when their grant funding runs out, eventually "if they don't get their grants, they're going to be [let go]" (Kirby, interview 18).

Several participants noticed that there was a change in the focus of faculty researchers in recent years away from the basic research and teaching missions of the school and towards a funding priority of the school. With the major emphasis on money, two participants called into

question whether or not SSU-Central was overemphasizing science as a business. To Dr. Alan Pharr, it was antithetical for research to have the goal of generating a profit. He acknowledged his idealistic perspective on it but wholeheartedly believed that "research, in my opinion, should operate at a deficit" (Pharr, interview 22). He believed that to be the case because research should not be geared towards "making money" but rather on "making discoveries" (Pharr, interview 22). Taking into consideration the climate of grant funding from the NIH, he did not think it was realistic "to think that the academic side…should generate revenue" (Pharr, interview 22).

Dr. Elona Moran (Participant 25) expressed a similar sentiment that science was a business, but correlated her belief to the way universities recruit employees. She explained "the whole concept of start-up money" was a "business concept" because businesses will provide start-up money to a venture or project (Moran, interview 25). These start-ups will then do their best to succeed. Some in business will succeed, and some will fail just as in academics "if you succeed [with your start-up funding] you get tenure, if you don't [succeed], you don't get tenure" (Moran, interview 25). She believed that it was sad to realize "that we don't really do science, we do business" and felt universities were also functioning as businesses. At SSU-Central, Dr. Moran is a tenure-track researcher with a grant-funded laboratory investigating cancer biology.

For several participants, the reality of academics boiled down to funding that justified their existence and their positions as researchers. For example, Dr. Daniel Goodrich (Participant 4) shared an experience he had with an Assistant Professor that made him aware of the realities of academics. He recalled working one afternoon with a colleague, another Assistant Professor in the lab; he asked his colleague if he thought their jobs were high-stress. In the words of Dr. Goodrich, "he looked at me like I stepped off a spaceship" and shared with him all the different

ways this job was stressful. He explained there were many pressures and responsibilities he dealt with "that had absolutely nothing to do with answering scientific questions" (Goodrich, interview 4). His colleague shared that "he had to daily justify his existence" as if "his value as a human being" was in question (Goodrich, interview 4). Dr. Goodrich began to realize "it's not fun and games, it's a real business…driven by money." At SSU-Central, Dr. Goodrich is a tenure-track researcher investigating cardiovascular disease in a grant-funded research group. Dr. Brian Gordon (Participant 21) also talked critically about how his productivity was assessed based on the amount of grant funding he brought in to the institution.

> The thing that matters is what discoveries you make. Right? If I had a dollar for every time someone introduced a speaker and said, 'this person is great because [he or] she has this many grants or whatever', I'd be a millionaire. It's just disgusting. It's like the grants are necessary and we celebrate them as a means to an end, but the end is discovery. (Gordon, interview 21).

Another participant talked about the instability of working as an early-career faculty member, whether on a tenure-track or a non-tenure-track appointment. For Dr. Prem Bremond (Participant 19), there was a level of risk associated with academics because "departments get dismantled all the time, and you always can get fired." Dr. Daniel Goodrich also mentioned the consequence of what happened when a star scientist in his program who "was fed up with the lackluster support from his division and his department," left the University. He noted that afterward, "the infrastructure for the…program just vanished", which left the "rest of us that were still interested in pursuing it and going forward with it…sort of hanging, in a sense." Dr. Goodrich also commented on the instability of his job situation and balancing all of his demands, and used a specific example.

> You've seen the guy on Johnny Carson balancing the plates. He's got ten sticks and ten plates balanced on those ten sticks, and if a plate falls off, the performance is kind of ruined. So there is that experience of [SSU-Central]. (Goodrich, interview 4).

Participants talked about his or her "plan B" in case their appointment contracts were not renewed for not generating enough funding at SSU-Central, or if they did not make tenure. This situation was the reality that Dr. Matthew Sealy (Participant 14) faced at the time of the interview. He described himself as having a "dark cloud that is hanging over" if he did not manage to get funding renewed this year. He acknowledged that it's a struggle to "keep my research program afloat…while at the same time, thinking about what I might do next" (Sealy, interview 14). Dr. Sealy is a tenure-track researcher, investigating neurodegenerative diseases in his grant-funded laboratory. Dr. Alan Pharr had considered but then rejected a move to the pharmaceutical industry.

> I love to work for me and not only that but to be able to really steer what I'm working on. Because if I go to a company, and they can always say, 'You need to work on this project.' I mean, I would work on it but I might not be as excited. And then I've also heard multiple stories of projects just being canceled, simply for business not for scientific reasons. (Pharr, interview 22).

Dr. Roger Bedias (Participant 5) also mentioned his desire to remain in an academic career setting, and that he would "go to a private company only as the last resort." Dr. Bedias is a tenure-track researcher with a grant-funded laboratory investigating infectious diseases.

Dr. Kala Socorro (Participant 20) confessed that she was interested in transitioning to more of a teaching role if she could not "continue with my research" (Socorro, interview 20). Dr. Socorro is a tenure-track researcher currently investigating cancer biology in her grant-funded laboratory. Even though Dr. Socorro could still conduct research in a teaching position, her salary would not be subsidized by grants as it is currently as an academic researcher, resulting in a substantial decrease. On the other hand, some of the participants, such as Dr. Carol Kempner (Participant 24), expressed that they had no career alternatives.

> I don't have a backup plan, and this is the job I want. And I like my job, and I have a Ph.D. I don't feel like I have any feeling that this is going to happen any longer. And it's

> scary, and it makes me sad. And yet I'm still fighting as hard as I can. So it's just there's a definite frustration that if I'm going all out, does anybody have my back? And maybe they can't. I think everybody is strapped for funding, and that's fine. (Kempner, interview 24).

Dr. Kempner also talked about how there used to be a program in place that provided a portion of the indirect cost (IDC) from grants that SSU-Central provided to create a rainy-day fund for each funded investigator. At SSU-Central, Dr. Kempner is a tenure-track researcher with an unfunded laboratory investigating neurodegenerative diseases. She explained that this program was helpful to researchers who had "gap time between grants" because it was like a "savings account" (Kempner, interview 24). When the University rescinded that program and her department took back the funds, Dr. Kempner recalled that they lost a senior faculty member, who said, "If you're going to cost me $300,000, I'm going to leave" (Kempner, interview 24). Now, faculty members in the departments have "no emergency account to go to" during periods of low grant funding and that has "caused resentment" towards the Department and University (Kempner, interview 24).

Dr. Suvana Yorktown (Participant 16) admitted to exploring career alternatives: "I'm actually taking some online classes. I'm going to probably do a Global Health Certification along the way" (Yorktown, interview 16). Dr. Teresa Kirby also talked about taking classes at SSU-Central. "I'm doing that now. They have a professional writing emphasis here in the English Department. I'm getting a degree there." She planned to use the degree as a professional writer "if this research stuff should go downhill, which it might depending on the [NIH] budget" (Kirby, interview 18).

For Dr. Ken Zang, the decision to leave academics for a biotechnology start-up company has already been made. Asked about his effort to write grants, he replied, "Not anymore, because our lab [group] has basically decided to form a company" (Zang, interview 12). He

noted that even with “two or three” NIH grants, funding would be insufficient for his lab to operate. “It's kind of disappointing [laughter]. Very disappointing because here, we expect that the greatest country, the richest country in the world can provide reasonable resource[s] for research” (Zang, interview 12). Dr. Zang believed that unless the United States increases its investment in biomedical sciences “in the next five years, China will surpass [us].” He also indicated that it is becoming more and more viable for Chinese trainees “just [to] go back” home rather than pursue an academic career in the United States.

Dr. Deming Huan (Participant 7) was in the process of looking for a new faculty position at another University because of his current unfunded laboratory situation. His contract will not be renewed at SSU-Central.

> I still have five months [of funding left], and I will know the results next month for one grant. And even if I do have [a] grant, I will have to…apply for [a] faculty position in [an]other University. (Huan, interview 7).

However, he was not optimistic about being able to find another position without any funding. He indicated, “But now, every University, they don't look at your [publications]. They just [ask], ‘Do you have money?” He also noted, “If you have a grant [laughter], everything is better. If you don't have a grant, it's more difficult…” (Huan, interview 7). Dr. Huan is investigating cell biology applications in his laboratory.

For Dr. Matthew Sealy, in his eighth year on a ten-year tenure clock, obtaining grant funding has been a struggle, which he blames on the current NIH funding situation.

> I mean, I love this job. I went into it knowing that I would like it and feel like I'm good at it. But I don't think American scientists have enough resources financially and otherwise to truly, across the board, be successful. (Sealy, interview 14).

Dr. Sealy also spoke about the stress that came with the tenure clock, and indicated the impact on his professional life.

> I wish I wasn't in this state where I was under this constant stress of just knowing if I can keep my job or not, knowing that's impacting my ability to think clearly at times, but it's just the reality. (Sealy, interview 14).

Participants described a significant commitment of time associated with being an academic researcher due to maintaining labs, completing teaching requirements, and providing professional service commitments. Two participants talked about how these three factors were prioritized in their job responsibilities, with the first being research, followed by teaching, and finally service requirements. As a result, participants shared the reality of long workdays. Dr. Deming Huan indicated, "I stay here seven day[s] a week…I even have dinner here. I have a cooker here [in my office]." Participants who had animal colonies would have to come into work over the weekend to take care of them. In addition to these responsibilities, participants had to make time to write grants during their busy workdays. Often, they would have to work "nights and weekends" to meet an upcoming "grant deadline" (Crowley, interview 1).

Dr. Amanda Crowley (Participant 1) is an academic researcher investigating diabetes. She joked that after the grant deadline passed her husband would email her with a "welcome back [laughter]." One participant described the experience of an emotional burnout from juggling her multiple different responsibilities. Dr. Carol Kempner shared that while she understood that being an academic researcher would not be a job that would run normal hours, she "did hope at some point [laughter] in my career that I would be able to go home at dinner time like a normal person." During the time of her interview, she talked about her exhaustive workload and acknowledged it was getting old for her. Another participant talked about the importance of taking "time outs" to recuperate and prevent herself from reaching her breaking point (Moran, interview 25).

There was also the reality of making sacrifices to be an academic researcher, which meant both personal and professional costs. For example, Dr. Carol Kempner was strongly dissuaded from having a personal life so that she could focus her attention on laboratory research. She shared that as a postdoctoral fellow she was even told to "get rid of your dog" so that she could put in a 12- to 14-hour workday (Kempner, interview 24). The rationale she was told for doing so was "think how much more productive you could be if you could give us four more hours a day" (Kempner, interview 24). When she started dating someone as a postdoctoral fellow, she was "discouraged from marriage or children" because her mentors did not want "biology to wreck my career" (Kempner, interview 24).

Dr. Suvana Yorktown (Participant 16) was in a difficult position as an academic researcher. She had funding but she also had to subsidize her own salary, pay the salary of her postdoctoral trainee, and fund the operation of her lab. As a result, she ended up having to let her postdoctoral trainee go after a couple of years "because it was either me or him surviving" (Yorktown, interview 16). She also had to get rid of her research animals because she couldn't keep the project running with the funding she had available. She explained, "We had a really great project going on, but then I couldn't afford to [continue]" (Yorktown, interview 16). Dr. Yorktown is a tenure-track faculty member, whose research is in cancer biology. Dr. Gloria Kemper also related a similar story about the consequence of a funding crisis.

> I have a friend…[who]…doesn't know what happens if he doesn't hit an R01 this year. This is the end of his guaranteed time, and so he has gone in and elected to kill off a large amount of animals out of his animal colony. So he doesn't have these year-and-a-half-old animals any longer because he's worried about the cost of maintaining. (Kemper, interview 24).

In referring to her own concerns about funding, Dr. Kemper noted, "I mean, to be perfectly honest, I sort of avoid talking to people at my level because we're all scared." She was also frank

about the consequences of her own start-up funds being depleted, which left her with few resources available.

> I had guaranteed support for a technician and graduate students for the first three years. I don't have that support anymore because the assumption was I would have an R01 by my third year. And so I spent the first four hours today over in the animal facility [today] because I have no one to take care of my animal colony. So my grant writing will happen this evening after dinner. Because that's what I do now is work 12 to 14 [hours a day]. (Kempner, interview 24).

Participants talked about teaching opportunities, even though this was not a significant component of their faculty duties. For example, Dr. James Gallatin, a tenure-track researcher investigating infectious diseases, mentioned that his teaching responsibilities were minimal compared to faculty at an undergraduate campus.

> My teaching load is very low, and in fact, without even trying and without stretching myself at all, I have already gone above and beyond the expectation for teaching that they have for a new Assistant Professor. I have taught five lectures [laughter] this year. (Gallatin, interview 15).

Many participants, however, confessed their preference for research over teaching as described by Dr. Amanda Crowley.

> I just really enjoy the job. I really do. I love mentoring students. I don't like classroom teaching. I'd do it, and I'd probably be fine with it. I've done it before. But the research is what I love – this topic of research and I just love being able to contribute. (Crowley, interview 1).

Dr. Frederick Kaufman, also admitted that he was “not a natural teacher” but felt he made his major contribution to teaching “all the time on a one-to-one basis in the lab” as something he enjoyed (Kaufman, interview 8). Dr. Kaufman is a non-tenure-track researcher investigating metabolic diseases.

Table 6 provides a summary of the participant dialog and major findings regarding their realities of academics. The participants described in detail the personal and professional sacrifices they made as faculty members at SSU-Central. In particular, participants described

Table 6. Summary of Participant Dialog in the Realities of Academics Sub-Theme.

