The 41st Chair: Defining Careers in the Current Biomedical Research Environment

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Abstract

In recent years academic capitalism and a distancing from Mertonian scientific norms have shifted the traditional reward of academic science from peer recognition to the award of grants. With the shrinking of the NIH budget in real terms since 2003, there are increasing numbers of researchers whose careers are at risk from lack of funding. This paper presents themes from an interpretive, narrative study of tenured biomedical research professors who have lost NIH support as the funding environment has tightened. Mechanisms for navigating this funding environment are suggested in light of these findings and inferences are drawn regarding how this may affect faculty careers. The potential of new, damaging scientific norms that are emerging in this funding climate are considered. The paper proposes actions administrators may take to help faculty who either occupy, or are moving towards occupying, the 41st chair. This paper is intended to help research administrators and medical school administrators understand faculty perceptions and experiences of funding loss, thereby allowing for greater perceived institutional support in a fiscally severe environment.

Keywords: biomedical research funding, academic capitalism, faculty careers, norms of science, institutional support

Introduction

Observing that scientists with Nobel Prize-worthy ideas were denied this most coveted award due to restraints on the number of recipients, Robert Merton (1968) described a phenomenon

he called the 41st chair. This name derives from the French Academy of Science's practice of restricting the number of members to only 40 scientists at any time, thereby withholding membership from a large number of brilliant minds (who all occupy the 41st chair). The appellation is not intended to denote a ranking of either the 40 members or the excluded. Rather, it symbolizes those who could be judged worthy of membership yet who are not elected. Merton notes that "the phenomenon of the 41st chair is an artifact of having a fixed number of places available at the summit of recognition" (Merton, 1968, p. 2; see also Zuckerman, 1996 for an extensive consideration of this concept).

The 41st chair phenomenon is pervasive today in academic biomedical research communities. By altering the scientific reward structure, academic capitalism has helped shape the 41st chair phenomenon in modern medical schools and research institutes. Peer recognition has partly been superseded by financial research support from the National Institutes of Health (NIH). The recent tightening of the NIH budget, however, has limited the available financial reward, forcing more researchers to occupy the metaphorical 41st chair. This has led to a situation where viable scientific ideas are either under-resourced or not funded at all. The crux of the matter here is less that ideas remain unfunded per se, but that *superb, innovative* ideas from established and recognized scientists, as well as younger researchers, remain unfunded. Since NIH funding for R01 independent investigator grants has been given to only approximately the best 4,000 applications, the French Academy's 41st chair can, in recent years, be translated to research's 4001st chair. Although there may be 3960 more 'chairs,' the consequences of occupying the 4001st chair are, arguably, higher for an individual's career today than when Merton first described the phenomenon. The consequences of this situation have not fully materialized, but could include a departure from academic biomedical research by waves of talented scientists from all career stages. This, in turn, would likely slow the rate of scientific advances and, ultimately, negatively affect global public health.

This paper considers the changes in the norms of science over the past 40 years, the evolution of the biomedical research environment, and the actions that institutions and the NIH are taking to alleviate the financial troubles experienced by many researchers who now occupy the 41st chair. Data are presented from unstructured interviews with four tenured full professors at a top ten NIH funded medical school in the United States who, after 20 years of continuous NIH funding, find their laboratories in financial hardship. This research enhances the understanding of the personal consequences and career definition that the current biomedical economy is forcing upon researchers. Based on the personal stories of these scientists, this paper presents possible new – and potentially damaging – scientific norms that could emerge and replace Mertonian norms should the current situation continue. Finding that academic capitalism now appears integral to biomedical research, the paper also examines the effect these potential new norms could have on public health and the advance of science. Ultimately, while biomedical research in institutions of higher education must undergo significant systemic change, the consequences of these changes could be severe for faculty careers in medical schools nationwide.

Grounding in the Literature

Traditional Norms of Science

In the middle of the twentieth century, peer recognition was the ultimate reward in biomedical science (Merton, 1968). This concept was aligned with science's traditional values: communalism, disinterestedness, organized skepticism and universalism (Merton, 1942). These norms dictated that scientific discoveries belong to the community, rather than to the researcher who makes them (communalism); the researcher should not be influenced by personal biases in arriving at and interpreting results (disinterestedness); research must be tested by the scientific community before it is acknowledged as plausible (organized skepticism); and science should know no boundaries, whether personal, racial or national, when advances can be made (universalism). Science was pursued to enhance mankind's understanding of the world. Financial reward was less a motivator than the eternal quest to make a new discovery and be recognized by one's peers. These Mertonian norms have subsequently been recognized by scholars as embodying traditional science (e.g., Etzkowitz, 1989; Hackett, 1990; Renault, 2006; Slaughter & Rhoades, 2004; Stuart & Ding, 2006).

Academic Capitalism – The Mechanism of Change for Scientific Reward

Over the last 30 years, however, the cultural norms of science have changed. Dasgupta and David (1994) make a distinction between the old and new cultures by calling the former "Science" [capitalized in the original] and the latter "Technology." This trend has been studied extensively under another label – academic capitalism, a term that first appeared in the literature in 1990 (Hackett, 1990), and was associated with Weber's description of large medical and natural science research institutes as "state capitalist" enterprises. Academic capitalism has been defined by Slaughter and Leslie (1997) as "institutional and professorial market or market[-]like efforts to secure external money" (p.8). In the twenty-first century, the term was modified to include "the new economy" (Slaughter & Rhoades, 2004), and took on the meaning of "a regime that entails colleges and universities engaging in market and market-like behaviors" (Rhoades & Slaughter, 2004, p. 37). The authors note that "in the information society, knowledge is raw material to be converted to products, processes or service" (Rhoades & Slaughter, 2004, p. 15), and that universities, with a focus on knowledge creation and transfer to students, are central to the information society and hence to the new economy.

The Bayh-Dole Act of 1980 encouraged formerly reluctant universities to commence patenting activities (Mowery, Nelson, Sampat, & Ziedonis, 2001; Shane, 2004). It legitimized the university ownership of knowledge by making it legal and therefore, one could argue, culturally acceptable. Since the act was passed, universities have increasingly responded to economic stimuli, creating a market of higher education and employing microeconomic theory of organizations in institutional administration (Gumport, 2000).

Academic capitalism is not limited to financial matters. It also encompasses "the attempt to increase individual or institutional … influence or prestige" (Louis, Blumenthal, Gluck, & Stoto, 1989, p. 110) and the consideration of behavior and culture. Hackett (1990) posits that since universities are increasingly dependent on the private sector to provide funding, they will start

resembling the private sector in their operations. He details how academic scientists are adopting an increasingly managerial work style (industrial norms). The trend that led Hackett to develop the term *academic capitalism* was not novel in 1990, but he provided the terminology through which the phenomenon could be studied.

New Cultural Norms of Science

The emergence of academic capitalism has resulted in new cultural norms of science, distinct from those delineated by Merton 40 years ago. These new norms are rooted in a corporate approach to scientific discovery and can present a direct conflict in terms of core values (Bok, 1982). The argument propounded by traditionalists in academic science is that the "profit imperative threatens to erode the freedom and autonomy of scientific inquiry, erect institutional constraints . . . to the flow of knowledge and information and allow pressures to engage in revenue generation to shape the questions that researchers are likely to pursue" (Vallas & Kleinman, 2008, p. 284). These pressures are relevant for academic scientists seeking extramural funding. Rather than allowing only research results to dictate future endeavors, if scientists pursue particular paths of inquiry that are more likely to be judged favorably by reviewers, they are engaged in what Hackett (1990) terms *dirigisme,* allowing capitalist values to dictate the direction of research. Many scientists would argue that tailoring research to suit reviewers is sound practice for a successful research program, which is indicative of the deep-rooted nature of the new norms of science.

