SCIENTISTS AND SELF-DOUBT ACROSS STRATA OF ACADEMIC SCIENCE

Joseph C. Hermanowicz

Most institutional studies of science have focused on the functioning of its reward system. Less is known about perspectives scientists develop on their variously rewarded and recognized careers. This study examines people's subjective appraisals of attainment in academic science based on a sample of interviews with physicists who discussed their perspectives on success, including the most salient self-doubts they experience in their roles. The sample is divided into achievement echelons to see how self-doubts vary among those throughout the strata of science. Self-doubts about work accomplishment grip scientists across productivity strata, but these self-doubts grow more uniform as productivity increases. The most diverse sources of self-doubt are found among the least productive scientists in advanced professional ranks.

KEY WORDS: careers; science; stratification.

Most institutional studies of science have examined the functioning of its reward system (see Zuckerman, 1988). This research tends also to be exclusively quantitative. Studies have typically developed statistical models to predict measurable career outcomes (see Long and Fox, 1995). Much less is known, however, about the qualitative perspectives scientists develop on their variously rewarded and recognized careers. If the drive for recognition is so important—indeed institutionalized—in science (and throughout academia), then scientists (and all other academics) presumably feel the effects of the drive and of whether their work has been properly recognized.

This study investigates people's subjective appraisals of attainment in academic science using a sample of interviews with physicists who discussed social-psychological aspects of their careers, including...

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perspectives on their success (see Hermanowicz, 1998). The sample of physicists studied is grouped into differing levels of achievement. In response to questions about their achievement, physicists described how it feels to live and work across strata of science. The findings are significant because they identify costs that come with success and relative lack of success in at least one field of academic science, and at the same time identify a possible characteristic—self-doubt about achievement—developed by those who achieve at high levels in science.

BACKGROUND

Success in science, as in all fields, is marked by recognition. In the absence of recognition, success and failure have no meaning, for it becomes unknown when accomplishments are made at various magnitudes. In his extensive sociological analyses of science, Robert Merton (1973a, b, c) has explained the underlying significance of recognition. According to Merton, recognition from people who are competent to judge a contribution is the prime indicator that a scientist has contributed to knowledge. Such indication conveys that a scientist has satisfied the institutional goals of science—to extend certified knowledge. Recognition, in its various forms, conveys impact, in its many degrees. Recognition thereby serves as socially certified testimony of accomplishment, and scientists' drive for it thus becomes both expectable and essential to satisfying the goals of science.

The scientific community, like other occupational communities, is stratified on multiple dimensions (e.g., Cole and Cole, 1973; Hermanowicz, 1998; Long, 1978; Zuckerman, 1970). In the case of science, stratification has been most readily measured by publication productivity and citation rates (Allison and Long 1990; Allison et al., 1982; Allison and Stewart, 1974). Following Merton, inequalities in publication productivity and citation (itself a form of recognition) result in inequities in the distribution of recognition (Cole and Cole, 1967; Crane, 1965; Fox, 1985; Reskin, 1977; Zuckerman, 1977). This inequity, in turn, has been found to reinforce stratification of the community through a feedback process known as accumulative advantage and accumulative disadvantage. A theory that seeks to explain stratification in science, accumulative (dis)advantage holds that "certain individuals and groups repeatedly receive resources and rewards that enrich recipients at an accelerated rate and conversely impoverish (relatively) the non-recipients" (Zuckerman, 1977, pp. 59–60). In other words, the rich get richer at a rate that makes the relatively poor become even poorer.

In her work on Nobel laureates, Zuckerman (1977) discusses the effects of recognition on scientists' careers. Among these highly recognized scientists, she found few who, for example, believed recognition for their work had been delayed. Many more prize-winners were apt to comment on how the prize itself could curtail research productivity by the demands it brought, representing an ironic functioning of rewards wherein recognition diminishes rather than elevates scholarly performance (Zuckerman, 1977, pp. 238–238). In this work, too, the analysis is largely quantitative and attuned to issues of stratification processes, such as accumulative advantage and mobility within the career. What is more, as Nobelists are the focus of inquiry, the majority of scientists and their reactions to recognition, great or scant, go unexamined.

The most recent work in the sociology of science—in the constructivist vein—focusses not mainly on careers but on scientific knowledge and how it is selectively organized, shaped, and presented (e.g., Clarke and Fujimura, 1992; Jasanoff et al., 1995; Pickering, 1995). Thus, outside of the operation of the scientific reward system, it remains unknown how recognition affects scientists as people and the perspectives they develop on their careers.

In higher education literature, a line of inquiry has investigated job satisfaction. The studies, based on surveys, have typically drawn two conclusions: (1) scientists are highly satisfied, and; (2) this pattern holds generally across sectors of the higher education system, from community colleges to elite research universities (Blackburn and Lawrence, 1995; Clark, 1987; National Center for Education Statistics, 1990). The latest survey, conducted by that National Opinion Research Center and based on a sample of over 1500 full-time faculty members at four- and two-year institutions, concluded that 90% of the faculty surveyed were satisfied with their career choices and would probably make the same decisions again (National Opinion Research Center, 2000).

Clark's (1987) comprehensive study of the academic profession offers among the closest considerations of its practitioners' satisfactions and discontent. In surveys, he found that academics across the board generally report that they would choose teaching if they were to start all over again, do not feel "trapped" in their line of work, and like the institutions that employ them (Clark, 1987, pp. 218–220). In interviews, he found that academics air frustrations about their relatively low pay and students who they increasingly find ill-prepared (Clark, 1987, pp. 218–225). Despite a focus on the profession's internal variety, Clark found relative uniformity in satisfaction among academics working in various types of schools and fields.