Code	Participant Dialog	Dialog Summary
funding	"the most important criteria"	– there was a grant funding requirement for tenure
salary	"cover my salary and run my lab"	– the reality of a soft money faculty position
funding	"if they don't get grants"	– there was a grant funding requirement for job contract continuation
research	"making discoveries"	– there was a priority in generating grant revenues over research
business	"we don't really do science, we do business"	– there was a start-up business mindset in academics
business	"driven by money"	– there was stress and anxiety associated with the business aspect of funding
funding	"celebrate them as a means to an end"	– grant funding was valued over research results
balance	"balancing the plates"	– there was difficulty in balancing the different career demands
program	"sort of hanging"	– there was instability in research programs
career	"what I might do next"	– finding an alternative career plan
career	"last resort"	– industry as an alternative career
backup	"this is the job I want"	– there was no backup career plan
indirect cost	"no emergency account"	– a loss of indirect cost return to individual investigators is a burden
career	"I'm getting a degree there"	– finding an alternative career path
business	"for a company"	– there was inadequate funding to maintain an academic research lab
funding	"I still have five months"	– beginning a job search after contract non-renewal was difficult
funding	"I don't think American scientists have enough"	– there was inadequate grant funding for research
stress	'under this constant stress"	– stress under the tenure clock
sacrifice	"I even have dinner here"	– there are long working hours in academics
	"welcome back"	– priority to work over personal life
sacrifice	"get rid of your dog"	– personal sacrifices were expected
funding	"either me or him surviving"	– there were difficult funding choices
funding	"kill off a large amount of animals"	– there were difficult funding choices
teach	"what I do now is work 12 to 14"	– personal sacrifices were involved
teach	"my teaching load is very low"	– priority of research over teaching
teach	"I don't like classroom teaching"	– preference for research over teaching
teach	"one-on-one basis in the lab"	– contribution to teaching was found through laboratory training

stress and anxiety invoked by the competitiveness of the grant-writing process. As a result, many participants explored alternative career paths.

4.2.3.3 Passion and motivation

Even in light of the realities that they faced as researchers, participants shared experiences that continued to motivate them to remain in the field of academic research. Often, participants talked about their passion and interest in research and expressed their belief in the value of their work to society. For many participants, passion for research helped motivate them to continue writing grants and doing research. However, this fervor was combined with a pragmatic attitude, and several participants described how they learned from their grant writing mistakes and moved forward. This mindset was the case for Dr. Patricia Hewitt (Participant 3), whenever she received feedback from a grant. She described how her thoughts revolved around "this is what I need to do to improve and address these questions better" because she believed in her research. She felt that "what we are doing is important" and was "passionate about making sure that we can continue" to do research (Hewitt, interview 3). Dr. Hewett is a tenure-track faculty member investigating cancer biology.

Participants expressed how much they enjoyed being academic researchers, for the autonomy or because they were involved with discovery. Dr. Carol Kempner shared how amazing it was to "look at the result, and you realize that you know something that nobody else on the planet knows." She "loved that feeling" of contributing to the body of scientific knowledge and "the reality of things" (Kempner, interview 24). For other participants, their love of science and doing experiments in the laboratory kept them motivated as researchers. For example, Dr. Brian Gordon loved his job and science, but "doing experiments and talking about experiments" kept him coming to work every day. He admitted that in a perfect world he would

not “have to write any grants,” he would just be able to research (Gordon, interview 21). Dr. Prem Bremond also spoke about his love for doing research. “It’s fun…every day you come and do whatever you want to do” (Bremond, interview 19). In contrast, he was adamant that has no ambition for fame. “So I came into academics, because of the love of science. It's not really for any prestige or anything like that” (Bremond, interview 19). Dr. Matthew Sealy talked about the independence that his position brought him.

> I love the autonomy that's associated with this position, but I've also been fighting to keep my job, for several months, even years now, and it's just, I don't know if I can keep doing this, frankly. (Sealy, interview 14).

Many participants talked about the importance of putting their ideas on paper and communicating their findings to the world. For Dr. Teresa Kirby, it was the most important aspect of being an academic researcher and made her feel fulfilled in her job. She explained that she loved “getting everything together” for a paper, “doing the research,” and “thinking about

Table 7. Summary of Participant Dialog in the Passion and Motivation Sub-Theme.

Code	Participant Dialog	Dialog Indicates
feedback	“this is what I need to do”	– the perception that grant feedback was a positive experience for improvement
important	“what we are doing is important”	– perception that there was social value perceived in academic research
research	“loved that feeling”	– perception that contributing to research body of knowledge was rewarding
research	“doing experiments and talking about experiments”	– perception that love of scientific career was a motivating career factor
enjoy	“It’s fun”	– perception that enjoyment of doing science was important
ambition	“It’s not really for any prestige”	– perception that career ambition was not a motivating factor
freedom	“I love the autonomy”	– perception that love of science was a motivation to continue despite career difficulties
communicate	“getting everything together”	– perception that publishing and communicating results was a rewarding experience

how [best] to say things" in communicating her results (Kirby, interview 18). As a postdoctoral trainee, she liked "the scientific communication part" of being an academic researcher because it gave her "extra training" to hone her skills before attaining an independent position (Kirby, interview 18). Dr. Kirby is investigating genetic diseases in her laboratory.

Table 7 provides a summary of the participant dialog and major findings regarding their passion and motivation in academics. Many participants described their love of science and performing research as the primary motivating factor for remaining in academics.

4.2.4 Mentoring

The theme of Mentoring discusses participant perceptions of their own mentors and themselves as mentors to graduate and postdoctoral trainees. Participants talked about giving advice to their trainees and helping identify the roadblocks they had experienced as postdoctoral

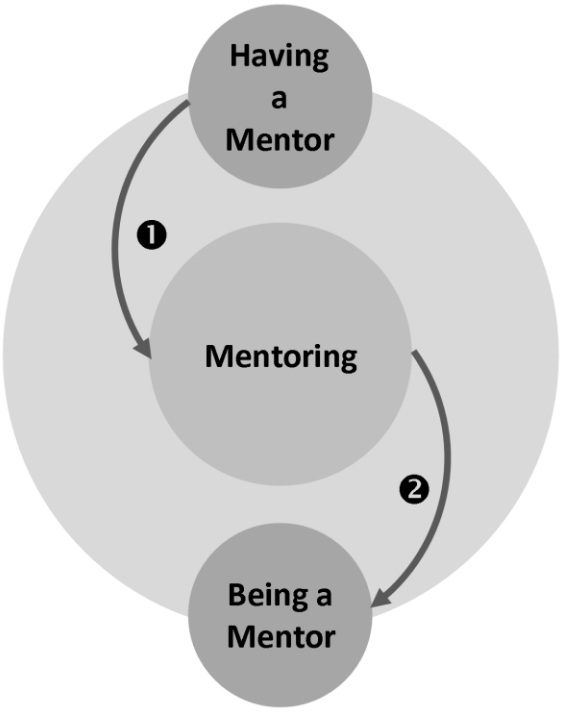

Figure 8. Connection of Mentoring Sub-Themes to Theme.

fellows. They wanted their trainees to be aware of what an academic career required of an individual, much as they were informed by their mentors. Participants talked about the help they received as postdoctoral trainees in writing grants or manuscripts. They spoke about their path to independence from their mentors and the need for freedom to explore on one's own. Participants mentioned two important aspects of mentoring: (1) having a mentor and (2) being a mentor. Figure 8 illustrates the connection of the sub-themes to the theme of mentoring.

4.2.4.1 Having a mentor

Participants talked about the mentors they had as they went through their postdoctoral training and the amount help their mentors provided. Two participants shared that their mentors did not assist them to write grants or were not supportive. Most participants, however, had positive experiences with mentors who taught them how to be effective academic researchers. For several participants, being forthright and honest about what they wanted to do helped their mentors understand their career direction; an open relationship helped their mentors give them appropriate advice. Dr. Michael Driscoll (Participant 11) provided an example of this interaction. Looking back, he referred to himself as "a little brash at the time" for stating that he wanted to "study this question" and "learn these techniques from your lab." Despite his brash words, his mentor "was in the right place in his career where he could allow that to happen" because he had "plenty of grant money coming in" (Driscoll, interview 11).

After becoming a postdoctoral trainee, Dr. Driscoll applied for grant funding to perform an independent research project. When he received the grant, his mentor was "comfortable letting me do what I wanted after[ward]" (Driscoll, interview 11). As an established investigator, Dr. Driscoll noted that his career was not going to suffer if a postdoctoral trainee failed in his lab. In contrast, a new investigator might be more hesitant to take on a trainee,

because if the "postdoc you hire is a total failure, your career might also be a failure" (Driscoll, interview 11). Dr. Driscoll is a tenure-track researcher whose laboratory is involved in the neurodegenerative diseases.

Two participants indicated their mentors did not have them write grants; it was not because they were incapable, but it was due to a significant amount of research funding available in the laboratory. Dr. Joseph Niederwald shared that his mentor "never encouraged us to apply for fellowships or apply for grants" because to him, it was a question of "why waste your time, I'm giving you everything." He was encouraged to just "be productive and work" because everything else was taken care of by his mentor (Niederwald, interview 13). Towards the end of his postdoctoral fellowship, his mentor recognized that he needed advice on how to write grants. His mentor provided him "free access to whatever he'd written" to have an example of what a successful grant looked like (Niederwald, interview 13). Dr. Brian Gordon shared that the institution in which he did his postdoctoral training, had a large endowment for research "so none of the postdocs were required to write grants." He explained that he was interested in writing and getting a grant before the end of his postdoctoral fellowship because "having outside funding was going to help you be more competitive to get a faculty job" afterward (Gordon, interview 21).

Dr. Mandar Nash talked about his co-mentor, someone to whom he was assigned shortly after entering the Ph.D. program when his original mentor unexpectedly retired. Dr. Nash explained that while he wished he "could have gotten better mentorship," he did not have any regrets about what happened. Dr. Nash indicated, "Instead of getting that kind of training, I got full freedom" (Nash, interview 23). For example, he was able to take a six-month sabbatical to another University where he "spent six months with another person [and] brought some new

ideas back" to his home lab (Nash, interview 23). Dr. Nash was able to publish a paper with this other person during his six-month sabbatical and was grateful to his co-mentor for giving him the freedom to explore. He elaborated that as a postdoctoral trainee, he was lucky to have the co-mentor he did because his co-mentor had "a distinguished career" and was successful at getting funding "throughout his life" (Nash, interview 23).

In addition to this realization, Dr. Nash felt that he was instrumental in helping his co-mentor to get additional funding. He explained that his mentor "was happy with me because I brought him right away a big grant." As a result, he was able to "develop my own ideas [and] take that with me" after his postdoctoral fellowship (Nash, interview 23). However, he explained that at the end of his postdoctoral training he also had to fight and argue with his co-mentor to "let me take my project with me" (Nash, interview 23). His co-mentor eventually acquiesced and let him bring his project to SSU-Central. This project allowed him to get grant funding at SSU-Central because he was "showing the signs of independence," something the grant reviewers "appreciated" about him (Nash, interview 23). For Dr. Nash, having the freedom to explore what he wanted early in his career helped him establish his independence later as an academic researcher.

Other participants felt they were not provided adequate guidance and training to write grants from their mentors. This deficit made it difficult for them to learn what was required in a grant application and caused them to stumble through the initial grant application process. While grant writing is tedious, it is important to the career of any researcher because of the necessity of funding. Dr. Brian Gordon had such a bad experience with applying for a grant. His mentor did not give any advice about what could have been improved. He shared that his mentor told him, "I'm not surprised you didn't get it, not because your science is bad, but because they don't like

me" (Gordon, interview 21). As a result, there was no possibility to improve his application to resubmit it because his mentor believed that it had to do with reputation rather than the research project. Dr. Ken Zang acknowledged that there was not any training or "special system to train us" in how to be effective grant writers or any opportunities to become better, outside of trial and error. Dr. Amanda Crowley recognized that if her mentor would not help her write better grants, then she would reach out to other grant writers to get examples of what a successful grant looks like. Without those positive examples, she would "still [be] kind of figuring things out on [my] own" (Crowley, interview 1).

Dr. Teresa Kirby mentioned that she had a precarious relationship with her mentor, not because of different views about what to research, but because they both perceived where she was differently. For example, she talked to her mentor about applying for a pilot project, and he did not think that she should "do this right now, we've got so much going on" in the lab (Kirby, interview 18). Despite that, Dr. Kirby told him that she wanted to "go ahead and just try" and reminded him that she "may not even get" chosen. As it turned out, she was selected for funding of the pilot project, which helped her get future funding when she became independent after completing her postdoctoral training. She shared that her mentor "was a little surprised" that she was successful in getting funding for the pilot project because "he still sees my flaws" (Kirby, interview 18).

Some of the participants talked about the importance of having supportive mentors, especially as they became more independent and sought their own funding. Their mentors helped guide them along their career paths and gave them opportunities to write papers and grants so they would have relevant experience in those areas. Dr. John Higgins talked about how his mentor "really mentored me in terms of the whole process" of being an academic researcher,

such as “publishing papers, writing grants” and showed him how to budget his research funding (Higgins, interview 10). Dr. James Gallatin had a mentor that helped him discover that he wanted to be an academic researcher when he was a graduate student. His mentor gave him the opportunity to “work on a couple of different projects” and to “take the lead on something and write a review article” (Gallatin, interview 15). Before working with his mentor, Dr. Gallatin was naive about academics. He indicated that his mentor “really gave me a chance to dig into what it meant to have a research career” (Gallatin, interview 15). His mentor “encouraged me to take this path” and helped him “figure out that this really was what I wanted to do” (Gallatin, interview 15).

Dr. Carol Kempner talked about her graduate mentor, who was supportive of her ambition to be an academic researcher. She talked about how he “was amazing” because he encouraged her and pushed her to do better (Kempner, interview 24). When she had laboratory skills that were weak and needed to be improved, “he insisted that I work on it” because it was “in my best interest” to improve those areas (Kempner, interview 24). When she would mess something up, “he didn’t make me feel bad” because of it. Instead he “corrected [those] things” and gave her another opportunity to do it correctly (Kempner, interview 24).

For Dr. Michael Driscoll, a significant figure that helped him as a mentor came in the form of an NIH Program Officer (PO). He explained that he was working on a grant and went to the NIH to meet with the PO to review his grant with him so he could get additional feedback. His PO reviewed his Specific Aims section and told Dr. Driscoll that he did not have any experience in that field; something the PO could tell would prevent him from getting the grant. As a result, his PO suggested that he chose a collaborator because it “would strengthen that part of the grant” (Driscoll, interview 11). Dr. Driscoll mentioned that his “PO went above and

beyond" and gave him a list of potential collaborators, and told him to "contact one of these people [and] say that I told you to contact them." He emailed one of the collaborators, and five minutes later, he received an email response stating "Sure, I'd love to collaborate" (Driscoll, interview 11). During his interview, Dr. Driscoll credited his PO to giving him "the single most important piece of advice" as a mentor: collaborate to overcome perceived weaknesses.