Table 1

Contradictory Objectives between Corporate and Academic Cultures (Fassin, 1991)

Academia	**Industry**
New discoveries	New applications
New knowledge	Added value
New financial means for additional research	Financial benefits
Basic research	Applied research
Long-term	Short-term
Know-how, what, why?	Product-driven
Publications	Secrecy
Free, public good	Protection, patents
Academic freedom	Commercial approach

Table 2

"Value Tensions" that Lie at Polar Opposite Ends of a Value Axis within Academic Capitalism (Hackett, 1990)

Academic Value	**Capitalist Value**
Freedom and autonomy	Accountability and *dirigisme*
Educating Students	Producing research results
Cosmopolitan orientation	Local orientation
Quality	Quantity
Generalization	Specialization
Cooperation	Competition
Effectiveness	Efficiency

The conflict between academic and capitalist norms is manifested both in practical (table 1) and theoretical (Table 2) polar extremes. These opposing values become sources of tension when academic scientists are socialized into Mertonian norms and yet feel pressured to conform to academic capitalism, either in their actions or in the value systems to which they adhere. It is the theoretical values (Table 2) that may be more applicable to academic scientists who are experiencing the trend towards academic capitalism by being forced to find financial support without seeking to privatize their knowledge. Hackett (1990) suggests that academic capitalism is forcing faculty to concentrate more on research than pedagogy (Table 2), which necessitates greater specialization if the researcher is to produce novel results in a highly competitive environment. In addition, regular, measurable productivity has become increasingly important as faculty are exposed to the shorter timelines more prevalent in industry, which are shaped by the drive for products (focusing on applied research) and the short-sightedness of focusing on quarterly profits (Fassin, 1991). The consequence of the marriage of the two cultures is an increased need for faculty to demonstrate their productivity on shorter time scales to funding agencies, as well as tenure and search committees (Fassin, 1991). This is a practical example of efficiency, one of Hackett's (1990) value axes at the other end of which sits effectiveness. The result of this increased faculty accountability to funding agencies and university administration (Gumport, 2000; Hackett, 1990) is a move towards more – but shorter – publications, a reduced quality of publications, as measured by the number of experiments conducted to demonstrate findings, or a rush to publish results before research is conducted thoroughly or has even been completed (Hackett, 1990). These measures represent a fall in the quality of science, and the increased pressure could cause a reduction in motivation or available time to mentor the next generation of researchers. In addition, these new norms are at odds with Merton's (1968) findings from interviews with Nobel laureates. If Merton's findings are indicative of how great science is achieved, long periods where few advances are made often precede extraordinary leaps in knowledge. Demanding regular productivity from faculty, while sensible from a perspective of accountability, may prevent them from pursuing paths of inquiry that culminate in profound new knowledge.

The cosmopolitan and local orientation value tension in Hackett's (1990) axis seems at odds with reality now, almost two decades later. Hackett places a cosmopolitan orientation on the academic end and local on the capitalist end. With the increased globalization of knowledge and business, few researchers, whether academic or industrial, can afford a local orientation. Research and business are now multinational, with clients or collaborators frequently on opposite sides of the globe.

The overall culture shift has been described in many ways, but perhaps the most colorful is provided by Giroux, who laments the "corrosive effects of the influence of corporate power on higher education" (2002, p. 435). "Corporate power" is easy to associate with profit; with enough profit, government lobbyists can be bought to argue a corporation's case and media relations teams can make corporate interests appear to align with public good, swaying public and governmental opinion. In the academic context, i.e., pure university research rather than university start-up and spin-off companies, the financial focus is not on profits but on extramural funding. It is not the purpose here to argue that academic capitalism and the new cultural norms have an explicitly positive or negative effect on daily academic scientific life – it is the change itself that is notable. Academic capitalism has been the mechanism of change for the culture of biomedical research in the United States over the past 30 years, to the point where financial matters are of utmost importance in both running a laboratory and for career progression.

Expectations for Faculty Careers

Regardless of the cultural norms into which a faculty member is socialized, general career expectations among those in the natural and biomedical sciences at Research I institutions (Carnegie Foundation for the Advancement of Teaching, 2001) are broadly similar. After a Ph.D. is completed, it is usual for researchers to assume a postdoctoral position. "Postdocs" are considered trainees, and pursue projects with mentorship from the principal investigator (who leads the laboratory), authoring peer reviewed manuscripts and frequently applying for postdoctoral extramural funding. It is not unusual for researchers to hold two or three postdoctoral positions, for an average of 2.8 years each (Assessing the Postdoc Experience, 2008) before seeking a faculty position. There are two main faculty tracks for researchers: tenure stream and research track. For those on the research track, no (or very few) institutional funds are committed to the individual or the laboratory. The researcher's salary is paid from grants – either their own or those of their principal investigator. There is little job security in this position as one is dependent on successful applications for extramural funding. Tenure stream faculty usually have an institutional commitment to cover their salary unfunded by grants, but there is frequently an understanding that the institution expects a certain proportion of the faculty member's salary to be covered by extramural funds and, for those in departments with undergraduate programs, the faculty member to engage in a certain amount of teaching per year. A number of grants are only open to faculty, and readiness to apply for these grants frequently drives the transition from postdoc to faculty status. In addition, there are a small number of grants, known as K99/R00s that are awarded by NIH to provide postdoctoral researchers a means of securing funding in their early faculty years. Once faculty status is reached, however, the funding demands are relentless.

The Current Funding Environment

The majority of biomedical extramural funding in the United States is provided by the National Institutes of Health (NIH) (Mandel & Vesell, 2004; Moses, Dorsey, Matheson, & Thier, 2005). Substantial funding for biomedical sciences and other scientific disciplines is provided by government agencies such as the National Science Foundation (NSF) and the Department of Defense. Between 1998 and 2003, the NIH budget doubled from $13.6 billion to $27 billion (National Institutes of Health, 2007a) – ostensibly good news for biomedical researchers. During this time the average success levels of all Institutes were above 25%, meaning that more than a quarter of applications were funded (National Institutes of Health, 2007b), and there were few restrictions regarding chosen areas of research. This comparatively freely-flowing funding prompted medical schools and research institutes to expand their infrastructure substantially (Couzin & Miller, 2007), resulting in increased research capacity. The favorable environment – both physically and economically – led to a boom in career biomedical researchers (Zerhouni, 2006). This boom is a manifestation of capitalist principals in academia: flowing money will attract individuals.

The commonly recognized gold standard of NIH funding is the independent investigator Research Project Grant, R01 (Mandel & Vesell, 2004; National Research Council, 2005). Since R01 grants are peer reviewed and awarded to individuals, being awarded one is indicative of the esteem in which a researcher's work is held by independent experts. Receipt of an R01 signifies the achievement of research independence in the academic biomedical research community. For this reason, receiving an R01 has traditionally been necessary for the promotion to assistant professor from either a postdoctoral position or an entry-level instructor faculty position (Vastag, 2006), and extramural funding is often a prerequisite for tenure and further promotion (Ascoli, 2007).

In addition to providing proof of scientific prowess, R01 grants provide an economic service to medical schools and research institutes by paying for supplies, researchers' salaries, and institutional costs via a facilities and administration overhead charge. The number of R01 applications in 2007 increased almost 48% over 1998, when the budget doubling began (National Institutes of Health, 2008), with success rates for new R01 applications falling to 16.3% in 2006 and 19.2% in 2007 (National Institutes of Health, 2007b).

The widely publicized period of growth was followed by annual growth rates below both the rate of inflation in the wider economy and the NIH's biomedical inflation index (Koizumi, 2006). This modest decline in spending power and the allocation of current funds has prompted much criticism (Avantaggiati, 2007; Boron, 2006; Cohen & Siegel, 2005; Couzin & Miller, 2007; Finkelstein, 2006; McCook, 2008; Mitka, 2007; Nathan & Schechter, 2006; Nurse, 2006; Werner, 2007), despite its well recognized advent (Frist, 2002; Korn et al., 2002). Several factors have contributed to the current "perfect storm" (Zerhouni, 2006, p. 1088) of the funding climate. First, as the research population expanded (initiated by the doubled budget), the number of grant applications also increased. Since 2003, however, the number of R01s funded annually has remained roughly constant, resulting in a decline in the proportion of successful applications. The NIH-wide 2007 funding rate for Research Project Grants (which include the R01) fell to 19.2%, with a smaller dollar amount allotted to each award (Koizumi, 2006). Second, the process of research and complying with federal regulations has become more expensive (Cohen & Siegel,

2005; Vastag, 2006; Zerhouni, 2006), meaning that smaller awards no longer suffice. Third, the political climate has seen portions of the federal budget that could have been apportioned for biomedical research directed to the War on Terror (Boron, 2006; Frist, 2002; Porter, 2005). Currently, Over 80% of the NIH budget is committed to ongoing projects (Zerhouni, 2006), leaving few funds available for allocation to new research projects.

The current reality facing the biomedical research community, therefore, is that federal funding has become unusually difficult to obtain, but its importance has increased as capitalist cultural values have become the new scientific norms. As a result of the paucity of funds, many experienced investigators are finding themselves without funding, even when their grant applications are given an excellent priority score during peer review.

The 41st Chair Today

Four out of five applicants in 2007 failed to win or continue competitive funding. In 2003, the year that the budget doubling ended, 4,521 new R01 grants were awarded (National Institutes of Health, 2007b). In 2006, that number had fallen by more than 20% to 3,601 (National Institutes of Health, 2007b). While the number rose again slightly in 2007, it remains at 87% of the total awards in 2003. During the fifth year of an R01 (which average five years each), it is common for a researcher to apply for a competing continuation of funding. These data imply that if all researchers awarded an R01 in 2003 applied for a competing continuation of their grant in 2007, even if astonishing breakthroughs had been made during the course of all grants, 13% would not be renewed. In reality, the situation is worsened by the fact that additional new applications further decrease the number of successful renewals. Thus, scientists with excellent research ideas are increasingly finding themselves occupying the 4001st chair.

A new and increasingly common story has therefore emerged in medical schools. Researchers who have previously been well rewarded by current academic norms, i.e., maintained a record of continuous NIH funding for a number of years, now find themselves unfunded. Their experience and recognition, to say nothing of their ideas to expand the boundaries of scientific knowledge, count for little if they cannot obtain extramural funding for their salaries, support their laboratory research and pay research personnel. Untenured faculty who receive no institutional support may be forced to leave academic research if they find themselves in this situation (National Research Council, 2005). Tenured researchers are under no such economic obligation, but present a financial burden to the institution, and as such may find that in some of the most aggressive institutions their laboratory space is removed once their ability to pay the rent through facilities and administration charges from grants is hampered. At any rate, with no or little funding, it is difficult to stock and staff a productive research environment. Once research capabilities have been curtailed, returning to extramurally funded research is extremely challenging, as R01 applications require a significant amount of preliminary data to prove the feasibility of the proposed experimental approach. Without a laboratory, personnel or resources, this is difficult to achieve (Boron, 2006; McCook, 2008).

Bridge Funding

To prevent the one-time loss of funding from ending a research career, both the NIH and a

number of medical schools and research institutions have created bridge funding programs. These programs have become necessary as the new reward for science – funding – has become a necessity for continuing research. The 41st Chair Syndrome has transitioned from a social phenomenon to one that can make or break careers. Under the NIH program, researchers cannot apply for bridge funding. Instead, they are nominated for an R56 bridge funding grant by NIH staff and study section members during the peer review process, usually if the two following criteria are met: 1) their R01 application falls just short of the current environment's pay line (the score needed to be awarded funds), and 2) they would have less than $200,000 funding without the grant under review. This interim grant allows the necessary time and resources for additional research to be conducted, with the aim of improving the application upon resubmission. The R56 grant is predominantly awarded to applicants who are likely to be successful after only minor modifications to their research proposal. Instituted in 2005, the number of awards has grown annually, with increases of 15% and 22% in 2006 and 2007, respectively (National Institutes of Health, 2007b). While there are no comprehensive published datasets regarding the success of R56 recipients at subsequently securing R01 funding for the same project, data were gathered for individual R56 recipients via the NIH online Computer Retrieval of Information on Scientific Projects database. Fifty-seven percent of R56 recipients in 2005 have had an R01 of the same title funded. This rate falls to 34% of 2006 R56 awardees and 18% of 2007 awardees. This decline can likely be ascribed to the fact that those awarded a bridging grant in 2007 have had less time to gather more data and apply for a renewal than those in earlier years. It remains to be seen if these percentages increase over time.

While the NIH bridge funding mechanism has provided a career lifeline to a relatively small number of researchers (167 in the period 2005-2007), more have been helped by their institutions. Bridge funding programs at medical schools and research institutions vary, but a common attribute is their increasing demand and proliferation. The author's informal survey of the websites of the top twenty NIH-funded medical schools in the United States reveals that 13 (65%) have institutional bridge funding mechanisms. Another is currently seeking donations to establish a fund for this purpose. These grants tend to be small (usually less than $100,000), last only for 12 months, and are usually only for faculty with grants that scored near the pay line and need minimal improvement to secure funding.

As the current NIH economic difficulties continue, an increasing number of researchers need bridge funding, yet the effect this will have on their career aspirations and enthusiasm has thus far remained undocumented. To help understand the personal effect that the changing culture and financial necessities of biomedical research can have on individual academic researchers, extensive interview-conversations were conducted with four faculty who have found themselves in need of bridge funding.

Methods

The narrative method with an interpretive stance was chosen to capture the stories of the researchers affected by the 41st chair phenomenon and academic capitalism. In the biomedical research community, the concept of these four researchers' experiences may be well known in an abstract way; faculty and administrators may have colleagues experiencing something similar. However, being aware of this happening does not give the depth of understanding that

can be gained by hearing the story told by the individual affected, replete with emotion and background information. Telling stories is central to the human condition: "People understand their lives and explain their lives through stories" (Hones, 1998, p. 226). Stories are told through narrative (Connelly & Clandinin, 1990), and provide a platform for making visible the meaning constructed from experience (McCormack, 2000). In trying to obtain an in-depth understanding of how faculty careers are affected by the current biomedical research environment, hearing voices recount the personal stories, events and associated emotions provides significantly more meaning than can NIH- or medical school-provided statistics. The unstructured interview-conversation format allows power in the conversation to rest with the interviewees (Mishler, 1986), who can introduce themes and topics as they desire. This approach led to richer data than those gained from a structured interview, where the interviewer may not have been aware of all relevant topics.

Following approval from the Institutional Review Board (IRB) to conduct recorded, anonymous interviews, the senior administrator in charge of research at the medical school contacted faculty who had applied for institutional bridge funding about the possibility of participating in this research. Four of these faculty approached the author indicating their willingness to be interviewed: Tom, Alice, Joe and Edward. The interviewer-author knew Tom and Joe through professional activities. Unstructured interviews were held in the faculty members' offices or nearby conference rooms, with the door closed to prevent interruptions. Interviews lasted 45-60 minutes and were recorded. Each interview began with questions concerning the faculty member's career history to the point of needing institutional funding, with subsequent questions emerging as the conversation progressed, led by the interviewee. Each interview was transcribed verbatim and analyzed recursively through the use of an inductively created coding scheme. Confirming and disconfirming data were sought to refine the common themes that emerged. Once results were written up, they were shared with the four researchers who had the opportunity to confirm that their vignettes and experiences had been articulated as each had intended.

The Four Researchers

Background

Tom, Joe and Edward are tenured full professors; Alice is under consideration for promotion to full professor. They all conduct research at a top ten NIH funded medical school in the United States, and are at different points in experiencing financial exigency in their laboratories. Tom's laboratory has been under financial duress for a few years. He is considered to be an excellent teacher and is head of a graduate program. Alice began as a non-tenure track researcher, and her career almost ended when funding was lost. Her lab has been financially stable for some time now. Joe's laboratory is experiencing severe financial distress, and his future is the least certain, even as a tenured professor. Edward is the director of an NIH-funded disease-specific center, currently receiving institutional bridge funding to support the center's research following two unsuccessful funding renewal attempts. He also has multiple individual grant applications pending.