In many cases, participants talked about being assigned a mentoring committee by their department chair, consisting of senior faculty members. Dr. Elona Moran's experience was positive with her mentoring committee. "I learned a lot in those mentoring committee meetings…how to write a grant properly or other things" (Moran, interview 25). On the other hand, Dr. Patricia Crowley has not found mentoring committees to be as useful as they could be. She indicated, "I've learned that you may not get the feedback you need unless you ask those specific questions" (Crowley, interview 1). Dr. Alan Pharr also had limited assistance from his mentoring committee. He stated, "I never had a mentoring committee until maybe my last year of my K award. All the time I didn't have a mentoring committee until the very last year which wasn't helpful" (Pharr, interview 22).

Dr. James Gallatin talked about the help he received from his department chair on the draft of his grant application, who gave him much more assistance than his mentoring committee did.

> And my department chair, who is the busiest [person] in the department, I mean [who] I expected [only] to glance at it. [My chair] went through it line by line and made detailed comments and suggestions, and sat down with me for an hour to talk through all of the things that she thought would, what to change to make it better, right? [This] was by far the most engaged person whom I gave it to, and that's been typical of my interactions…is that [my chair] doesn't do anything halfway and [who's] very committed to helping people, at least the junior people of the department, to succeed. (Gallatin, interview 15).

Other participants noted less support from their department chairs. For example, Dr. Kala Socorro noted this about her previous chair, “the last one was definitely…I don't say it in a bad

Table 8. Summary of Participant Dialog in the Having a Mentor Sub-Theme.

Code	Participant Dialog	Dialog Summary
mentor	“a little brash”	– perception that a forthright relationship with a mentor was important
mentor	“comfortable letting me do what I wanted”	– perception that mentors were dependent on their trainees’ capabilities in the lab
mentor	“never encouraged us to apply”	– perception that some mentors did not support training in grant writing
mentor	“free access to whatever he’d written”	– perception that examples of successful grants were an important learning tool
postdoc	“having outside funding was going to help”	– grant experience as a postdoctoral trainee helped obtain a faculty position
postdoc	“could have gotten better”	– perception that postdoctoral training was inadequate
postdoc	“I got full freedom”	– perception that a supportive mentoring experience was important for career growth
postdoc	“develop my own ideas”	– perception that good mentoring offered the opportunity to develop a research program
mentor	“I’m not surprised you didn’t get it”	– there was a poor mentoring experience in providing training in grant writing
mentor	“go ahead and just try”	– there was little support was offered by a mentor in applying for a grant
mentor	“really mentored me”	– there was a positive mentoring experience in obtaining holistic training
mentor	“in my best interest”	– there was a supportive mentoring experience as a graduate student
NIH	“went above and beyond”	– there was a positive mentoring experience from an NIH Program Officer
mentoring committee	“I learned a lot”	– there was a positive experience from an assigned mentoring committee
mentoring committee	“wasn’t helpful”	– there was a negative experience from an assigned mentoring committee
chair	“went through it line by line”	– there was a supportive department chair in mentoring grant writing skills
chair	“bring in money or you’re out”	– there was an unsupportive department chair in career development
chair	doesn’t “have a lot of confidence”	– perception that department chairs lacked mentoring ability

way…but [he] kind of clamped down, bring money or else you're out" (Socorro, interview 20). Dr. Frederick Kaufman indicated that he doesn't "have a lot of confidence currently as to whether chairs are well-equipped with the information to know how to put young faculty on a path of promotion" (Kaufman, interview 6).

Table 8 provides a summary of the participant dialog and major findings regarding their having a mentor in academics. Many participants described the personal relationships with their mentors that provided support for their career paths. Administrative mentoring, however, received a mixed perception of value from the participants.

4.2.4.2 Being a mentor

Participants talked about how they learned to be mentors from their experiences with mentoring relationships as graduate students and postdoctoral fellows. Dr. Patricia Hewitt noted that her postdoctoral mentor taught her a lot about being a mentor herself because he gave her the opportunity to learn about the other aspects needed to have a research career. She explained that she learned "how to train graduate students" and "how to do a lot of the grant writing" required to support her own lab (Hewitt, interview 3). She recognized that "it was really critical" in transitioning to an Assistant Professor position having her mentor, continue to be "actively engaged" as a resource in supporting all the other aspects of an academic career (Hewitt, interview 3). Throughout Dr. Amanda Crowley's training with various mentors, she learned to take "pieces" from each one and create her own style of mentoring. She learned the importance of having a general laboratory meeting with all her students and then one-on-one sessions with each trainee. In the context of one-on-one interactions, she wanted to know what their career goals were after their postdoctoral training was complete. For her, it was important to know the "career trajectory" of her graduate and postdoctoral trainees so she could "encourage them"

effectively (Crowley, interview 1). For those trainees who expressed an interest in pursuing a career in academics, she would encourage them to write a grant to experience the writing process.

Most participants felt it was important to have their trainees write their own grants and to seek independent funding because it would help them if they pursued a career in academics. These individuals encouraged their trainees to find grants they qualified for and provided them feedback on the grant applications they were drafting. They wanted their trainees to exactly understand what a career in academics meant regarding the effort devoted to grant writing. Even if some trainees did not want to pursue academics, participants felt it was still useful to comprehend the technical aspect of grant writing. For example, Dr. Brian Gordon acknowledged there is a "new economic reality" that most students face now in which "they will have to write grants." For his students, he wanted them to begin by writing a "review article" in "whatever topic [they're] interested in" so that they learn about the field (Gordon, interview 21). He felt it was helpful for postdoctoral trainees to "summarize what's known" and to present "the unanswered questions" of that topic (Gordon, interview 21). He initiated this requirement because he believed a review article would help students refine "their ideas." It would be a publication for them, and the review article could be turned "into a grant" (Gordon, interview 21).

For early-career faculty members, being a mentor to trainees also meant learning alongside them, especially when it came to determining the approach to guide them. Dr. Amanda Crowley acknowledged that she was still learning the best way to mentor her postdoctoral trainees and that "it's a steep learning curve." In the beginning, she was more hands-off with her students and gave them the opportunity to be self-directed, which she

admitted, “probably wasn’t best” (Crowley, interview 1). As a result, she decided to become a more “hands-on” mentor and set up “weekly meetings” with her students to get an update on what project they were working on and how far along they were (Crowley, interview 1). Dr. Crowley encouraged her students to “set aside time every day to write” because she believed no matter what career they pursued after their postdoctoral fellowship, “writing is going to be critical to their career.” She also encouraged her students to reach out to one another and get additional support because “they see each other every week” and “it’s really good for them” to begin forming peer relationships with one another (Crowley, interview 1).

A part of being a mentor meant the ability to recognize that not every trainee would pursue an academic career and to provide opportunities for acquiring career skills that transferred to other settings. Dr. Kathryn Cresson talked about how her experience as a postdoctoral trainee led her to take a different approach in mentoring her trainees. She went to a highly competitive environment for postdoctoral fellowship, where the expectation was to pursue an academic career. She admitted, “Other career paths are things that we did not talk about” in that highly competitive environment because the impression was “that’s not what you’re supposed to do” after completing a postdoctoral fellowship (Cresson, interview 2). As a result, she made sure to support her students who were not interested in an academic career and to give them advice about their next steps. Dr. Cresson used her own experiences to help her trainees avoid the obstacles she faced. She told them that “if you want to go to industry, go immediately after Ph.D., do not do a postdoc” because it would only hold them back in the end. She explained that going into industry “as a new Ph.D., you go in kind of [an] entrance [level] position.” After completing a postdoctoral fellowship, “you’re in limbo” because you have some experience but not enough to qualify for “a more senior position” (Cresson, interview 2).

Honesty with their trainees about future difficulties in academic careers was an important aspect of being a mentor. Participants wanted their trainees to understand the economic reality of being a scientist. For example, Dr. James Gallatin (Participant 15) was very straightforward with his trainees and told them to "be prepared to not necessarily have a career in academics." He explained that it was important to "have at least an idea" of what they may want to do outside of academics because the field continues to become more and more competitive. He was blunt with his trainees, saying that he "got lucky." He indicated, "I got the job, but the competition is fierce." Moreover, "the number of [faculty] jobs is small" even while "the number of postdoctoral trainees is constantly growing" (Gallatin, interview 15). Dr. Gallatin is a tenure-track researcher investigating infectious diseases.

Dr. Brian Gordon likened success as a scientist to success as a musician. He shared his sentiment with his trainees that "most of you are going to fail." To him, it had nothing to do with skill or talent as a scientist, but "because of luck and the economy" (Gordon, interview 21). He acknowledged that unlike the fine arts, there were plenty of opportunities for graduates and postdoctoral trainees to "make a decent living being a staff scientist or a teacher" (Gordon, interview 21).

Participants did not want to shield their trainees from the realities of having an academic career, even if it meant that some of them began considering other options. This situation was the case for Dr. Carol Kempner whose trainees recognized how hard she worked as an academic researcher and how difficult it was to "maintain this style of career" during the current funding climate. In response, some of them did not "want it [a career in academics] because of what they've seen."

Table 9. Summary of Participant Dialog in the Being a Mentor Sub-Theme.

Code	Participant Dialog	Dialog Summary
mentoring	"actively engaged"	– learned how to mentor from previous mentoring experienced
mentoring	"pieces"	– took the best examples of mentoring experience to be a good mentor
mentoring	"encourage them"	– provided grant writing experiences for trainees
writing	"new economic reality"	– perception that grant writing was an essential skill to give trainees
mentoring	"it's a steep learning curve"	– perception that learning how to be a good mentor was difficult
mentoring	"hands-on" mentor	– took a more active role in mentoring trainees was important
career	"that's not what you're supposed to do"	– supported alternative career paths that were previously not considered
career	"be prepared"	– supported trainees to be informed about non-academic careers
career	"most of you are going to fail"	– provided trainees a realistic view of an academic career path
sacrifice	"maintain this style of career"	– showed trainees the sacrifices involved in academics

Table 9 provides a summary of the participant dialog and major findings regarding their being a mentor in academics. Many participants described a learning curve involved in becoming a mentor that was based on their experiences of being mentored. The participants described their efforts to teach grant-writing skills to their trainees and provide them with a realistic perspective of a career in academic research.

4.2.5 Grant writing

Participants talked about their experiences and perceptions about grant writing, including their belief in themselves as writers and the technical aspects of the application process. They discussed the training they received from either mentors or courses that helped them improve their grant writing skills along with other necessary skills required to write successful grants.

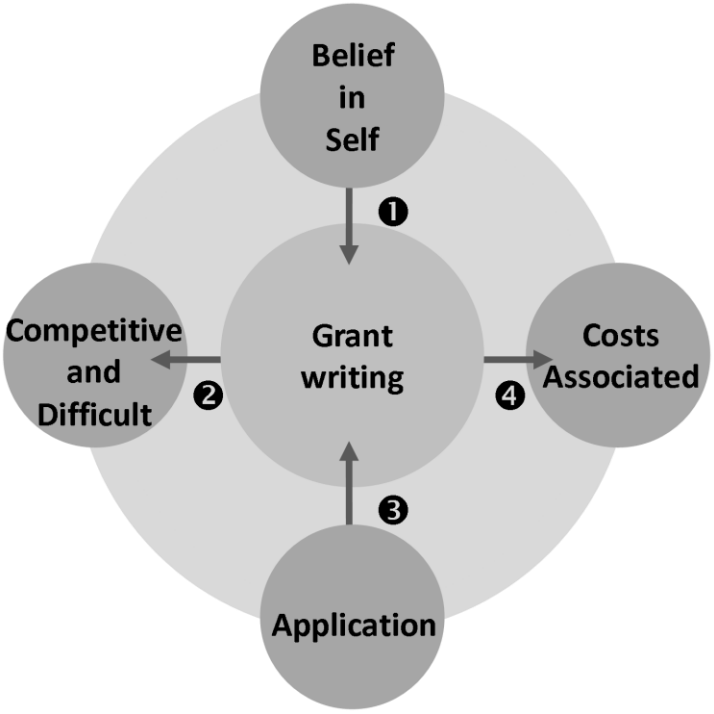

Figure 9. Relationship Between Grant Writing Theme and Sub-Themes.

Included was information about the costs associated with grants, such as indirect and direct costs that grant budgets covered along with start-up funding that participants received from SSU-Central. Every participant honestly talked about how competitive grant writing was and the difficulty associated with obtaining a grant. There were four sub-themes within the theme of grant writing: (1) belief in self as a writer, (2) competitive and difficult nature of obtaining grants, (3) the grant writing application process, and (4) the costs associated and covered by grants. Figure 9 outlines the relationship between the sub-themes and the theme.

4.2.5.1 Belief in self

Three participants mentioned being confident in their writing skills for producing both manuscripts and grants, while others did not openly talk about their abilities as writers. In contrast, Dr. James Gallatin was honest that writing was not a natural skill for him, and even shared that he "would not describe writing as coming naturally to anyone" (Gallatin, interview

15). He explained that he "worked very hard to be a good writer" and spent much time thinking about the mechanics of writing, specifically scientific writing (Gallatin, interview 15). Even though he was not a native English speaker, he continued to practice and hone his writing as a critical skill he needed to be an academic researcher.

Dr. Amanda Crowley exemplified three participants who enjoyed writing papers and grants. She explained that while she now "quite enjoy[s] the writing process," she did not always feel that way. She shared that in the beginning "there were definitely frustrations" with writing grants (Crowley, interview 1). To her, writing grants required "strategic planning of what I should focus my energies on" and singling out a topic that she had enough data with which to make a convincing argument.

For Dr. Kathryn Cresson, becoming a good grant writer was something she attributed to her mentor whom she indicated "is an excellent writer." While she did not find writing to be enjoyable, she admitted that she wrote "fairly quickly." Whether she wrote quickly simply to get the grant writing out of the way, she did not share (Cresson, interview 2). She did acknowledge that writing quickly and being "a good writer" were two "of my strengths" that helped her as an academic researcher.

Another participant who truly enjoyed writing grants shared that "it's my favorite aspect of what we do" as researchers (Kirby, interview 18). Dr. Teresa Kirby realized early on in her career as an academic researcher that "I really enjoy the grant writing" process and found that she was successful in getting funded (Kirby, interview 18). She explained that the gratification was not because of scientific prowess, but because she improved her writing skills as a trainee from all the feedback she received.

Table 10. Summary of Participant Dialog in the Belief in Self Sub-Theme.