The average expectable funding patterns of researchers in the current environment can be represented as a cycle (figure 1), with the four researchers situated at different positions. The starting level and dip in funding are relative for each individual's circumstances. The timing,

too, is individual – it cannot be expected that researchers follow this cycle at a set speed or for a specific amount of time. Also, the shape of the curve in front of each researcher is unknown; Edward could be about to fall lower in the funding cycle than the line shown, or he could have an early upswing and join Alice. Joe perceives himself to be at the bottom, and is unsure if his cycle will ever go back up. Tom has come through the bottom of the cycle, but his top may never be as high as it was in the past. Alice has seen her research funding return to a comfortable level. In summary, the only certainties for these researchers are their past and present experiences. The dynamics of their future cycle is unknown.

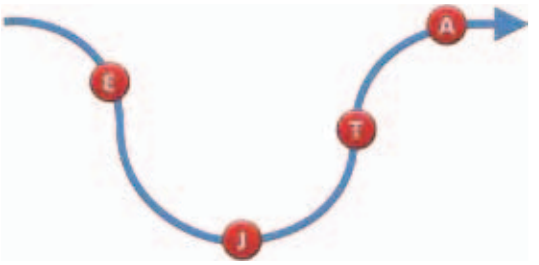

Figure 1. Position of the four researchers along a proposed funding cycle.

By most common scientific and academic standards, all four researchers would be considered highly successful. All play an active role in the scientific community, serving on NIH study sections, one is an editor of a well known journal, another the Director of a National Research Center of Excellence. All are regularly asked to lecture nationally and internationally, and their publication records are strong. Between them, they have more than 80 years of continuous NIH funding. Although they have all experienced the need to revise grant applications before being funded, only in Alice's case has the viability of a laboratory been previously threatened.

Historical Funding Experiences

These researchers have seen a variety of funding environments in the course of their careers. In the early 1980s, extramural funding was much less competitive than it is now. Speaking of his first grant, which was a postdoctoral fellowship, Tom notes "I don't think the grant was particularly outstanding" and "I didn't have very much preliminary data at all," and yet it was funded on first submission. He attributes this to the fact that he wrote it as a graduate student while still attending an Ivy League university, and that the strength of the institution was sufficient to give reviewers confidence in his abilities. Joe began his independent scientific career in the early-to-mid 1990s, when funding levels fell and a large number of people left science. He appears not to have been affected at this time, remarking that he was "naïve" (in paying little attention to the stress that such an environment can cause) and also "fortunate" to have obtained funding within a year or two of starting out. While Alice had difficulty obtaining an NIH grant in this same period, Edward remarked that he had not noticed the downturn in funding at that time. By all accounts, the current funding environment is the most severe any has experienced.

Themes

Four main themes emerged in conversations with these researchers: 1) luck, randomness and the peer review process; 2) methods to navigate the current funding environment; 3) potential solutions; and 4) unanticipated perspectives gained from their experiences. As may be expected, the immediate effects of the current funding environment contain numerous sub-themes.

Luck

Funding success was attributed to luck by three of the four researchers. Reflecting on his three R01s sustaining an expensive line of research that relies heavily on specific strains of transgenic mice, Joe comments "I've been pretty lucky." At no point does he accredit his success to his ability as a researcher. Similarly, Tom remarks that it was "just fortuitous" that he had two grants. He also tells a story of how, when the NSF was still funding biomedical research, he had failed to win an NSF grant and called up the program officer to find out why. The program officer read him the reviewers' comments, all of which were superlatively positive, at which point she asked him how much money he needed to do the research and awarded it to him right over the telephone. Alice too attaches a significant role to fate for the rescue of her career when she was struggling to get a grant renewed in the early-to-mid 1990s: "I was just lucky. I just happened to fall into that niche."

While references to luck could be ascribed to humility (either real humility or to make their discussion of earlier success more socially acceptable), it could also be a coping mechanism. This use of luck to explain the inexplicable correlates with Jencks' (1994) study of the homeless. In refuting the assertion that homeless people are merely "down on their luck" (p. 46), Jencks writes that luck often is used as a "covert [argument] about the assignment of blame" (p. 47). These researchers are in the opposite position, perceiving themselves as having been the recipient of good luck, but the same observation can be made if "blame" is replaced by "explanation." These researchers have not identified a clear explanation for their success in obtaining funding thus far; responding to the human need to understand events, therefore, they attribute their success to luck. Perhaps a subconscious benefit of ascribing success to luck is the lack of accountability during less successful periods. Also apparently unconsidered is the notion that the researchers may have positioned themselves in the right place at the right time. If the infrastructure or funding environment was supportive at the crucial times in their careers, they will have benefited. Whether this could be called luck or appropriate alignment of one's interests with the environment is a matter of debate.

Randomness and the Peer Review Process

Rather than discussing luck, Edward uses the word "randomness" to describe funding decisions. He tells how, when individual projects within his program-project grant have been adapted and submitted as an R01 application, the result has been quite different from the score received when reviewed as part of the program-project grant. With this story he demonstrates the lack of defined standards among different study sections. He also believes that reviewers are unduly influenced by a grant's previous score, in as much as they feel some compulsion to move the score closer to the pay line on subsequent review, but they also are unlikely to score a grant that

received a prior mediocre review at a fundable level – the improvement must be in smaller steps.

Further perceptions and experiences of the imperfect peer review system also emerge in conversation with the other researchers. Alice tells a story of how, through a series of unusual events, her own grant application ended up at the study section on which she served, providing expertise on a less commonly studied area. Since researchers cannot review their own grants, Alice had to fight to have her grant reviewed by a special emphasis panel (one established if no other expertise exists on the study section). Once this happened she was funded. Joe, too, recounts how people outside his area of research do not fully understand his work. He even notes that "there's been a lot of people complaining about the expertise on the study section." NIH examined the peer review system in 2008 and has begun to change the process (Tabak, 2008). However, Joe still maintains, "I guess you never know if a grant's great or not because it seems like it all depends on who reviews it."

All four researchers have extensive experience serving on study sections, and so are intimately aware of the vagaries of scoring grants. Although Alice stressed that when serving on study sections she tries to look only at the merit of the science, Tom says that funding decisions appear random and "based on other factors," such as whether the applicant has additional funding. If the lack of a new award would significantly curtail a researcher's ability to conduct experiments, they are more likely to have a grant awarded. This comment is also made by Edward, who says that applicants on their final review may be given "extra credit." Alice discusses how, if it is apparent that the applicant has been creeping towards the pay line in earlier applications, the reviewers may try to move them into a fundable level without specifically commenting on "the F Word" (funding). In this environment, funding decisions "are out of [the investigator's] control" – all they can do is "write as good a grant as [they] can" and hope that circumstances come together to result in funding. In Tom's words, there is no longer any "inevitability that you're going to get funded now if you're doing good work. You may not get funded ever, or not by the NIH at least … It's a crap shoot."

Navigating the Current Funding Environment

In conversing with these researchers, it was apparent that they were being hurt by the current funding environment. Tom commented a number of times on the change in funding levels. He received funding for an R01 that had been scored in the 22nd percentile earlier in his career. When that grant was up for a competitive (i.e., not automatic) renewal, two attempts earned Tom a score of 20%. This score was no longer sufficient to garner funds, which left the application "dead in the water," meaning that he is no longer funded to pursue a line of research on which he had focused for a number of years. Edward speaks of an acquaintance who had a similar experience, and furthermore was told by the NIH that any subsequent applications would be carefully examined to determine if they were the old (unfunded) grant being submitted as a new application, in which case it would not be reviewed. More recently, Tom had earned a score of 12.5%, but this had not been sufficient to earn him a grant, and was submitted prior to the establishment of R56 awards. In Tom's words, "It was 0.5% off the funding line. And the person who was . . . managing that grant . . . would not give me anything. Not even any bridge or anything. And I was, like, really pissed off." Although the grant was subsequently funded, Tom remarks that the changes necessary for the grant to be funded were so minor as to be considered

inconsequential. He is not alone in remarking that there appears to be essentially very little wrong with grants that are not funded – the only problem is the lack of money for good ideas.

Staying Afloat in the Queue for Funding . . .

With fewer funds to support the many scientists applying for R01s, all the researchers mentioned how scientists must queue for funding. Specifically, Tom, Alice and Edward spoke of "lining up" for funding, Joe talked about grants "piling up" and Tom called it a "backlog." The result is that more researchers may be left with gaps between the end of a grant and its renewal, if, as Joe and Edward noted, it is becoming increasingly common for R01s to be funded on the second (and, previously, third) applications -- an observation confirmed by a recent report on peer review (Tabak, 2008). Given the recent removal of the opportunity for a third submission, the "queue" for funding is likely to be shortened, and the situation observed by these four researchers may improve to some extent. Further research will be necessary after the new system has been implemented for at least a year.

Other than bridge funding, researchers have found two notable ways to help their financial situations. The first is collaborating with other researchers; Alice had been "covered" by collaborating with her division chief on another research project and sharing research staff; she says that trying to maintain two independent projects is the safest approach. The second is to encourage laboratory personnel to be aggressive in pursuing their own funding. All have had partial success in funding their postdoctoral researchers and students on fellowships, which helps alleviate some of the burden. However, it does not appear to be enough. Even with two R01s, Joe is contemplating having to let a technician go, and he has not replaced another staff member who recently left to pursue further education. Tom had to reduce his laboratory personnel from seven to two, and says that the "new experience" of having to "let people go" due to lack of money was "really discouraging." Edward's lab is half the size it was a year ago, despite a larger-than-usual institutional bridge funding award.

. . . Or Sinking

A third measure that some of these researchers have been forced to take is to halt work on specific lab projects – either because animals or supplies were too costly or personnel could not be paid – thereby preventing scientific progress in that particular area. Tom speaks of long periods where no progress was made on specific projects in his lab. In the end, work "got so far behind that the one project I'm funded for I'm not even really that interested in anymore." This, like his previous grant that did not get funded, means that a path of research has ended. This experience shook Tom's confidence and changed his attitude. He "became less of a risk taker" in hiring decisions. Where previously he may have been "juggling" between grants, fellows winning independent funding, and finding clinical funding, now "there were no balls to juggle." In Joe's case, as soon as he heard that his third attempt to renew his grant was unsuccessful, he immediately destroyed mice that had cost thousands of dollars to engineer. Both Alice and Edward remark that if they are forced to let go technicians and researchers who have been with them for a large part of their careers, it will take years to retrain someone if funding is subsequently awarded. In Edward's case, this scenario is inconceivable; instead he says, "I would probably just stop." One can only hope that important work that is losing funding under one investigator will be taken up by other

scientists, otherwise it may result in an unfathomable loss to medicine and science, and even a loss of new understandings and cures.

Survival of the Fittest . . .

Although Joe began his career in a period of relatively low funding, the situation was not as severe as it is currently. Drawing parallels between 15 years ago and the current environment, Tom notes that the result of having already lost the "people at the bottom third of the curve" is that the "whole distribution has shifted" and "the competition is tougher." With a significant part of the scientific community having already left science, the remaining researchers – whom Tom considers generally better scientists than the group who changed careers – now compete against each other for funding, therefore heightening the competition. The result is that to be funded, scientists must be the best of the best. Edward likens this situation to Olympians, who a century ago could devote only a small part of their daily routine to training, versus today's athletes who frequently train full-time. As Tom asks, "how do you take the top half that have already been, basically, naturally selected for being outstanding scientists, and now say 'okay, we're only going to fund 10% of you, or 5, 6% of you, or something like that'? It doesn't make sense." Compounding the problem is the fact that the current system was not designed to distinguish between the eighth percentile and the twelfth percentile of grant applications, as Edward points out. It is possible to discern the top quintile from the second quintile, perhaps, but fine distinctions between percentage points that the current pay lines necessitate are, as noted earlier, subjective and imperfect. In summary, it punishes those who, in other times, would be rewarded.

. . . And the Young Die Out

All four researchers see the current environment negatively affecting younger researchers' aspirations for a career in academic biomedical research. Alice noted that "we're scaring off the really good students from continuing in academic research" because they "just don't want that stress." Similarly, Joe says that younger researchers see what is going on in their mentor's laboratory, and "get the feeling that it's not worth it, so they just go on and do something else." Edward's comments focus more on early-career, untenured faculty with Ph.D.s (as opposed to M.D.s), whom he sees as "[questioning] what they're going to do with the rest of their lives."

Futility of Grant Writing

One commonly held belief is the futility of grant writing in the current environment. While Tom accepts that the medical school administration may like him to pursue ever more funding opportunities, this is not a path he is likely to follow now:

> There's just so many times you can spend writing grants and then get… rejected. Then you say, 'well, what's the point of it? I've got one grant, I can do some good work and I can pay attention to these people, or I can just spend my time in here writing and writing and writing for no return.'

Joe shares Tom's opinion that writing and rewriting grants is a wasted effort: "It's just not worth it anymore." Edward says, "I wouldn't want to say a majority of our time, but a very large amount

of our time [is spent] writing grant applications now, and that's not terribly productive in the short run." Tom comments that the enormous focus on winning grants means that investigators can "lose track of what the other parts of science are," which does not portend well for future research. It appears that he may be calling for a return to more Mertonian norms, before money – whether public or private – became the focus of scientific endeavors. He admits that this attitude may "put him on a collision course" with the administration, but is not overly concerned about this because he is tenured and considers himself to work hard on important parts of science that happen to have a goal distinct from chasing funding. Joe's situation is less clear cut – at the time of this conversation he was planning on meeting with his department chairman or vice-chair to discuss what would happen if his current two grants were not renewed. His future is currently undefined and "it's killing [him]."

Alternative Career Paths

Although all four researchers express their love of science, the effect of the current environment is clear. Alice's confidence in her independent research has been affected: "I felt like I was incompetent, like I couldn't seem to get my own research going," despite her prior fifteen years of funding, and it made her feel "really sick." Despite this, however, she says she never seriously contemplated leaving science. Her ease at saying this could reflect the fact that she has overcome possibly her leanest funding period and is now in a more comfortably funded environment. Edward reflects that he has sufficient teaching experience and wide-ranging interests that he could be comfortable accepting a new definition to his current role – either with increased pedagogical or administrative duties. Tom acknowledges that he may have to withdraw from bench science, and in the last few years has come to terms with the idea of moving into a more teaching-oriented role. Ten years ago he would not have felt comfortable becoming a teaching faculty member in a research institution. Now, however, he recognizes the importance of this contribution to science and the future of research, and declares that he "gets rewards out of it" sufficient to sustain him professionally, if need be.

Alice, Edward and Tom are in a different situation from Joe. They either can see a way out, or no longer need a way out, having garnered funds again. Joe, on the other hand, has lost one grant and is facing the competitive renewal of two more in the near future. He has had numerous "sleepless nights" and remarks on how "demoralizing" he finds it. Unlike Alice, he is currently considering his options if his laboratory's financial situation does not improve in the next year – before he is due to run out of funds altogether. Although no obvious alternative springs to mind, he comments, "to tell the truth, if I could figure out another way to make this kind of comfortable living doing something else, science-related or not, I'd consider doing that. That's how bad things are right now in my mind." He also remarks that, "knowing what I know now, if I was starting out, I would probably think long and hard about going this route."

Potential Solutions

In this bleak environment, what do these researchers see as potential answers? Both Joe and Tom see institutional bridge funding as fundamental to the continuation of biomedical research. In Tom's words:

> Some of these [institutes that together form the NIH] are down to single digits, you know, and how can you tell somebody who writes a grant that's in the ninth percentile that they can't get funding? … I mean, it's ridiculous. So I think [medical schools] have to pony up the money, and they're going to have to find a way to … put that into their budgets if they want to maintain … active research faculty.