Code	Participant Dialog	Dialog Summary
Writing	"worked very hard to be a good writer"	– perception that grant writing was a honed skill
Writing	"strategic planning of what I should focus my energies on"	– perception that despite the difficulties, grant writing was an important tool
Writing	"a good writer"	– perception that grant writing was a skill learned from a mentor
Writing	"I really enjoy grant writing"	– participants attributed career success to having learned writing skills
Writing	"was sick for two weeks after"	– perception that grant writing was a demanding task that took a physical toll

Many participants talked about the personal and professional sacrifices that grant writing demanded of them. For example, Dr. Charles Wilson mentioned the toll that grant writing took on his health. Dr. Wilson is a tenure-track researcher investigating cardiovascular disease.

> Writing the R01, the first draft, that final push I stayed awake for three days straight editing. I think I slept a total of four hours in the three days, and then [I] was sick for two weeks after [laughter]. (Wilson, interview 6).

Dr. Elona Moran also talked about the toll that grant writing took on her health, in which "it's not a mental stress – it's a physical stress…because I had to go without sleep" (Moran, interview 25).

Table 10 provides a summary of the participant dialog and major findings regarding their belief in self in academics. Many participants described their learning experience in grant writing that provided them with a self-assurance in their skills. The participants also discussed the challenges involved in grant writing.

4.2.5.2 Competitive and difficult

Participants talked about how competitive and challenging it was to get grant funding now. Two participants mentioned that their senior colleagues talked about the good times of grant funding in the past, before the funding situation became difficult. When the down turn of funding began a decade ago she remembered that "the younger investigators were very worried,"

but the "older investigators were absolutely not worried [and] were saying 'oh it's just going to pass'" (Cresson, interview 2). Despite the reassurances of the senior investigators, participants saw funding continue to decrease every year, and there was a collective realization "that it's not cycling back as they expected it" (Cresson, interview 2).

Participants faced a new economic reality in which the amount of money funded stayed the same, but the number of grant applications continued to increase every year. For example, Dr. Kathryn Cresson noted the pool of funding was "steadily [going] down" and that "it's more and more difficult to get a grant." She explained how it was common for grant agencies to go through cycles of reduced and increased funding availability, but that this downturn seems permanent. Dr. Sealy also acknowledged a part of the issue regarding the grant-funding situation was that there was not enough money "available for the number of investigators submitting applications."

Participants shared how decreased funding meant a change in the infrastructure of universities because it "is becoming very, very, very, very difficult" to get any funding (Bremond, interview 4). Dr. Alan Pharr recognized that universities "leveraged [themselves] on assuming that revenue stream would always be there" to provide for institutional costs, and now that money is harder to come by universities need to reconsider their approach to funding (Pharr, interview 22). Dr. John Higgins believed universities took advantage of the money in good times and created a model where "faculty are completely dependent on getting grants" for their salary. As a result, there was an increased sense of dependency on the NIH for money, despite his belief that NIH was "a broken system to run the universities based on money from the government" where the government dictates and regulates research (Higgins, interview 10).

Grant writing has become a highly competitive environment that required faculty members to be resilient and determined. Dr. Daniel Goodrich felt being resilient and determined was an important skill to have as an academic researcher submitting grants. He explained that grant writing was difficult because of the "intellectual energy that you have to burn" to "organize" and create a "cogent, logical story" that will "convince someone that you're correct" (Goodrich, interview 4). The skill of communicating on paper and making a convincing argument "based on facts that are in the evidence" was utilized in a variety of fields, including law (Goodrich, interview 4). Dr. Goodrich talked about grant writing as not only "baring your soul on a piece of paper" but also laying your heart, ego, and mind out "for some faceless bureaucrat." He acknowledged the process of putting himself out there as an academic researcher and having another person assess the "value of yourself as a human being and the value of your work" was to be in a vulnerable position. This situation was stressful because "the value of your life becomes dependent on what some pinhead thinks of your hypothesis" (Goodrich, interview 4).

Dr. Goodrich shared how a negative review "can destroy [some] people." He also noticed a difference between the people who succeed and the ones who give up. He indicated those who succeed say "I made this mistake, they called me on it, and I'm going to fix it" instead of saying "Oh my gosh, they're right. I'm stupid" (Goodrich, interview 4). He mentioned there was a different personality for the person who could "get back on the horse" and decide, "It may not be perfect, but it's the best we got" (Goodrich, interview 4). To him, succeeding as an academic researcher meant having that "kind of resilience" and "determination where they've laid it all out there" (Goodrich, interview 4). He felt those individuals with resilient and

determined characteristics demonstrated a level of maturity and depth that does not "fear failure" or "fear rejection" (Goodrich, interview 4).

For Dr. Matthew Sealy, hiring a life coach was an important approach to regain his self-belief after struggling with his lack of success in grant writing.

> It's definitely given me perspective and a better outlook on life and knowing that it's given me more self-worth, in a sense. And given me the power to know that if I need and want to make a change, then it's okay. Because I'm at the point where, in my head, even if in the best-case scenario in my current position, I get another R01, is that what I want to do? I mean, I probably would keep that job, but I'm fine with the reality of what happens. And it's allowed me the opportunity to explore opportunities that I was not able in the past to take advantage of, potentially. (Sealy, interview 14).

He admitted that it has been hard just getting to the point of accepting that he may not have an academic career in the future. Through the life coach process, he has found peace of mind and talked about keeping an open mind about the future, "whether I want to start another company, or join a nonprofit, or become a scientist in industry" (Sealy, interview 14).

Dr. Teresa Kirby talked about the extreme level of scrutiny that grants received in the review process, because of the highly competitive environment. She also shared how important the finer details were to grant writing; grants have been "tossed out…because your bibliography wasn't formatted correctly" to help differentiate between the many worthy grant applications (Kirby, interview 18). To Dr. Kirby, it was very much the "Goldilocks Principle" in which she could not have too much or too little data in support of a project. She indicated, "You really have to have just the right preliminary data" and "pitch it just the right way." She mentioned there were grant mechanisms that were only funding the top seven percent of grant applications, so "it gets to the point where people are looking at formatting to decide which grant gets funded" (Kirby, interview 18). Another participant felt similar frustration in generating data for grants

but “you can't publish the preliminary data because then you can't put it in the grant because it's no longer preliminary” (Pharr, interview 22).

Perceptions about the difficulty in obtaining a grant could affect future funding success. This relationship was a point brought up by two participants, who acknowledged that if they were turned down multiple times they would not be enthusiastic about grant writing again. Dr. Kathryn Cresson realized that “if I had applied 15 times and not gotten a grant,” she would think, “it’s just luck” that determines whether someone gets a grant or not. She continued, “I don't think it has necessarily to do with the ability of that researcher.”

Dr. Joseph Niederwald shared a saying from his home country that “your view depends on where you sit” and if an academic researcher gets grants, “you think everything is working.” Dr. Niederwald was currently grant-funded. He recognized that this was a reason he believes “the NIH system is fair” and that “90% of the grants of the grants are given to the people who deserve them” rather than luck (Niederwald, interview 13). Dr. Brian Gordon, however, attributed some degree of success in obtaining grants to an element of luck. He noted, “There’s all this evidence that to some extent the grant score that you get is based on luck, [depending on] the person who reviews the grant.” Dr. Gordon proposed changing his grant submission strategy to account for the element of luck. He suggested, “I'm seeming [*sic*] to advocate the scattershot approach where it's based on luck, so if it's based on luck, you should be applying as much as possible.” Dr. Joseph Niederwald also confessed, “A certain amount of luck into that [the review process] because it depends on…who reads your grant” (Niederwald, interview 13). On the other hand, Dr. Daniel Goodrich (Participant 4) believed that “you make your own luck” when it comes to grant submissions. Dr. Gordon conceded that he was not entirely convinced in a component of luck. He went on to explain that “if it turns out that [my] hypothesis is

wrong…and if there is a measurable skill involved, then you would argue that number of applications is not the relevant metric, it's the quality of the application that matters" (Gordon, interview 21).

Eleven participants described a new approach that is available for early-career faculty in which funding priority is given to new investigators, defined as those who have never had an R01 grant in the role of Principal Investigator. Additional leeway in grant review scoring is provided by the NIH for preliminary data available from early-career investigators, defined as those within ten years of their terminal degree. Dr. Daniel Goodrich believed these extra breaks are "absolutely the right thing to do" (Goodrich, interview 4). However, these advantages are transient, as noted by Dr. Carol Kempner, who said she was "not in early stage any longer" (Kempner, interview 24). Dr. James Gallatin lamented, "Once you are no longer available for the new investigator funding" you cannot compete with "somebody who's been working in the field for 25 years and publishes major papers every week" (Gallatin, interview 15).

Many participants were supportive of the Dean and his agenda to increase the number of NIH-funded faculty on campus, which Dr. Roger Bedias (Participant 5) acknowledged. "I think the last couple of years, that…[SSU-Central]…has become more demanding. They're expecting that every faculty should have a grant…and I understand that is needed for the health of the University" (Bedias, interview 5). Dr. Jeff Wharton (Participant 9), a non-tenure-track researcher investigating infectious diseases, also recognized the importance of bringing in grant revenues for the economic well-being of the institution.

> Well, my life is a business. [SSU-Central] needs to grow, faculty numbers need to grow, and departments need to grow. This is how they're being measured in terms of how successful they are. If they don't grow, if they don't recruit, if they don't get money in, then they are not successful. And this is the same for me. It's on every level. The Dean is measured on how well his University performs in terms of recruiting money. (Wharton, interview 9).

Table 11. Summary of Participant Dialog in the Competitive and Difficult Sub-Theme.

Code	Participant Dialog	Dialog Summary
competition	"it's more and more difficult"	– perception that decreased funding levels have increased competition
cycle	"oh it's just going to pass"	– expected cyclical nature of funding has not been realized
funding	"that revenue stream would always be there"	– institutions have leveraged their growth based on research funding
salary	"faculty are completely dependent on getting grants"	– institutional growth fueled through soft money faculty positions
broken	"a broken system"	– institutions dependent on NIH funding
story	"intellectual energy that you have to burn"	– putting together a persuasive story for grant reviewers was difficult
review	"baring your soul on a piece of paper"	– there was difficulty with the critical review process
review	"I'm going to fix it"	– resilience in responding to criticisms was necessary to be successful
perspective	"It's definitely given me perspective"	– it was important to maintain a healthy life perspective in the grant writing process
pitch	"pitch it just the right way"	– a strategic approach was needed to obtain grant funding with attention to detail
luck	"it's just luck"	– perception that an element of luck is involved in successful grants
luck	"you make your own luck"	– perception that learned skill is an important element in successful grants
funding	"absolutely the right thing to do"	– there was support for the NIH to provide priority funding to early-career investigators
revenue	"needed for the health of the University"	– perception that additional grant revenues is necessary for the institution to function
dean	"he's a good leader"	– support for the dean's policy on increasing grant revenues to the institution

Despite the concerns about needing to get more grants funded, most of the faculty were supportive of the Dean. Dr. Charles Wilson felt "inspired" by the Dean, and felt that "he's a good leader". Regarding the Dean's goal to increase the amount of NIH grant revenues to SSU-Central, one participant thought, "He has a good vision" (Wharton, interview 9). Another

participant joked, “I like the Dean. The Dean is good, and that's not because you're recording [me]” (Niederwald, interview 13).

Table 11 provides a summary of the participant dialog and major findings regarding their difficult and competitive experiences in grant writing. Many participants described their difficulties involved in grant writing, and the need for resilience to continue the process. Elements of luck were perceived as necessary to be successful.

4.2.5.3 Application of grant writing

Participants spoke about learning the grant writing application process, such as figuring out what was required and learning ‘the game’ of grant writing. Grant writing was not a process in which it was made explicitly clear what was necessary for each grant. As a result, many participants had to figure out the proper formula to write a successful grant. To Dr. James Gallatin, it was necessary “to have a library of successful examples of whatever grant you’re writing” because those examples could help the grant writer understand what made a successful grant successful. He believed that going into the grant writing process “blind seems foolish.” Instead, he reached out and talked “to people who have succeeded” (Gallatin, interview 15). Despite extolling the benefits to reaching out for successful examples and talking to successful grant writers, he admitted there were limits as well. For example, he wanted to apply for a specific grant and knew two people who received the funding mechanism. Dr. Gallatin reached out to both those individuals to get copies of their grants so he could have a couple of examples of successful submissions. He shared how “wildly different” the grants were “from each other” (Wharton, interview 15). Another participant noted frustration in the grant review process, which he found unhelpful.

> I write a grant; I don't think about it for five months, I get the reviews back. Half the time the reviews don't make too much sense. Sometimes I wonder if they even read the

> grant. They're like, 'You need to do this.' And…then I went to my chair, and I'm like, 'They said I need to do that.' And he goes, 'Well, did you?' I'm like, 'I counted five times in the grant that I said this stuff.' And I know that it's not an entirely anyone's fault because everyone's stressed. The system is overworked [and] there's not a lot of money. (Pharr, interview 22).

For one participant, being a grant writer meant having to be flexible in order to get funding for her research. Dr. Amanda Crowley submitted a grant for a project she wanted to continue to explore. The proposed project looked at one set of experiments but rejected because the reviewers focused their criticism based on a specific pattern she identified in the experiments. She admitted that she modified her research to match "what the reviewers want to see" because that was going to give her a better chance to obtain the grant funding she needed (Crowley, interview 1). As a result, she asked the help of a colleague and resubmitted her grant that used the new collaborative relationship. Even though she did not receive the grant, Dr. Crowley was scored well and was given feedback that "was very positive and consistent" (Crowley, interview 1). As a result, she was going to address the reviewers' feedback and resubmit the grant. Dr. Crowley talked about how her current project "wasn't what I was originally going for…it has taken me in [a] different direction," but the project "fits my overall research."

Some of the participants talked about shifting their research programs from what was most interesting to emphasize what they perceived was most fundable by grant agencies. Dr. John Higgins noted, "Everybody is driven to a grantable project rather than, hey, let's do this project and really figure it out." Dr. Kala Socorro also lamented about leaving her long-standing research projects behind. "I've had to work to change my field and go to something else so that I can have a selling point; I can have something that I can actually sell to the viewers. To me, that has been my biggest challenge, having to navigate through this" (Socorro, interview 20). Other participants talked about having to "sell" their research ideas to reviewers. "I always tell my

students again, ‘You are scientists, but at the same time you are a business person too.’ You're pretty much marketing your research” (Yoakum, interview 17). Dr. Yoakum, a tenure-track researcher investigating cellular injury and repair, noted, “When I first started my K [award] and got this position, my research questions were driving the grant funding. But now I have grants and it’s the opposite.” Dr. Elona Moran went further to explain her feelings about shifting her research to what she perceived was fundable.

> So what is ending up happening is I'm actually doing my research based on the kind of funding that will be provided. So that's total scientific prostitution…it's totally backward, and I don't know if once I get sucked up into this cycle, will I be able to ever come out. (Moran, interview 25).

Some of the participants spoke about the resources available to them to make sure grants were successful; other participants talked about the process of grant submissions during their interviews. For example, two participants described a faculty success center on campus that some faculty members utilized to have their grants proofed and preliminarily scored by their senior faculty colleagues. This center was the primary resource that participants talked about during the time of their interviews. One participant noted that this center provides “statistical help [and] grant writing help” (Kaufman, interview 8). Another participant talked about the networking benefits of the center: “it's been helpful to connect me with other people that have similar interests” (Crowley, interview 1). Dr. Gloria Yoakum, noted additional resources available at the center.

> You also have [a] stress management type of resource for junior faculty who are dealing with grant funding, or maybe family issues, like I have two kids for example. I really [obtain] great help from [the] time management people that tell me how to keep going in a school of medicine type of job with two kids and write grants, and so some helpful time management strategies are taught in that center. (Yoakum, interview 17).

Despite widespread advertisement of its availability, many participants remained unaware of the

center's existence. One participant exclaimed "At the beginning, nobody helped. I asked people to read my grant. Nobody is willing…" (Huan, interview 7).

While two participants noted that they often finished writing grants close to the deadline, three other participants noted the assistance of the faculty success center in completing the text of a grant. For example, Dr. Ken Zang explained how a "small committee" reads the draft of the grant application and "make[s] a lot of suggestions" about the draft (Zang, interview 12). Dr. Teresa Kirby shared this was to "catch any mistakes" and to "put a package together that will get funded" during the first submission (Kirby, interview 18). She talked about how this was "a very different approach than the way most investigators used" to proceed with their grant submissions (Kirby, interview 18). This two-step process focused on improving the ratio of grants submitted to grants funded, because "they want to increase the success rate" to grant submissions (Nash, interview 23). Dr. Brian Gordon, however, was unconvinced about how much the success center helped regarding grant funding success. "The problem is…my experience with that is that they do not track outcomes to know if those interventions are effective" (Gordon, interview 21).

Participants mentioned other resources that helped them learn about the grant writing process and what skills they needed to have successful grant submissions. Dr. Amanda Crowley shared that SSU-Central offered "little workshops" on grant writing for faculty members. She talked about a grant-writing course she attended that was available to faculty members; it was not clear whether it was available through the school or not. Dr. Crowley described some of the lessons she learned about grant writing, with the most important being to get "in the minds of the reviewer" (Crowley, interview 1). She recognized how important that lesson was to her because previously she would have other faculty members review her grant. She explained the faculty members were "too close to the content…they already know that it's an important question." In

contrast, her reviewers did not have extensive knowledge in that field, so their awareness was "does this get me motivated to want to learn more" about this project (Crowley, interview 1). If not, "you're dead in the water," she indicated. However, if the project tells a convincing story to the reviewers that makes them want to learn more, then it will be funded. Dr. Crowley learned to "take a step back from the details" because "reviewers don't get it [the details]" and "you [end up] losing the forest for the trees." To her, the skill of "writing for people that are in your field but not so closely related to your content area" was an important lesson she learned from taking the grant-writing course.

Only a couple of participant with foreign backgrounds acknowledge their writing difficulties in English, as exemplified by Dr. Jeff Wharton.

> So for me, being a foreigner that was the realization I had for a long time, but the practical skills to succeed, that took me quite some effort to get there. I mean, face it: I was a little disadvantaged regarding writing in English, which is not my first language, and I'm still learning every day. And so you have to find a way how to overcome that disadvantage. (Wharton, interview 9).

In writing his grants, Dr. Wharton indicated that the "English language is very precise. You have [to use] one particular word if you want to express something [specific]. And that is a challenge."

For Dr. Goodrich, the skill of grant writing was "understanding that there's a bit of gamesmanship that happens" and how "you can work the system to your advantage if you know what you're doing" (Goodrich, interview 4). He indicated that being an academic researcher was not "just answer[ing] the question that I'm interested in personally." Instead, being an academic researcher meant asking a scientific question "tied to an integrated scientific program wherein grant funding is a major component" (Goodrich, interview 4). The endpoint of research for Dr. Goodrich was not "just to understand the answer to a biological question," but rather "to be able

to convince other people that this issue is important." He had "to be selective" in what he researched because the "goal is simply not to answer a question," but answer it in a way "that it has to perpetuate itself" into other important research topics (Goodrich, interview 4). He admitted conducting research this way was "a means to an end" and the "end always has to be funding" (Goodrich, interview 4).

Dr. Elona Moran expressed a similar sentiment in what she called "the game," of grant writing. She talked about her experience with "the game" and reiterated how the rules to "the game" were not written down anywhere; they were information passed on from senior to junior researcher (Moran, interview 25). At the time of the interview, she shared an experience of meeting with her mentors about submitting a grant. She gave copies of her grant to them, and

Table 12. Summary of Participant Dialog in Application Sub-Theme.

Code	Key Participant Dialog	Dialog Summary
game	"the game" of grant writing	– perception that understanding the process of grant writing was important
reviewer	"wildly different"	– perception that grant reviewers had different opinions about the grant quality
reviewer	"Sometimes I wonder if they even read the grant"	– perception that grant reviewers did not adequately evaluate a grant
reviewer	"what the reviewers want to see"	– perception that research must be tailored to the reviewer expectations
fundable	"everybody is driven to a grantable project"	– perception that research was driven by topics that might be fundable
success center	"it's been helpful"	– perceptions of the benefits from using an institutional success center
resource	"nobody is willing to read	– disparity in perception of grant writing resources available
outcome	"they do not track outcomes"	– perception that the institutional success center has not proven to be beneficial
game	"understanding that there's a bit of gamesmanship"	– perception that the approach to grant writing is different than academic writing
game	"the game"	– perception that there are unwritten rules to be competitive in grant writing

they asked her about her CV, specifically about her publications as a “middle-author” writer (Moran, interview 25). She explained that beforehand she had not paid attention to those papers because “those are not my papers.” However, her mentors told her, “Don’t underestimate them” (Moran, interview 25). When she began looking at successful examples of the grant she was seeking, she reported, “They have thousands of middle-authored papers” (Moran, interview 25). She believed one of her colleagues did not have a recent publication from his own lab but received the grant because of his middle-authorship numbers. That made her realize how “the game” was actually “the game of how to be mediocre” (Moran, interview 25). Dr Moran also mentioned an aspect of peer criticism she experienced in failing to obtaining grants.

> Even though I try not to think about it, there's a lot of peer pressure for sure. You see your colleagues getting grants and moving on, and if you did not get one, you are going to go backwards, and there's no in-between here. (Moran, interview 23).

Table 12 provides a summary of the participant dialog and major findings regarding the application process of grant writing. In particular, the participants described the strategies they used to enhance their success in grant funding.

4.2.5.4 Costs associated with grants

There were costs related to grants, including indirect costs and unanticipated direct costs that were addressed by some of the participants. In addition, the start-up funds that participants received after signing on as a faculty member were addressed. For example, the indirect costs that grants covered include costs the keep the building running, such as “keeping the lights running, the plumbing, and all that stuff” that universities would otherwise pay on their own (Goodrich, interview 4). Dr. Amanda Crowley, explained that even though she was told to not “think too carefully or too much about the indirect costs” to keep in mind that if “you're not

[bringing in] the indirect costs [along with your grant], it's not really helping the institution" cover the research infrastructure costs (Crowley, interview 1).

Two participants expressed their frustration with the current funding mechanism regarding indirect costs. Dr. Alan Pharr brought up the point that even though SSU-Central owned the building, he was still subject to paying the equivalent of rent for his lab space from the indirect cost portion of his grant funding. These costs left him frustrated with SSU-Central because the costs covered by the grant was another "way to squeeze a little bit more money from the NIH grants" (Pharr, interview 22). He indicated other unforeseen costs as well. "And my startup package is not being drained by my research; it is being drained by my salary in particular. Or the 50% of my salary [I contribute]. And I have students that I pay from that as well" (Pharr, interview 22).

Dr. Mandar Nash expressed a similar sentiment that the "University infrastructure [does] not give us anything for free." He detailed how he had to "pay extra" for his phone line, for his internet connection, for his freezer's alarm system connection, and for the installation cost associated with a new biosafety hood in his lab. He explained that when he was given his lab space, he was not even given any furniture or computers. Instead, he had to budget his start-up to buy the items he needed. Dr. Brian Gordon talked about how having departmental space was dependent on bringing in grant money.

> I got a grant, which meant that we were publishing enough, we got this grant, and now I can hire more people, I can expand. So, my chair was like, 'Great. You're an investment that's paying off. I want to give you more space. You can hire more people and do better work.' But in contrast, you meet people that are not bringing grant money; they're not being productive. The chair is like, 'Okay, I'm taking away your space. Let's give this to someone else in the department.' So, the most important thing is can I do is the science that I need [in order] to publish papers and get grants. (Gordon, interview 21).

Grants covered a variety of costs for an academic researcher, such as a percentage of their salary and provided funding to pay for the salaries and benefits of their graduate and postdoctoral trainees as well. These two costs took most of the amount that was covered by grants because the participants had to pay a significant percentage of their salary through grant funding (Kirby, interview 18). Dr. Mandar Nash indicated that "if they expect you to cover 70% of your salary, you cannot have [only] one R01" (Nash, interview 23). In addition, since there was a set salary cost that each postdoctoral trainee was entitled to earn from SSU-Central, the fringe benefit rate (covering health insurance and other benefits) was another additional expense that participants had to account for and pay for from their grant funds.

Beyond salaries as a major drain on grant funds, there were also "reagents and equipment" costs to run the laboratory, depending on what the researcher was investigating (Goodrich, interview 4). For those participants who had animal colonies, grant funds that went towards animal housing and care was another major drain on their budgets. If academic researchers needed to run a particular experiment, they might reach out to other departments to use core facilities or equipment. In this case, they would also need to pay user fees from their grant funds. These expenses were why participants felt compelled to propose as large a grant budget as possible; otherwise, the funding would barely go toward salary support. Dr. Mandar Nash complained that a single grant is not adequate to run a laboratory successfully anymore.

> You cannot. So that means you have to have more than one [grant]. It doesn't have to have to be two R01s, but you have to have at least one R01 and one Foundation grant or something, or at least some [percent] effort on someone else's grant. (Nash, interview 23).

Faculty members recruited externally had a better opportunity to establish their labs because of the start-up funds they received from their departments. Two participants reported that they were not provided any start-up funds because they were recruited internally. In

addition, only two participants mentioned they still had start-up funds remaining from their initial recruitment packages. Dr. John Higgins, noted his department's chair wanted to "treat insiders the same as outsiders" and mentioned there was a difference regarding packages offered to externally recruited faculty compared to internally recruited faculty (Higgins, interview 10). For participants who were provided start-up funds when they were hired, those funds were used to establish their lab. Start-up funds (separate from any grant funding they currently had) helped them buy equipment, furniture, computers, supplies and reagents, and animals to set up their laboratories.

Most participants who received start-up funds were quite pleased with the deals they obtained. Dr. Amanda Hewett reflected this sentiment when she noted the following: "I got a very nice package, so I was very pleased with everything. I didn't have any concerns, and most importantly, everything that they told me that they were going to give me, they did" (Hewett, interview 3). However, Dr. James Gallatin indicated that his start-up was partially incentivized to his grant writing progress: "So, chunks of it were sequestered until I achieved certain milestones" (Gallatin, interview 15). Dr. Michael Driscoll (Participant 11) was recruited to SSU-Central with his own grant funding, through a new investigator (K99/R00) transition award. He realized that having this grant in place gave him considerable advantage in negotiating his initial contract. In worrying about adequate resources to start a lab, he recalled being told by his potential chair, "Don't worry about that. You have your R00. We'll give you a generous start-up. You'll be able to do whatever you want to do." However, he also noted that his performance expectations were never clearly defined.

> I recall there was never a definitive [statement] where you have to get an R01 in order to get tenure, or you have to get two R01s in order to get tenure. There were never clear[ly] laid out guidelines that were explicit. Something at some point in the offer letter…[to say]…'Your tenure date clock starts at this time, and your evaluation for tenure will be

> based on your ability to maintain a productive research [program] as measured by that. (Driscoll, interview 11).

Dr. Driscoll said that he had several competing offers, but the start-up and lab space available at SSU-Central were deciding factors "once I laid it all out on a spreadsheet." He also felt that the ten-year tenure clock at SSU-Central was an advantage over other institutions using more traditional seven-year tenure clocks under which "you'd have felt some pressure there" (Driscoll, interview 11). Dr. Brian Gordon also mentioned the reputation that drew him to SSU-Central, one that he hoped would make him more competitive. "So, [SSU-Central] has provided an environment where I can come up with a good idea, a good intellectual environment, and then I have the resources to do the work" (Gordon, interview 21).

Table 13 provides a summary of the participant dialog and major findings regarding the costs associated with grant writing and academic research. In particular, the participants

Table 13. Summary of Participant Dialog in the Costs Associated Sub-Theme

Code	Participant Dialog	Dialog Summary
indirect cost	"keeping the lights running"	– there was realization that indirect costs funded through grants was necessary
institutional cost	"squeeze a little bit more money"	– there was a perception that many institutional costs were passed on to individual researchers
space	"You're an investment that's paying off"	– laboratory space was dependent on maintaining grant revenues
salary support	"you have to have more than one"	– the costs associated with faculty and staff salaries could not be supported by one grant
start-up	"treat insiders like outsiders"	– there was a perception that internal recruits did not receive adequate start-up funding
start-up	"I got a very nice package"	– start-up funding was provided to external recruits to set up their research programs
recruitment	"We'll give you a generous start-up"	– there was a perception that having a grant increased the competitiveness of recruits
expectation	"there was never a definitive [statement]'	– there was a perception that tenure expectations were inadequately described
tenure	"laid it out on a spreadsheet"	– there was a perception that a longer tenure clock was an advantage for faculty

described the costs related to maintaining salary support on grants, and the expectation to cover many institutional costs.

4.2.6 Discrepant cases

Discrepant cases were included in the presentation of the results that showed the variation between participants' thoughts, feelings, perceptions, and experiences as early-career faculty members. To maintain clarity and avoid redundancy, the presentation of the results utilized meaningful excerpts from participants and omitted repetitious excerpts. There were no discrepant cases omitted from the study aside from those repetitious excerpts that did not exemplify new or meaningful content.