A problem with relying on departmental or institutional support, however, is that it may not be forthcoming, or there may be emotional strings attached to it. When she lost most of her funding in a non-tenure stream position earlier in her career, it was suggested to Alice by the chairman of her basic science department that she should see if she could use bench space in another investigator's laboratory. Thus, the department was insinuating that they would not support her if she failed to renew her grant, and would not hesitate to take her space away. (She subsequently left the department and renewed her grant, causing the chairman to rue his hasty dismissal of her.) Later in her career, when the institution supported one of her postdocs, Alice was reminded of the fact at frequent intervals by the administration. This experience was not shared by Tom or Joe, but Alice's experiences are sufficient to demonstrate some of the pitfalls of relying purely on the institution to support faculty with funding gaps, assuming this is economically possible.

If institutional budgets are insufficient, then shrinking the number of researchers at medical schools appears the only option to Tom, and for Joe is a logical reaction to the current problem. The problem Tom sees with this solution, however, is that this is going to "squeeze the middle much more than it is going to squeeze the top. And the middle is good. The middle is excellent, and a lot of good things come from the middle," by which he means that excellent scientists who are not the top 5% elite group have much "solid" science to contribute. While they may not provide groundbreaking ideas, they add a significant amount of smaller but "important findings" to enable the progression of research.

Other suggestions that administrators may consider if this low level of funding continues – which Edward thinks will happen for at least the next few years – include Joe's idea to reduce the salary coverage medical schools expect faculty to maintain on grants and Alice's idea of five-year rolling tenure. The former idea, Joe admits, may just be "moving money around," as the financial support must be provided from somewhere. However, the benefit of this idea is that it allows faculty to spend more time on their research and less time worrying about their laboratory finances. Naturally, some consideration must be made to the economics of their research, but not at the current level where funding appears to be almost as – if not more – important than research productivity and creativity. Alice's proposal is to offer tenured faculty a five-year contract every year. This way, they know their jobs are secure for five years, but if they find themselves in financial distress for two or three years, they still have time to recover their funding before their five year contract expires. Edward's suggestions include demanding a higher percentile for each subsequent grant held by a researcher. For example, anybody's first R01 would have to be in the top 30% of grants. To get a second, concurrent R01, one would have to score in the top 20%, with the percentile decreasing to the top 5% for a fourth R01, with nobody allowed to have more than $1 million of direct costs from NIH at any one time. He also suggests trimming R01 funding periods from five years to four.

Unanticipated Perspectives

Serving on NIH study sections has been helpful to both Tom and Alice, although less so to Joe and Edward. This has changed their perspectives, which are now different from those of unestablished researchers. Participating in the process by which others are funded has given Tom an opportunity to see other "totally amazing" people "who were also having trouble." This afforded him the sense that he is not alone in this experience, and nor is it a reflection of his scientific abilities. For Alice, serving on a study section gave her a perspective of others standing in line for funding from the other side of the review process. Joe, who has been a regular member of a study section, does not share this experience because he remarks that he always has known that "not every good grant is funded." He also notes that he feels disinclined to serve on a study section until he secures funding; at the moment he feels this is time he cannot afford away from his laboratory. If others share this view, this may partially explain the problems noted earlier regarding finding suitable expertise for study sections.

Of the four researchers, only Tom appears to have gained something positive from this experience thus far. While all remark that tenure provides some income protection, Tom remarks that the "comfort" given by the knowledge that his "life's not going to stop" and he wasn't "going to be out on the street" has enabled him to understand that even though "things are going to slow down," he can still continue making "worthwhile" contributions to science. This becomes an important positive message: although his research may dry up, Tom has a lot to contribute in other ways. He has "a reputation from doing other things too" and has "protected himself" by doing a significant amount of teaching of graduate and medical students, even assuming a leadership position within the curriculum committee at the medical school. He remarks that going through this dearth of funding has changed his attitude towards teaching. While he always enjoyed it and was "excited" to teach, he was aware that teaching faculty were unfairly regarded as "lower class citizens" in the research institution's culture. Now, teaching appears to be his salvation if he loses all his funding. While this revelation has been positive for Tom, Edward – who shares this outlook – appears to find comfort from this alternative career path. However, Edward says he did not need the current environment to help him see the other ways in which he could forge a fulfilling career.

Tom's aforementioned comfort extends beyond the scientific realm to increased professional confidence: "I've had successes in so many different arenas that I don't worry about the connotation of not having grant success now." Whereas earlier in his career when he didn't get his first grant refunded he "walked around with [his] head hung low," now he does not feel that the attitude of the medical school administration towards him has changed as a result of needing bridge funding. He reported less of a "stigma of not getting a grant funded" now than 10 years ago because "nowadays it's so common that I can't imagine that there's that much of a negative connotation." While Joe does not share Tom's optimism in this regard, he believes that many more researchers will soon find themselves in this position, so feels that medical schools will have to adopt a more clearly defined stance on what will happen to tenured researchers without funds to support their research.

Discussion

The first section of this paper outlined the firm hold academic capitalism has taken in academic

science in the United States. This, combined with the current NIH funding shortage, has evidently populated the 41st chair far more heavily than Merton may have originally imagined. The stories of the four researchers clearly illustrate their personal experiences in this situation and suggest that they are far from alone in this position. However, whereas Merton's metaphor denied researchers their due peer recognition, now the stakes are higher: careers of both senior and junior professors are at stake. It seems clear that the combined effects of academic capitalism and the shrinking (in real terms) NIH budget of recent years are systemic.

With their experience of occupying the 41st chair, the four researchers in this study describe the beginnings of a possible shift away from the Mertonian norms of science — communalism, disinterestedness, organized skepticism and universalism. While it is too early to say if a shift has indeed started, and the methodological approach of the study does not permit wide-spread generalizations, the stories told by these researchers suggest that they are experiencing a change in Mertonian norms:

Communalism has the potential to become not the secrecy and commercialization seen in the biotechnology world, but *abandonment*. Instead of belonging to either everyone or a select few, research programs – some of which have been in progress over 20 years – risk desertion due to lack of funding.

Disinterestedness could morph into *hyper-interestedness*. That is not to say that researchers allow personal bias to influence their interpretation of results. Instead, with careers of researchers and the livelihood of their staff depending more heavily on obtaining significant positive data, it is plausible that paths of inquiry in biomedical research diverge from Merton's ideals, and are instead driven by a desire to follow the most financially secure route.

Organized skepticism, which demanded that findings be tested by the scientific community, could be reinterpreted as *conservative reins*. Instead of exercising sensible caution while allowing great leaps of science to occur, the current environment appears to be pulling back the advance of discovery, forcing researchers to focus on projects deemed 'safe' by their peers. With research programs sometimes half way to completion by the time they are proposed in grants, due to the demand for strong preliminary data, one could argue that there is no room for organized skepticism in the research environment anymore. Instead, these researchers' stories could indicate that scientific ideas are tested before they reach the scientific community. If this is not the case, it appears unlikely that funding will be secured.

Universalism appears to come in second to *politics* in the stories told by these researchers. Instead of science being open to all, regardless of creed or color, they perceive funding decisions to take into account previous funding history and prior scores for grant submission. Even though these researchers all have experience serving on study sections, they feel that merely having good scientific ideas no longer suffices; the paucity of funds has made the peer review process for grants appear politicized, random and a numbers game.

Given the potential shifts in Mertonian norms suggested by these four researchers, the scientific administration community may benefit from further research into this area. A qualitative study on a larger scale could expand on these researchers' interpretations of how Mertonian norms may

be revised and help elucidate current or currently-forming scientific culture. A quantitative study could then assess whether the proposed depiction of current or new scientific culture is becoming a revision to Merton's scientific norms.