Two participants could be considered outliers among the other participants in the study. Specifically, one participant had stopped writing grants and was planning to transition to a start-up company that the head of his research group was founding. He expressed no regrets or anxiety with his decision, and in fact, seemed to be looking forward to the move by his tone and demeanor during the interview. The youngest individual to be interviewed also had the least experience at the level of Assistant Professor with only two years at SSU-Central. However, she had identified many of the resources from SSU-Central available to junior faculty, of which many of her more senior colleagues were unaware.

4.3 Conclusions

Participants talked about three important topics during their interviews: (a) their personal and professional experiences as early-career faculty members, (b) their experiences with mentors and being mentors to their trainees, and (c) their perceptions of grant writing. All three themes provided support to answer the three research questions; the first research question was answered primarily by the first theme of Personal and Professional Experiences. Participants reflected on

their backgrounds and motivations that proved useful or were obstacles in the process of seeking grant funding.

The second research question was addressed when participants described their perceptions of productivity with grants relative to the ratio of grants submitted to grants funded. They also talked about resources in place to help faculty members write grants and increase the success rate of grant submissions. Participants spoke about the hard line SSU-Central had for obtaining grant funding, and a couple of participants recognized the need to make other plans if they could not obtain grant funding. The University made resources available to participants to increase the success of their grants. However, SSU-Central did not uniformly provide start-up funding to non-tenured faculty members. The third research question was answered as summarized by participants who recognized the reality of their situation and tried to prepare themselves for other opportunities while working hard to collect preliminary data for grant submissions.

CHAPTER 5

DISCUSSION, RECOMMENDATIONS, AND CONCLUSIONS

5.1 Introduction

In this study, 25 early-career faculty members at SSU-Central were interviewed over a four-month period about their grant writing experiences. All of these interviews were conducted on-site at SSU-Central in the offices of the participants, except for one interview that was conducted via Skype video call. During the study, it became apparent that saturation was reached because no new themes were emerging from the interview questions. Nonetheless, the number of interviews continued to the target goal of 25 participants; this approach added to the richness of the study, with multiple examples available to support each of the sub-themes. In this chapter, the findings of the study are summarized and discussed from the perspective of theoretical frameworks and the current literature, with recommendations provided for future research.

5.2 Summary of the Findings

From a data analysis of the interviews, three major themes emerged. The first theme encompassed the personal and professional experiences that brought these individuals together as a representative cohort of early-career faculty members. The second theme focused on how mentoring brought them to their present circumstance, and how they incorporated mentoring of their trainees. The third theme was grant writing as a compilation of their experiences to identify meaningful perceptions.

Within the theme of personal and professional experiences, the participants described their backgrounds that brought them to a scientific career. From the interview data, there was no common entry point into science, as some of the participants described an intentional career path while others found their way into a scientific career accidentally. Many participants described their recruitment to SSU-Central through networking or personal connections. Other participants described their entry into SSU-Central as trainees, which reflects the large number (13/25) of internal recruits to the position of Assistant Professor. More internal recruits (five) were non-tenure-track than were external recruits (two). Concerning these non-tenure-track faculty members, the work of Zhang and Ehrenberg (2010) described in the literature review showed that these recruits could negatively affect the level of funding from extramural grants. Peterson et al. (2012) supported the competitive disadvantage of non-tenure-track faculty. It would be useful in future studies to track the funding success of tenure-track versus non-tenure-track faculty at SSU-Central.

Once at SSU-Central, the participants discovered the realities of the academic career. In particular, many participants talked about the personal sacrifices involved. Some of the participants described the grant-writing experience they had as trainees, which helped them later as faculty members. They also were indoctrinated into the business aspect of the job, including the need to maintain grant funding for their laboratories and their own salaries. The findings of the participants in this study are supported by the literature review by the work of Gonzales et al. (2014), which examined the effect of institutional pressure on faculty members at a striving University. These performance pressures were correlated with negative faculty experiences in a highly competitive environment, including a lack of space to think through their work, less time for academic pursuits other than research and grant writing, and a heightened sense of

institutional surveillance. The participants also discovered the instabilities associated with the academic career, which drove many to consider alternative career paths. Nonetheless, there was a strong consensus among participants that related their passion for science and performing research. A study by Bucklin et al. (2014) in the literature review showed similar instability at another academic medical center, which led to dissatisfaction among those newly hired faculty who were considering leaving. Reasons for considering leaving correlated with inadequate salary support, dissatisfaction with the institution as a workplace, lack of outside funding, unsatisfactory pace of career advancement, and lack of feedback from department leadership.

Within the theme of mentoring, the participants described their experiences of being mentored for a scientific career and subsequently, mentoring their own trainees. It is interesting to note that the theme of mentoring emerged de novo during the interview process since there were no questions in the interview instrument that covered this topic. Many participants made a point of relating the positive impact that a personal mentor had on their careers. These participants were deeply grateful to their mentors who often showed them the ropes about their careers. Some mentors gave the participants their first opportunities to write grants, which seemed to translate to greater self-confidence later on. Other participants related that they had the freedom to operate and expand professionally under their mentors' direction. There was also the feeling from many participants that their mentors helped their careers by providing useful scientific ideas. However, a favorable mentoring relationship was not universal, with some of the participants expressing conflict with their supervisors. Nonetheless, participants spoke of a strong respect for their mentors, and a continued personal relationship that was helpful later on in their careers at SSU-Central. Interestingly, mentoring committees assigned to early-career faculty received mixed reviews; some found these committees helpful and others found them to

be no help at all. Many participants related experiences in mentoring their own trainees after transitioning to their positions as faculty members at SSU-Central. Most felt it was important to pass on their professional knowledge to their trainees. In particular, they related frank and open discussions about a career path in academics. Most participants talked about supporting their trainees if they were considering alternative career paths.

Within the theme of grant writing, the participants described their experiences in learning and applying the grant writing process. They also realized the personal and professional costs associated with applying for and obtaining grants. Of the participants who viewed themselves as successful in obtaining grants, there was also a belief in their skills in writing grants. Nearly all of the participants spoke about how difficult grant writing is and how competitive it is to obtain grant funding. Others spoke about an element of luck involved in obtaining grants. In support of this proposition, a recent study by Graves et al. (2011) showed a majority of grants funded by the National Health and Medical Research Council (NHMRC) of Australia could have missed funding based on random scoring variability.

The literature review supports the possibility of bias in NIH grant reviews affecting outcomes, from the studies of Lee et al. (2013) and Wessely (2007). There was a consensus among participants that the current system is untenable, yet there was also an acceptance that the academic enterprise is embedded in perpetuating grant funding for research. The academic culture studied by Hardré and Cox (2009) in the literature review supports this notion, in which research activities received priority over other academic activities such as teaching and service in faculty evaluations.

Experience with the grant submission and review process came with the acknowledgment by some of the participants that resilience and determination are necessary components. In

particular, participants related that a thick skin is required from the review process. Many of the participants delved deeper to describe the costs involved in grants and grant writing. For example, participants spoke about the stress that grant writing had on their personal relationships. Participants talked about how running a laboratory came with many hidden costs that were associated with the University operation. Several participants were aware of the institutional pressure to obtain more grants. Nonetheless, there was general support for the Dean.

Based on the participant interviews, tenure was a secondary goal for most faculty in seeking grant funding, with the immediate need for grants to provide support for laboratory expenses and salaries for research personnel. Nonetheless, several participants spoke about being concerned with the potential of receiving or having already received a letter of employment contract non-renewal. As described by Burton & Corrice (2011), SSU-Central is an example of many institutions that have extended the tenure clock to beyond the traditional seven years. Participants described the ten-year clock as an advantage, in providing more time to obtain grant funding.

In summary, all three themes presented in the results described above provided support of the initial three research questions. The participants described the relevance of their backgrounds in the context of seeking grant funding for their research. They described in candid detail how their grant-seeking experiences affected them professionally and personally. Finally, they reflected on the reality of their situations and placed their future careers into this perspective.

5.3 Discussion – Linking the Results to the Theoretical Frameworks

Three theories were used to understand the results; each provided a unique perspective through which to interpret the data. Self-Determination Theory was useful in analyzing the participants' perceptions of themselves in the context of their work-related responsibilities. Academic Capitalism was useful to analyze the participants' perceptions of the institutional structures related to University and NIH granting agency. Bourdieu's Theory of Practice was useful in analyzing the participants' perceptions of the interrelationships between themselves and those in the hierarchy of resource allocation.

5.3.1 Framework 1 – Self-Determination Theory

Self-Determination Theory provided a structure for evaluating faculty motivation in grant writing based on the participants' intrinsic perceptions of autonomy, competence, and relatedness as well as their extrinsic perceptions of causality. Although relatively few, some of the participants did provide specific examples that were consistent with intrinsic motivation associated with autonomy, competence, and relatedness. According to Self-Determination Theory, autonomy describes the actions of an individual from of their own volition. For example, the ability to run an independent laboratory was a strong motivating factor for several participants to continue a scientific career in academics. There was also expressed a love of the scientific discipline and the pure pursuit of knowledge that was a related motivating factor for the career. Autonomy seemed to be important for these participants, and this positive passion was the driving factor for some of the participants to accept the responsibility of seeking grant funding as necessary to maintain independence.

According to Self-Determination Theory, competence refers to positive outcomes that are produced through individual actions. Competence was a particularly strong intrinsic motivation

associated with those individuals who felt that they were good at grant writing. Consistent with Self-Determination Theory, those faculty members who felt that they had particular skills in grant writing also spoke concurrently about their enjoyment in writing grants. Dr. Kathryn Cresson, in particular, saw the benefits to grant writing in providing an organizational structure to her research plans. However, this qualitative study cannot answer whether a perceived competence in grant writing could also translate to a higher success rate in obtaining grants. Future studies using a qualitative approach could be used at SSU-Central to understand this question. Many participants felt competent in their grant writing skills, yet were frustrated by their lack of success. This, there was also a different perception that seemed to opine no matter how competent an individual is in grant writing, there is an element of luck involved in obtaining grant funding. This perception would exert an extraneous element beyond the control of participants. Although none of the participants admitted to being incompetent in their grant writing skills, many admitted to a difficult learning process. The work of McAlpine et al. (2016) suggested that luck is a useful rationalization that provides applicants with sustaining motivation and resilience in accepting a lack of success.

According to Self-Determination Theory, relatedness describes the desire for group connectivity. Relatedness was not a particularly strong intrinsic perception that was voiced by the participants, other than the understanding that their grant writing struggles were similar to other faculty members. Many participants accepted the need for obtaining grants as part of the overall mission of the University, and that their grant revenues would contribute to the success of the institution. Nonetheless, when it came to seeking grants, there was an overall perception that "it's every man for himself," perhaps exacerbated by the common stress and anxiety involved in the struggle to obtain grant funding.

By far, the greatest motivating factor observed in this study was extrinsic, as identified in the external expectations of the University and administrators to get grant funding. According to Self-Determination Theory, extrinsic motivation describes an activity that is performed in response to an external factor. Consistent with Self-Determination Theory, most of the participants expressed extrinsic concern that their job security depended on the continuation of a grant revenue stream. Although the loss of salary support would not be immediate if there were a gap in funding, it was clear to the participants that eventually that loss of income would happen, even to tenured faculty. Dr. Brian Gordon noted that even his laboratory space could be taken away as punishment for not obtaining grant funding, and given to someone else. This external pressure also seemed to instill a great deal of anxiety in most of the participants. It was interesting to note that the anxiety did not seem to decrease in participants who were grant funded. Indeed, one participant alluded to the fact that a single grant was not adequate anymore to cover all of the expenses involved in running a laboratory. Also, the University newly emphasized support for faculty who were already successful in R01 funding, to try for additional grant funding. While the extrinsic motivation of avoiding punishment through job loss was present, there was also the reward of tenure available to tenure-track participants in seeking grant funding. Thus, grant writing performed to avoid sanctions or obtaining something of value are examples of extrinsic motivation. Although unstated in their appointment letters of contracts, many participants believed the expectation from SSU-Central that having grant funding, particularly success in having obtained R01 grants was a requirement to be awarded tenure.

Interestingly, introjected motivation (*i.e.*, task performance that prevents feelings of guilt or anxiety) was not an extrinsic factor associated with grant writing. Importantly, the grant writing process did seem to invoke considerable stress and anxiety among the participants, which

was not alleviated once their grants were submitted. This pressure may have been due to the low success rate in grant funding acknowledged by the participants, or due to the anticipated criticisms involved in the subsequent grant review process. Similarly, participants indicated a significant time lag between submitting grant and obtaining the results of the review. Notably, many of the participants also described grant writing as a never-ending process.

5.3.2 Framework 2 – Academic Capitalism

In this study, the theory of Academic Capitalism was used to explore the grant-seeking experiences of faculty who work in a research-intensive institution. In the context of Academic Capitalism, scientific research can be understood as an economic pursuit by universities to create knowledge that can be marketed. Overall, very few participants overtly expressed a perception of the business enterprise setting at SSU-Central. It is possible that early-career faculty members do not have a sufficiently broad experience to provide a perspective of how a university operates. At the highest level, the effort of the Dean of the School of Medicine to increase grant revenues could be seen as a business-driven decision to balance institutional income and expenses. From his speech quoted in Chapter 4, there was expressed a sense of rank or prestige of the University with the amount of NIH funding brought into the institution compared with other institutions. A study focusing on administrators at SSU-Central could help to further understand the relationship between grant funding and academic capitalism. Alternatively, more experienced faculty (at the Associate or Full Professors) may have a deeper understanding of the business perspective of the institution.

Academic Capitalism can be used to describe faculty members as managed professionals who work for the knowledge economy. Many participants in this study expressed their grant funding regarding providing essential support for their laboratory operations. Loss of grant

funding had dire consequences, for example, loss of resources such as animal colonies. Dr. Matthew Sealy also related having to let some of his research staff go as his grant funding dried up. Dr. Jeff Wharton, saw his laboratory as analogous to a start-up company, in which the University provided an investment. He also noted that the University seemed to accept that there would be winners and losers, similar to businesses that would succeed or fail. There was also the perception from several participants about giving up the purity of science and the simple pursuit of knowledge in exchange for the pursuit of grant money. Academic Capitalism describes the prioritization of research over other academic pursuits such as teaching, because discovery leads to commercially valuable products. In support of this theory, participants acknowledged that they spent relatively little time in teaching or service.