Academic capitalism's new norms of science appear integral to biomedical research in the current NIH funding environment. Returning to an earlier quotation, the reduction in funding levels is "[shaping] the questions that researchers are likely to pursue" (Vallas & Kleinman, 2008, p. 284), in the hopes of receiving a positive peer review and, eventually, NIH funding. This observation was also made by Slaughter and Leslie (1997). Six of the seven capitalist values described by Hackett (1990, table 2) have come to the forefront. Researchers are *accountable* to their institutions in terms of supporting their own research programs; they must be highly *productive* in obtaining a large *quantity* of data for grant applications; the drive to secure funding forces researchers to become highly *specialized* in one area; there is intense *competition* for resources, which can influence the sharing of data and collaboration; with so much time spent writing grant applications, researchers now must be incredibly *efficient* in their research as they have less time to spend at the laboratory bench.

The increasing focus on funding makes the scientific enterprise a negative sum game, with the pursuit of funding and the advancement of science as the two components that, rather than remaining at a steady state when combined, eventually detract from each other. As the pursuit of funding increases due to NIH pay lines languishing in single digits, so the advancement of science slows. In conditions of scarce funding, study sections have become increasingly conservative, as demonstrated by the vignettes from Tom, Alice, Edward and Joe. Peer reviewers appear unwilling to take chances on less-than-conventional ideas. Instead, they opt to fund projects likely to provide small, incremental advances to the current body of scientific knowledge, whose success is almost guaranteed by virtue of the fact that applicants are either using technologies already proven or are providing so much preliminary data that the "proposed" work is near completion. Under this practice, it seems highly unlikely that investigators funded by an R01, constrained by conservatism, will make the sort of paradigm-shifting discoveries that create a new path for science and permit rapid advances of knowledge (Kuhn, 1996). In addition to the forced-conservatism slowing scientific progress, those who are unsuccessful at obtaining funding are finding that they must relinquish lines of inquiry that they may have been pursuing – in many cases successfully – for several decades. If not adopted by other researchers in their field, these paths of investigation may never be brought to fruition, which could be deleterious for the public health of the nation as cures are delayed and our understanding of biomedical mechanisms is not advanced.

Thus, it is clear that the adoption of market-like behaviors by institutions and the treatment by administrators of departments and schools as cost centers that must be financially viable (Slaughter & Rhoades, 2004) is having a negative effect on both faculty research outcomes and morale. The increasingly business-like approach to biomedical research may be a financial necessity, but it may also be preventing researchers from fulfilling the institutional mission at research universities – to further knowledge and educate students to do the same in the future. Instead of furthering knowledge in a significant way, only conservative, incremental advances are being made because peer reviewers must opt for the grant applications perceived as "safer" in the

current NIH funding environment. This harms not only science, but also the faculty's excitement surrounding the potential for their research.

Nevertheless, the researchers studied here have found several meanings to ascribe to their experience of needing bridge funding, which have helped make it more psychologically manageable. One is that established members of the scientific community can make contributions in domains other than research. While research is important and probably the most desirable activity for those who have been successful in it for multiple decades, to secure enough funding for a feasible research program (i.e., at least two grants) and to satisfy medical school administrators, scientists either must be lucky with regards to the timing of their funding or be in the top few percent of grant applicants. This is an environment in which the extremely successful will thrive, denying either entry or continuity of sustenance to the excellent – but not top – researchers. In Tom's words, "the rich get richer and the poor get poorer," an example of the Matthew Effect in practice (Merton, 1968). Bridge funding can give more scientists a chance to become successful while they await their turn for funding, if it comes at all. Edward says that without funding, in his current position with his current job definition, "there's nothing useful I can do." However, his experiences have allowed him to perceive an alternative career where he accepts additional administrative or pedagogical duties, and finds merit in this new role. This may have seemed unfathomable to him without having experienced the threat of laboratory financial distress. Another helpful understanding derived from their experiences is that funding decisions are not strictly a reflection of scientific merit. Other factors play a part, such as scores received on prior reviews, and an individual reviewer's understanding of the proposed work.

Implications for Research and Other Administrators

There are many different levels of research and other administrators in institutions of higher education. The findings of this study are likely to be of greatest utility to those administrators who interact with faculty on a regular basis. Nevertheless, the findings also suggest a number of implications with relevance to research and other administrators who have less regular personal contact with faculty. Table 3 suggests which actions may be most appropriate for research and department administrators, who may have more frequent faculty contact, and those that may be more suitable for senior administrators and research administrators who have less frequent personal faculty contact.

Foremost of all the findings, and relevant to all administrators, is the understanding of how researchers interpret and react to such experiences on a personal level. In busy and competitive academic environments, researchers may lack the confidence to speak up and administrators may lack the time to listen extensively. It is plausible that the common themes narrated by Alice, Tom, Joe and Edward are replicated at research institutions around the United States, and thus could be used to direct administrative support. Based upon each theme or subtheme described in this paper, there are support mechanisms or attitudes that administrators may consider adopting to help those occupying — or threatened by relegation to — the 41st chair.

Table 3

Actions that Research and Other Administrators may Take to Help Those Occupying, or at Risk of Occupying, the 41st Chair

Theme	Actions for Research and Department Administrators	Actions for Senior Administrators
Luck	Help faculty assess other factors contributing to prior success	Foster a culture of accountability
Randomness and the peer review process	Provide an initial empathetic ear. Encourage select faculty to contact funding agency regarding negative decisions.	Encourage faculty to participate in peer review process.
Navigating the funding queue	Facilitate collaborations. Encourage strategic grant applications Connect staff from downsizing laboratories to laboratories looking to expand. Encourage younger faculty to gain experience in, and excel at, teaching and institutional administration.	Encourage strategic grant applications. Provide institutional support and leadership in preparing for known future large funding opportunities. Foster networks with science-related organizations in the community.
Potential Solutions	Develop guidelines and practical obligations for the provision of departmental/ institutional support.	Consider other financial models that reduce the proportion of salary coverage required of researchers.
Unanticipated Perspectives	Help faculty appreciate their other contributions to scientific and academic community.	Appreciate other contributions faculty make to scientific and academic community. Define policy towards tenured, unfunded researchers.

Luck

Encouraging faculty to consider the reasons for their successes, other than luck, may help researchers identify prior behavior that they could adopt to become or remain successful in their pursuit of funding. Careful consideration of the steps that led to an earlier, successful grant application may help remind faculty of the parts in the grants process over which they have control and can take responsibility. The act of helping faculty recognize factors other than luck that contribute to funding success or failure may promote a culture of accountability within an institution. Accountability, or focusing on an individual's contributions towards a goal, can increase productivity and quality of work (Bogue & Hall, 2003), but care must be taken to avoid an overly officious or managerial approach that may run counter to the traditional academic culture of the specific institution (Bergquist, 1992).

Randomness and the Peer Review Process

As shown above, and described further in a recent study on peer review (Lamont, 2009), faculty may perceive that factors other than scientific merit influence funding decisions. Perhaps the strongest support administrators can offer in this regard is to recognize this perception without judging whether it is warranted. In dealing with a researcher unhappy at a funding decision, an initial empathetic ear may be most important.

However, once a faculty member has taken time to absorb the decision and its implications, there are two supportive approaches suggested by the stories of Tom, Alice, Joe and Edward. The first, demonstrated by both Tom and Alice, is to encourage faculty members to contact the program officer at the funding agency to discuss the funding decision. While this will not be appropriate in all cases, where grants have been scored close to the payline or sent to an inappropriate study section, there may be merit in personal communication with the agency to determine if any beneficial outcome could be salvaged. The second – which could be adopted regardless of an individual's funding experiences – is to encourage researchers to participate in the peer review process. Doing so will provide them with firsthand experience of both the difficulty of funding decisions and the care taken by many reviewers over the scientific merit of applications.