Many participants talked about the competitive nature of obtaining grants, and regarding economics, and indicated that their research directions were often market-driven to pursue areas deemed more fundable. Finally, many participants identified the business of being charged for resources provided by the institution. This finding is consistent with the concept of Academic Capitalism, in which an academic institution functions as a business enterprise. Also consistent with Academic Capitalism is the prioritization of research over teaching and other academic duties. Many of the participants admitted that either they were not good at didactic teaching in the context of formal courses, or they were simply uninterested.

There were several positive comments about core facilities and other resources, which were consistent with investments by the University to make faculty more competitive. Also, investment in a faculty success center was a clear approach to increase the competitiveness of the faculty. In this regard, SSU-Central has developed an “academic enrichment fund” in which clinical revenues are redirected into making the research enterprise more competitive. These

efforts could also be viewed as an attempt by the University to recruit successfully the best and brightest young faculty with the greatest potential for grant funding. One of the external recruits, Dr. Driscoll, characterized his recruitment process regarding a star athlete, in which he courted several offers and compared the packages in an excel spreadsheet.

One result that was not consistent with the theory Academic Capitalism was the scarcity of examples describing the commercialization of the participants' research by SSU-Central. Likewise, in general, the participants did not mention entrepreneurship, although several were performing research in new research areas such as bioinformatics and cell therapy. There was only one participant, Dr. Ken Zang, who described his plans for leaving academics in favor of a start-up company. In this example, the participant described moving to the start-up, which was exploiting the discoveries of his research team. It would be useful in future studies to assess early-career faculty in developing intellectual property (IP) based on their research, and determine whether any IP concerns restricted their research dissemination. Likewise, it would be interesting to know the extent to which early-career faculty members are considering commercialization of their research as an alternative revenue stream to fund their laboratories.

5.3.3 Framework 3 – Bourdieu's Theory of Practice

Within Bourdieu's Theory of Practice, the concepts of habitus, agency, and fields can be used to as a helpful lens to describe the complex interaction of faculty, administrators, and reviewers in the academic field of grant funding for research. In his Theory of Practice, Bourdieu characterized social fields as places of power relationships where struggles for legitimacy and viability occur. Thus, Bourdieu's Theory can be particularly useful in characterizing the relationship between early-career faculty and administrators as well as between early-career faculty and grant reviewers.

According to Bourdieu's Theory, individuals establish a sense of identity, or habitus, as they work through different scripts for legitimacy. Bourdieu indicated that habitus is constructed from an individual's history and experiences. In support of Bourdieu's Theory, participants described the various personal and professional experiences that brought them to academic careers in biomedical research. They described the process of learning how to perform academic research as trainees and the strategies of writing manuscripts and grant applications. Bourdieu also argued that as individuals work through different scripts, they establish the capacity to operate in the world. During their recruitment to SSU-Central, participants coming from external positions enjoyed a sense of empowerment, receiving generous start-up packages that often surpassed $1 million. Participants also realized the academic reputation of SSU-Central was an asset that could be used as capital. Because the early-career faculty were not typically well known in their fields, being associated with an institution having well-established national reputation provided them with academic legitimacy.

Regarding the relationship between early-career faculty and grant reviewers, the participants perceived building up a body of preliminary data that would support a grant application was most important. Dr. Kirby, for example, mentioned the need to have just the right amount of data. From Bourdieu's Theory, these data (scientific capital) are what provides legitimacy for grant reviewers to exchange belief in the capability of the applicants to perform a proposed project (symbolic capital). In many cases, participants spoke about trying to guess what grant reviewers wanted to see, and tried to mold their data to fit that impression. Dr. Yoakum brought up the concept of trying to "sell" the data. Other participants, such as Dr. Crowley, spoke about shifting their research programs in an attempt to focus on areas that could be considered more fundable by the reviewers than other less competitive areas.

One of the difficulties identified by the participants is the considerable lag time between submitting a grant and getting communication back from the reviewers, which can take five months or longer, as noted by Dr. Pharr. Dr. Pharr also described a disconnect between the critiques from the reviewers and his grant content, which left him perplexed as to whether they had even read it. One proposal by the NIH has been to change the basis of funding individual investigators, from project-based grants to grants based on the performance. The advantages of this approach are supported in the literature review by the data of Azoulay et al. (2011). Their data suggest that providing grants based on investigator qualification and past performance may increase productivity. However, it should be noted that only the most exceptional investigators are appointed to the HHMI to receive funding. Nonetheless, the results of this study suggest that investigators at SSU-Central are spending an inordinate amount of time grant writing, which could be dedicated to research in the laboratory. Ultimately, there was widespread consensus among the participants that the NIH grant funding system is broken, but little in the way of ideas on how to fix it. Being invested in the system with their careers, the participants had little choice but to "play the game."

In the context of Bourdieu's Theory, the relationship between early-career faculty and administrators was represented by a struggle for legitimacy. After arriving at SSU-Central, participants realized nothing seemed to matter more than the economic capital obtained from grant funding. Even in having a grant, there was a little diminution in anxiety or stress. In fact, only one participant (Dr. Alan Pharr) talked about taking a break from grant writing for a year after he received funding. This situation seemed to come from an administrative message that having a single grant was not sufficient for tenure. Among the participants, there was also the perception that a single grant was insufficient to run a laboratory after accounting for investigator

salaries. Without a grant, the participants had little capital in exchange to negotiate with administrators for resources. Dr. Deming Huan noted that without a grant, finding another faculty position would be difficult. These findings are consistent with Bourdieu's Theory, as an exchange of economic and symbolic capital represented by grant revenues for promotion and tenure.

For tenure and promotion, there was also a concern among the participants that the requirements were not carefully laid out to them. This obscurity was particularly evident by Dr. Michael Driscoll when he talked about not having these terms spelled out in his initial contract letter. Many participants identified additional resources that administrators were providing to enhance grant competitiveness, such as a faculty success center. Its utilization seemed haphazard; one participant, Dr. Deming Huan, bemoaned that no resources were available to help with grant writing. Another program established by administrators that was viewed with mixed success by the participants, was a formal mentoring program in which early-career faculty were required to participate. These results were not consistent with the literature review on self-efficacy, in which Garman et al. (2001) identified positive outcomes using a formal mentoring program. Likewise, Reis et al. (2012) showed a higher retention rate for those who participated in a mentoring program. It may be possible that the mentoring committees established for early-career faculty at SSU-Central were more evaluative than supportive. The work of Pololi et al. (2015) would indicate that trusting relationships with colleagues are necessary to achieve optimal vitality, something that may not be present in impersonal mentoring committees.

One result identified in the study was a high level of dissatisfaction alluded to by many participants. Many participants spoke about struggles in balancing their work with their personal life as well as dissatisfaction with certain practices of the University. This dynamic interplay

between personal and professional experiences is not considered in Bourdieu's Theory of Practice. However, Bourdieu's Theory provides an understanding power and powerlessness in the context of an unequal distribution of different kinds of capital. It would be possible to extrapolate from Bourdieu that those with inadequate capital would be dissatisfied.

In the literature review, the work of Stoykov et al. (2017) indicated that a lower confidence in their research capabilities, decreased job satisfaction, and higher levels of job burnout were factors associated with faculty members considering quitting. Likewise, Ryan et al. (2012) identified two predictors for faculty members who are considering leaving their institution as a perceived lack of support and job dissatisfaction. These publications support the results obtained and suggest that some faculty in this study are at risk for considering leaving SSU-Central.

5.4 Limitations of the Study

There were some limitations to this study. First, the research took place at a single institution. Although a request was emailed to all eligible faculty, participation was self-selected and was constrained to a minority of the total faculty population at SSU-Central. The study did not include more senior faculty at the Associate or Full Professor level. Thus, the results of this study may not be defined as representative (*i.e.*, findings that are typical of other faculty or institutions). However, the results could be considered as generalizable (*i.e.*, findings that apply to other faculty and institutions). For example, the specifics of the faculty in approaching the ten-year tenure clock at SSU-Central may not be typical, but the concerns of the faculty described tenure in the results may be generalizable to other institutions. Thus, it would be worthwhile to repeat this study at other institutions. In addition, a quantitative approach could be used, by administering a survey instrument to faculty at multiple academic institutions.

Although gender and racial/ethnic differences among the participants were identified, these variables were not considered in analyzing the data. These demographics could potentially have influenced the study. All participants except one worked in the laboratory setting. However, this participant provided support capabilities for the research projects of other investigators. Indeed, he participated in the grant writing process as Co-Investigator; and grant revenues were expected to fund a portion of his salary. None of the participants brought up any gender or other diversity issues, which may have affected them personally or professionally. Similarly, even though foreign graduates made up nearly half of the participants, there were no issues discussed involving cultural differences brought up beyond a language barrier identified by a few participants in grant writing. Also, no professional conflicts were mentioned between participants and administrators or other faculty members. Based on the literature review, it would be worthwhile to explore further the variables of gender, race, ethnicity, and culture in the context of seeking grant funding.

5.5 Implications

This study primarily revealed a high level of stress and anxiety expressed by early-career faculty members in seeking grant funding. These results imply that there is a need for additional training in grant writing skills. Many early-career faculty in this study struggled to learn strategies in seeking grant funding that would make their applications more successful. These results also imply that expertise in grant writing has not been a major criterion in faculty hiring practices. New faculty have historically been hired into academic medical centers to develop research programs that would fit into the programmatic profile of each department. These results suggest that the institution has not established a comprehensive strategy to promote faculty success. Mentoring programs can be one component in such a strategic approach. In addition to

providing grant-writing skills, good mentoring experiences described in this study appeared to bolster faculty resilience and self-belief. This study also has implications involving the criteria for promotion and tenure. The faculty members in this study were expected to be entrepreneurial in covering their research costs, including salary support. Participants reflected that tenure decisions at SSU-Central take into account the grant funding status of candidates. The results of the present study provide further evidence of the need for administrators to address the funding situation that early-career faculty face.

5.6 Recommendations

This study explored early-career faculty perceptions of seeking extramural grant funding in a highly competitive environment. The results from this study may catalyze improvement of faculty conditions at higher educational institutions performing biomedical research. Based on the findings discussed in the context of the theories used as theoretical frameworks for this research, there are several recommendations that arise. These recommendations including the preparation of grant writing skills, the protection from anxiety, stress, and burnout, the establishment of effective faculty mentoring programs, and the incorporation of new academic funding models. All of these recommendations will require additional studies to determine their efficacy.

5.6.1 Adequately prepare new faculty members with grant writing skills

As illustrated by data of the study, many participants' perceptions were that they were ill-equipped with grant writing skills coming into their current positions. Even after some years of experience, many participants still struggled with grant writing. It is important to note that grant writing is different that academic writing for research papers and other scholarly publications. For example, one participant mentioned there is an element of salesmanship involved in grant

writing that is not typically found in academic writing. Grant writing as a technical skill should be taught as part of the graduate curriculum, and further honed through professional development at the postdoctoral stage. Likewise, grant-writing ability should be evaluated by institutions as part of the hiring process.

Despite institutional resources available to early-career faculty, there was a wide discrepancy in its utilization. Likewise, there was a perception of differences in grant writing resources that were available in individual departments. A strategic plan should be incorporated to provide a uniform approach in grant writing resources across the institution. This plan should also be comprehensive, by providing reviews and critiques at the concept stage, early draft stage, and advanced pre-submission stage. Because of the current multidisciplinary and team approach to research projects, institutions should facilitate focus groups based on research interests, to aid in the formative process of grant writing. Additional institutional resources should be considered to enhance grant writing success rates. For example, professional grants specialists could provide editorial assistance to improve readability and accessibility of the text. Many participants spoke about the uneven pace involved in the grant writing process, with frantic writing and longer hours as the deadline loomed. This practice should be discouraged by institutions to allow for adequate review and editorial assistance with sufficient lead-time before the submission deadline.

5.6.2 Adequately protect faculty members from anxiety, stress, and burnout

Many participants spoke about the stress involved in grant writing, as well as the anxiety evoked in in career-related issues, such as salary support, laboratory funding, and promotion and tenure concerns. These stressors can often trigger professional burnout, yet many participants perceived them as a natural part of the job. Obviously, the most direct way to reduce their stress

would be to address their real concerns about low funding levels at the NIH. Given the inordinate amount of time, the participants perceived they spent on grant writing, improving funding levels (and concomitant success rates) would also increase their research productivity. Since it is unlikely that NIH funding for research grants will increase substantially in the near future, institutions should incorporate new resources that could help to mitigate faculty stress and anxiety. For example, stress reduction programs could help faculty better address burnout through facilitating better time management among other issues. Likewise, organized peer-to-peer support groups and work-life balance programs could help to reduce the chronic anxiety voiced by many participants. Efforts like these should also translate to lower stress and burnout among faculty, with higher job satisfaction and retention. Career counseling programs should be incorporated to assist those faculty members whom administrators recognize will not be successful in obtaining promotion and tenure. Importantly, better access should be provided to those faculty members who need more intensive help from mental health professionals. Future research should be conducted to address the relationship between faculty stress levels and productivity in obtaining grant funding.

5.6.3 Establish effective faculty mentoring programs

While personal one-on-one mentoring relationships were described positively, the group mentoring committees assigned by the institution had mixed results as perceived by many participants. These were mandatory committees established by the institution and may have suffered from a mismatch between the early-career faculty members and mentors assigned to them. Some of the participants indicated that their committees rather than having a mentoring role in promoting their successes took more of an evaluation role in reviewing their progress. Mentors with personal relationships had the highest perception of value from the participants.

Therefore, in its best practice, mentors should be selected with the input of the faculty members, with the goal of providing career and professional guidance, as well as personal advice about work/life balance. With this in mind, the mentoring structure should be outside administrative units to avoid any potential conflicts of interest with tenure consideration. Several different mentoring models have been developed at academic institutions that are targeted toward early-career faculty (Geraci & Thigpin, 2017). Future research is needed to quantify the value of different mentoring approaches in facilitating faculty success in obtaining grant funding.

5.6.4 Incorporate the current grant-funding situation into an academic business model

Based on the current budgetary constraints for NIH funding, it is likely that institutional expectations are unrealistic, particularly for maintaining faculty salary support on grants. From the participants' perspective, they struggled to sustain the requirement of 70% to 100% salary support on their grants, depending on whether they held tenure-track or non-tenure-track appointments. None of the participants had major teaching responsibilities; tuition revenues typically support teaching positions. Participants indicated that they needed to have more than a single grant funded to maintain this level of salary support. As a result, they were spending most of their time writing grants. Although the NIH has explored caps to limit investigator salaries on grant budgets, the current limitation for awards is relatively modest, which encourages the continuation of soft money support for faculty positions. Federal policy changes should be considered to address this practice.