Navigating the Funding Queue

With a recent NIH announcement that 14,000 scientifically meritorious grant applications are awaiting funding (Harris, 2009), navigation of, and survival in, the funding queue must be strategically managed. Perhaps one of the most important actions a research administrator may take in the current environment relies on the position serving as a funnel through which pass a large number of applications from a variety of individuals or departments within an institution. As part of the funneling process, it may be helpful to researchers for administrators to take time to consider the content of applications and how they relate to other applications passing through the same office. In this way, staff may be able to point out complementary research interests among individuals at the same institution, thus facilitating research collaborations. Bringing together individuals whose research paths may not have otherwise crossed has the potential to increase partial salary coverage for otherwise unfunded investigators. This oversight role also may be instrumental in cases where funding solicitations are limited to a small number of applications per institution. Research administrators could be best positioned to recommend which faculty members would form a strong team to submit a competitive application.

Another important action point is to encourage faculty to ask their graduate students and postdoctoral researchers to write grants, thus alleviating financial pressure on the principal investigator. In cases where faculty can no longer afford postdoctoral researchers or laboratory staff, administrators may be aware of newly funded researchers looking for individuals with similar skill sets, thereby preventing the end of academic careers for younger researchers or the unemployment of staff in whom the institution has invested resources.

A focus on strategic applications could help avoid the submission of excessive numbers of grants that can appear a futile waste of time to faculty and can place a burdensome workload on the research administration. For example, more careful consideration may be given to the most

appropriate funding opportunities for proposed projects, and preparation for known future, substantial funding opportunities may be made an institutional priority.

If, however, funding and collaborative opportunities have been exhausted, administrators may be called to act as a career counselor for researchers considering alternative career paths. For example, promoting opportunities for younger faculty to make substantive pedagogical and administrative contributions to the academic and scientific communities, and – crucially – fostering the perception that such contributions are valuable and difficult to do well. This experience and professional understanding of activities other than research can help provide some career protection or potential for role redefinition in times of limited funding. If, however, researchers decide to leave academic research, administrators could help them find other fulfilling work by keeping abreast of employment trends in science-related fields and by fostering networks with groups in their communities who may provide suitable employment to former academic researchers.

Potential Solutions

Unless there is systemic change, potential solutions to the current funding environment are likely to be limited to reactive, stop-gap measures. Nevertheless, the researchers in this study presented experiences from which administrators could learn. Alice described being reminded of the support her department had given her research, and thus feeling under a constant emotional obligation of gratitude. This created a negative environment for her. Therefore, while departmental and institutional support for researchers can be critical for faculty who have lost funding, the practical obligations should be laid out for both parties in full from the start, and the department/institution should thereafter refrain from behavior that could provoke emotional duress in the researcher related to the departmental/institutional support.

At the institutional level the researchers suggested two solutions – a reduced demand for salary coverage, and rolling tenure. Clearly, these are potentially contentious changes that could be difficult to implement, and will depend on institutional finances and environment.

Unanticipated Perspectives

In the course of the interviews, Tom and Edward recognized that there are multiple contributions, other than research, that they could make within the scientific community. As noted above, administrators could encourage faculty to acknowledge this perspective and gain broad professional experience early in their career. However, it is also important that administrators themselves appreciate the contributions of faculty like Tom, who may not have a large laboratory or a well-funded research program, but who bring prestige to the institution through acting as editor of a major journal, and who participate significantly in the educative mission of the institution.

Joe commented that medical schools need to define their policies regarding tenured researchers who have no funds to support their research. This is a clear call to action. The pronouncement of school- or institution-wide policies, regardless of content, may help provide some form of certainty and clarity regarding the professional ramifications of losing funding, and the

anticipated institutional response. Such a policy could even help individuals in this situation move towards a constructive course of action, rather than languishing in a paralysis of uncertainty.

Limitations

This research was conducted with four faculty members, and while this number may be criticized as not statistically significant, wide generalizability is not the aim of narrative, interpretive research. Rather, this study aimed to elicit thick descriptions and rich stories (Denzin, 1998) to provide a context and more complete understanding of the four researchers' experiences. By doing so, this study attempts to provide the personal meanings behind the statistics readily available from the NIH and medical schools, and gain an understanding of how some faculty perceive the current funding environment, how it might be affecting their careers, and what actions they feel would be most beneficial. Learning from this, research and medical school senior administrators may be better positioned to help faculty in danger of occupying, or currently in, the 41st chair.

The experiences of these researchers have been shaped by their careers within the United States, their focus on obtaining funding from the NIH, and the scientific norms and academic practices at U.S. medical schools. Given the importance placed on context and personal experiences in narrative inquiry, this research may resonate most for those in similar institutions. Researchers and administrators from other countries, with different funding structures and academic systems, may find they can draw fewer parallels between their own work and experiences and those presented in this study. Nevertheless, in an environment with a strong focus on obtaining competitive grants, there are unlikely to be sufficient resources to satisfy all who apply for funding. Similarly, in countries with severe restrictions on the number of professorships, and where research funds are not as readily available – as is the case in many European and Asian countries – the 41st chair may become more pertinent to those researchers seeking academic jobs rather than research funding.

Conclusion

While the researchers studied here make several suggestions for potential remedies, the ultimate assessment appears to be that significant systemic changes will have to occur – either more money will have to be provided by the government for biomedical research, or medical schools will have to start reducing the number of researchers they employ. The 2009 American Recovery and Reinvestment Act (ARRA) provides two years of increased financial support for biomedical research, with the aim of sustaining employment in the field. Initially, this appears a positive step to assist researchers undergoing experiences similar to those of the four faculty in this study. However, some institutes are anticipating a precipitous drop in funding in FY 2011 (e.g., National Institute of Allergy and Infectious Diseases, 2009), when the NIH budget is expected to return to levels similar to FY 2009. Therefore, while the ARRA may provide temporary relief for biomedical researchers and medical schools, it does not yet appear to be a lasting systemic change. As a result, in FY 2011, the biomedical research community may find itself returning to the issue of the 41st (or 4001st) chair, and its accompanying prospect of reductions in research personnel. This would, logically, lead to a reduction or obstruction in the progression of biomedical

knowledge, which has the potential to harm public health if cures for diseases are set back by years. Even with the best of the best researching problems, as Tom noted, without the mid-grade researchers to do solid science, the laborious and painstaking research underpinning great breakthroughs may not be conducted.

Certainly, the protection afforded by tenure helps researchers who are significantly advanced in their careers. Those earlier in their careers, however, have no such shield. If many researchers decide that depending on the hand of fate for their reward (and livelihood) in the new culture of academic capitalist science is not a path they wish to pursue, then one of the structural suggestions made by Tom, Alice, Joe and Edward may occur naturally as researchers leave the profession. It is impossible to predict accurately the effect this could have on the health of the nation, but it is unlikely to be positive. This study has focused on researchers who have reached the pinnacle of their careers – full professors with an average of at least 20 years of experience. They should be at their most productive period, and have significant management experience to run their laboratories effectively and efficiently. The same cannot be said for the younger and untenured scientists. Further research must be conducted to determine the effect the current biomedical environment is having on this population, and what it may mean for science in the United States over the next twenty years. The increasingly common relegation to the 41st (or 4001st) chair in academic biomedical research today is defining careers. Shaped by academic capitalist values, researchers must adapt their work to position themselves most favorably for NIH funding. Some may be able to continue as before, with minimal change. Many, however, find themselves having to queue up for the NIH lottery and hope that bridge funding can support their research programs in lean periods. This situation is likely to dissuade many graduate students from entering the field and cause postdoctoral fellows and research associates to look for alternative career paths. While the pipeline is currently strong, anecdotal evidence suggests that today's young researchers are already deterred from remaining in the biomedical research profession, having witnessed the stress suffered by senior, formerly highly successful professors. If this is the case, who will be the senior investigators when today's elementary school children become graduate students in the biomedical fields, and who will be providing cures for the diseases ailing an increasingly aging population? These are the questions with which this country must be concerned as the 41st chair is forced to become a sofa to accommodate its increasing population.

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