A significant problem faced by many participants is the short-term nature of grant funding, typically three to five years, that requires them to be in a constant state of grant writing. This situation is also tenuous for institutions as well, because it fosters high faculty turnover. Alberts et al. (2014) recommended changes in NIH grant mechanisms to provide more stable

funding support that focuses more on the quality of individual investigators than on their proposed projects. Another important priority is for institutions to set a more realistic goal of about 50% support from grants. This level would mean that every faculty researcher would have at least a 50 to 60% commitment from the institution for salary support. Having at least some salary requirement on grants would provide an incentive to continue seeking grants, while also producing some security for faculty members. Finally, there needs to be institutional support for faculty and their research programs during the inevitable dry spells in funding cycles. Finding ways to decrease soft money dependence, however, may be difficult for institutions that are already budget-constrained. In this regard, Sanberg et al. (2014) advocated for academic institutions to promote faculty entrepreneurship by incentivizing commercialization activity.

5.7 Conclusions

The qualitative approach used to explore the question of how do early-career faculty members perceive grant-seeking in the highly competitive environment of higher educational institutions performing biomedical research, described the lived experiences of the 25 study participants. This study contributes to the scientific body of knowledge by providing a new interpretation of these faculty experiences and reaffirming much of the reviewed literature. The findings were aligned with three theoretical frameworks that were used to understand the results, namely Self-Determination Theory, Academic Capitalism, and Bourdieu's Theory of Practice. The findings identified the importance of mentoring in learning how to write grants effectively. The findings also revealed that the competition for limited grant dollars has contributed to heightened stress and anxiety among the participants. Because of this study, higher education leaders have useful data that support the importance of an environment that is conducive to successful grant-seeking strategies.

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APPENDIX A

BIOGRAPHICAL SKETCH

Growing up during the 1960s, James (Michael) Mathis was inspired by the Apollo moon missions to study science, and fulfill his dream to pursue a scientific career. He began that pursuit by completing a B.S. degree in Chemistry in May 1982 from Texas A&M University, followed by a Ph.D. degree in Biochemistry in May 1988 from the University of Texas Southwestern Medical Center, and by postdoctoral studies at the University of California, San Diego from 1988 to 1992. Michael returned to U.T. Southwestern Medical Center from 1992 to 1997 as a Research Assistant Professor in the Department of Obstetrics and Gynecology, where he established a research program to study the process of carcinogenesis and to seek novel cancer therapies. There, he entered the field of gene therapy by engineering an adenovirus (a natural cold virus) to attack and kill cancer cells.

In 1997, Michael joined the Department of Cellular Biology and Anatomy at LSU Health Sciences Center in Shreveport as Assistant Professor and became Associate Professor in 1999 and Professor in 2006. In 2001, he was named as Director of the Gene Therapy Program. To provide new research capability, he was able to obtain funds from multiple sources to create a Small Animal Imaging Facility, with state-of-the-art equipment for *in vivo* CT, PET, SPECT, and optical imaging. During this time, he performed sabbatical research twice: in 2005 and again in 2012. To enhance his capability as an administrator, he completed a Master's degree in Health Administration from LSU in Shreveport in August 2011. This degree led him to seek additional administrative responsibilities in higher education. In October 2013, he was named as Department Head of Comparative Biomedical Sciences in the School of Veterinary Medicine at

Louisiana State University. In this position, he leads a faculty of 22, a staff of four, and directs two core facilities in providing teaching, research and service responsibilities for the Department. To date, he has published over one hundred scientific articles in scientific journals.

Michael is married to Mitzi, who has a faculty position in higher education and teaches anatomy, histology, and clinical laboratory sciences. He has a blended family, consisting of his son Timothy, his daughter Emily, and his three stepdaughters (Ginny, Landry, and Chandler). He has a granddaughter (Laura) through his son Timothy and his wife Ellen, and a step-granddaughter (Carson) and step-grandson (Griffin) through his stepdaughter Landry and her husband, Joey. He also has three dogs, a cat, and a bird in their family with Mitzi, who are their surrogate children.

APPENDIX B

EMAIL TO FACULTY

Date

Name, Ph.D.
Assistant Professor
Department of _____
Southeastern State University – Central (SSU-Central)

Dear Dr. _____

We are conducting a research study through the University of Alabama to better understand the experiences of faculty at SSU-Central, in seeking federal grant funding from the NIH and from other sources for biomedical research, and we invite you to participate.

Given the current emphasis on obtaining extramural grants at institutions like SSU-Central, we are interested in exploring the different personal and professional experiences of tenure-track faculty at the Assistant Professor level. In particular, our study seeks to better understand the experiences of faculty in the context of seeking grant funding and how this relates to obtaining their career goals.

Your participation in this study would involve a one-hour interview, and a short follow-up interview (only if necessary) to clarify any answers from the first interview. You may also be asked to fill out a brief questionnaire about your funding history and provide your current CV. I have attached the Informed consent agreement, as approved by the Institutional Review Board at the University of Alabama. The agreement contains detailed information about the study.

Your perspective is extremely important to us. The results of our study may help faculty in the future to develop new strategies for obtaining research funding in an increasingly competitive environment.

Please consider participating in this research study. If you are open to participating, please respond to this email. I am more than happy to discuss the study and answer any questions you may have.

Sincerely,

J. Michael Mathis, Ph.D.
College of Education
University of Alabama

APPENDIX C

INTERVIEW INSTRUMENT

Interviewee:_____
Date:_____
Place:_____
Time:_____

Questions

Section 1: Focused History

1. If I asked you to tell me a little bit about who you are as a person, how would you describe yourself? How would you describe yourself professionally?

2. I am interested in learning about how you became interested in the field of biomedical research. Tell me in your own words.

3. Before entering a research profession, what did you think your work would be like? What did you want it to look like?

4. What was your understanding of the process for obtaining NIH grants as you progressed in your career?
   a. What (if anything) in your background has prepared you for seeking NIH grant funding for your research?

Section 2: Details of the Experience

5. Tell me about your arrival at SSU-Central. How long have you been here?
   a. How were you recruited?

6. What was your understanding of the expectations in coming to SSU-Central for performing biomedical research? For obtaining NIH grants?
   b. What support have you received from SSU-Central for obtaining NIH grants?

7. Tell me about your current experience in applying for extramural research funding for your laboratory.
   c. What is your perception of the current grant funding availability from the NIH for biomedical research?
   d. What funding strategies (if any) have you used or changed since coming to SSU-Central?

Section 3: Reflections on the Meaning of the Experience

8. How has your experience in applying for extramural research funding from the NIH affected you? Personally and professionally?

a. What worries you or concerns you about research funding? What challenges have you faced?

9. How do you think your experience compares to your peers at SSU-Central? To the biomedical research community at large?

10. What thoughts do you have about your efforts in seeking research funding at SSC-Central?
    b. How has this effort affected your research productivity?
    c. What has motivated you to continue applying for grant funding?

11. What would you tell your trainees (such as graduate students or postdoctoral trainees) about biomedical research careers in an academic setting? In terms of research support, funding, success strategies, etc.
    d. What (if anything) has changed in your career aspirations since coming to SSU-Central as Assistant Professor?

12. Tell me anything else you would like to share about your experience in seeking NIH research funding at SSU-Central.

APPENDIX D

IRB CONSENT FORM
THE UNIVERSITY OF ALABAMA
HUMAN RESEARCH PROTECTION PROGRAM
UNIVERSITY OF ALABAMA INSTITUTIONAL REVIEW BOARD

Title of Research: **Faculty Perceptions of Seeking Extramural NIH Funding for Academic Biomedical Research**

lnvestigator(s): **J. Michael Mathis, Ph.D.**
Karri A. Holley, Ph.D.

IRB Approval #: **OSP#:**

Sponsor:

You are being asked to be in a research study.

The name of this study is "Faculty Perceptions of Seeking Extramural NIH Funding for Academic Biomedical Research."

This study is being conducted by J. Michael Mathis, Ph.D. He is a graduate student in the Executive Ed.D. Program in Higher Education Administration in the College of Education at the University of Alabama. His advisor is Karri A. Holley, Ph.D. She is an Associate Professor in the College of Education at the University of Alabama.

What is the purpose of this study-what is it trying to learn?
This study seeks to understand the individual perceptions and experiences of faculty who seek to obtain extramural research funding.

Why is this study important-what good will the results do?
Academic research in the biomedical sciences drives innovation in producing new clinical devices and drugs. In fulfilling this mission, academic research institutions rely on federal grants from the NIH and other agencies that are awarded to faculty to fund biomedical research programs. However, after decades of growth, federal funding for grants for biomedical research over the last ten years has remained flat. Thus, the ability of faculty performing biomedical research to obtain federally funded grants has decreased due to competition for limited grant resources. For early-career faculty, the competition to secure grant funding can be a particularly daunting career obstacle in obtaining promotion and tenure. Therefore, it is important to understand the perceptions of faculty toward research funding and how this relates to obtaining their career goals.

Why have I been asked be in this study?
You have been asked to participate because of your role as an Assistant Professor on a tenure/non-tenure-track or as an Administrator at SSU-Central. We seek participants who have expertise and insight into the competition to secure grant funding.

How many other people will be in this study?
A total of 30 individuals from SSU-Central will be asked to participate.

What will I be asked to do in this study?
You will be asked to complete a one-on-one interview with the Principal Investigator. The interview will last approximately 1 hour, and will be audio recorded. The interview will be conducted in person at a location mutually agreed upon by the participant as well as the Principal Investigator. A follow-up interview by phone or Skype connection that will last approximately 30 minutes may be requested to clarify specific points raised in the first interview. You may also be asked to provide information about your grant funding history, and your current Curriculum Vitae.

The interviews will be audio recorded. However, if you do not wish to be recorded, tell the Principal Investigator, who will then take handwritten notes.

How much time will I spend being in this study?
Participants will complete a one-on-one interview that lasts approximately 1 hour and fill out a short survey. A second interview may be requested by the Principal Investigator that lasts approximately 30 minutes.

Will being in this study cost me anything?
This study will not cost anything other than the time required to complete the interview(s) and survey.

What are the benefits of being in this study?
There are no direct benefits to be gained by participants in this study. Results from the study will be used to understand and provide information to faculty about the perceptions of research funding and how this relates to their career goals and their institution.

What are the risks (dangers or harms) to me if I am in this study?
There are no known risks involved in this study. Your identity will remain confidential, and you may decide to discontinue your participation at any time.

How will my privacy be protected?
We will not tell anyone you are in this study. You do not have to answer any questions or give us any information that you do not want to.

How will my confidentiality be protected?
Names will be known only to the Principal Investigator. The names will not be used as identifiers in the research to ensure confidentiality of the participants and the institution. No information will be released that identifies you by name or affiliation. Information from the interviews will be kept in a locked filing cabinet. Electronic data will be maintained on a password-protected computer. The audio recordings of the interview will be destroyed when the study is completed.

Do I have to be in this study?
No. You can refuse to be in the study. You can also start the study and decide to stop at any time. Agreement to participate in an interview with the Principal Investigator implies consent to take part in this research study. Taking part in this study is voluntary. It is your free choice.

If I don't want to be in the study, are there other choices?
If you do not want to be in this study, the other choice is to decline participation.

What if new information is learned during the study that might affect my well-being or decision to continue in the study?
You can tell us at any time whether you want to continue in the study or not.

What if we have questions, suggestions, concerns, or complaints?
If you have questions about the study now, please ask them. If you have questions or concerns later, you can reach Dr. Michael Mathis at ***-***-**** (********@crimson.ua.edu) or Dr. Karri Holley at ***-***-**** (********@ua.edu). If you have questions about your rights as a research participant you may contact Ms. Tanta Myles, The University of Alabama Research Compliance Officer, at 205-348-8461 or toll-free at 1-877-820-3066.

You may also ask questions, make a suggestion, or file complaints and concerns through the IRB Outreach Website at http://osp.ua.edu/site/PRCO Welcome.html. After you participate, you are encouraged to complete the online survey for research participants, or you may ask the researcher for a copy of it. You may also e-mail us at participantoutreach@bama.ua.edu.

What else do we need to know?
You do not give up any of your legal rights by agreeing to participate in this study.

You will be given a copy of this consent form to keep. Save it in case you want to review it later or you decide to contact the investigator or the university about the study.

The University of Alabama Institutional Review Board (IRB) is the committee that protects the rights of people in research studies. The IRB may review study records from time to time to be sure that people in research studies are being treated fairly and the study is being carried out as planned.

I have read this consent form. I have had a chance to ask questions. I agree to take part in it. I will receive a copy of this consent form to keep.

Signature of Research Participant _____ Date _____

I agree to have my interview audio recorded: Yes _____
No _____

Signature of Investigator _____ Date _____

THE UNIVERSITY OF ALABAMA®
Office of the Vice President for
Research & Economic Development
Office for Research Compliance

December 16, 2016

James Mathis, Ph.D.
ELPTS
College of Education
Box 870302

Re: IRB # 16-OR-438, "Faculty Perceptions of Seeking Extramural NIH Funding for Academic Biomedical Research"

Dear Dr. Mathis:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on December 15, 2017. If your research will continue beyond this date, please complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, please complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Request for Study Closure Form.

Please use reproductions of the IRB approved stamped consent forms to obtain consent from your participants.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer
Office for Research Compliance

358 Rose Administration Building | Box 870127 | Tuscaloosa, AL 35487-0127
205-348-8461 | Fax 205-348-7189 | Toll Free 1-877-820-3066

THE UNIVERSITY OF ALABAMA®
Office of the Vice President for
Research & Economic Development
Office for Research Compliance

March 30, 2017

J. Michael Mathis, Ph.D.
Department of ELPTS
College of Education
The University of Alabama
Box 870302

Re: IRB # 16-OR-438-A "Faculty Perceptions of Seeking Extramural NIH Funding for Academic Biomedical Research"

Dear Dr. Mathis:

The University of Alabama Institutional Review Board has reviewed the revision to your previously approved expedited protocol. The board has approved the change in your protocol.

Please remember that your protocol will expire on December 15, 2017.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer
Office of Research Compliance

358 Rose Administration Building | Box 870127 | Tuscaloosa, AL 35487-0127
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APPENDIX E

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Title of the article or chapter the portion is from	Chapter 4. The Monopoly Mechanism in Science
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