However, Clark notes that there has been much to frustrate academics over the past two decades that would seemingly contradict self-reports of high satisfaction: salaries have not kept pace with inflation, teaching loads
have stiffened, research budgets have shrunk. But in Clark's calculus, these frustrations are off-set by intrinsic rewards of academic work. Research by Evans and Laumann (1983) shows that exit rates from professions, including college teaching, science, and engineering, are surprisingly high, challenging the conventional view that professions entail life-long commitment to their practice. In principle, high satisfaction would coincide with a profession's strong holding power over incumbents.

Throughout the survey research that predominates this literature, the academic profession is either treated globally, or no substantial differences are found within its parts. This is surprising, given the different nature of those parts. Three main questions are prompted by the results generated by this body of research. First, do interview methods allow for greater expansion than do surveys, whose close-ended formats may preclude the kind of detail that would render "satisfaction" a more nuanced phenomenon? The discrepancy that Clark found when utilizing these contrasting methods suggested that structures of significant sentiment revealed through interviews were hidden by surveys. Second, what is the relationship between satisfaction and self-doubt? It is conceivable that both can co-exist in single individuals, even in high magnitudes. But knowing more about the doubts and anxieties that systematically characterize the people of a profession would arguably cast greater light on what "satisfaction" means, since it is then viewed as part of larger whole of how work and career are experienced and understood by its practitioners. Third, does experience of academic reward systems vary throughout the profession? Drawing the conclusion that satisfaction is high throughout academe can indeed be empirically true in principle, but it seems to postulate a level of invariance that is at odds with variation in the structures and cultures of "academic worlds" that are seen to comprise the profession.

DATA AND DESIGN

A sample of sixty physicists interviewed about their careers forms the basis of this study. The physicists were interviewed as part of a broader national study of scientific careers that examined multiple social-psychological aspects of their experience of work, including their aspirations, attitudes and beliefs about success and failure, and perspectives on their own professional attainment—that is, how successful they believe they have become (Hermanowicz, 1998).

Conducted at the physicists' offices, the interviews averaged 90 minutes in length. All were completed under the assurance of both individual and institutional anonymity. All of them were tape-recorded, transcribed, and coded for analysis. Most of the physicists contacted expressed an eagerness to participate; the response rate for the study was 70%.

Moreover, all of the interviews were constructed and defined as occasions to talk about the academic career (as opposed to, say, family and leisure). Put in experimental language, all respondents received the same stimuli under the same "definition of the situation," but as we will see, their responses broke into variegated patterns.

Physicists were selected randomly within their departments. Female physicists were oversampled due to their overall small number in the field, but the women in the study were selected independent of any other criteria. Departments were selected on the basis of their ranking in the assessment of graduate programs conducted by the National Research Council (NRC) (Goldberger et al., 1995; Jones et al., 1982). All of the departments had masters and doctoral programs, although one of the departments had discontinued its doctoral program in the past 5 years. Top-, middle-, and low-ranked departments were selected from the NRC assessment as part of the research design. This was done on the premise that differences in these departments establish different conditions—both structural and cultural—for careers. Thus, the selection of departments across a spectrum aimed to maximize variation in careers in order to see how individual scientists view and experience them from various locations in the institution of science.

In earlier work, the author found that scientists' anxieties about accomplishment and recognition varied systematically by departmental type, indicated by their rank and the structure and culture of work obtaining in disparately ranked departments (Hermanowicz, 1998). In that work, strata of science were defined by department. Departments, however, are also internally diverse, and not merely dissimilar from one another as whole units.

The present work adopts a different measure of strata—physicists' publication productivity—in order to assess physicists' perspectives on recognition. As an index of strata, publication productivity may further differentiate scientists' responses to recognition than does departmental type, since in any given department one will likely find variously productive scientists in the same rank and specialty area. Publication productivity establishes an objective ground on which to study correlated characteristics of scientists' beliefs, including perspectives on recognition and outlooks on having reached any given echelon of science.

Curriculum vitae collected from each of the physicists establishes a record of their publication. Publications ranged in number from 6 to 324. The median was 32; the mean 57.49. Treating publication as a form of recognition, the sample is divided into strata that enable an examination
of physicists' perspectives on variously recognized careers. The bottom stratum consists of physicists who had published between 6 and 33 articles. The middle stratum consists of physicists who had published between 37 and 89 articles. The top stratum consists of physicists who had published between 100 and 324 articles. The strata are so divided because each breaking point (i.e., 33–37 and 89–100) represents the greatest distance between any two physicists' number of published works within the lower and upper levels of productivity. That is, no other two sets of points have greater distance between them than the ones employed at these lower and upper levels. The number of physicists by publication strata are listed in Table 1.

Number of publications is a central but, of course, not the only measure of productivity the scientific community uses to judge its members. Quality of publication outlet, for example, is typically used as a productivity measure. Citation of published works is another. Teaching and service, while more difficult to operationalize as measures, may also be used in departments as indicators of productivity and performance. Publication quantity is used here because of the importance of publication to academic work. All of the scientists' publications counted in the measure were peer reviewed. Publication thus constitutes a merit-based form of recognition of work that has passed the judgments of peers who evaluated the work—at least in principle—according to collectively generated criteria. As used, the measure includes only physicists' published journal articles, which in physics (as in many of the sciences) is the standard medium of publication. It therefore excludes books, monographs, edited volumes, and the like. If a physicist's article was re-published multiple times, it is counted only once for analysis.

Furthermore, comparing physicists' productivity independent of any measure of age would be misleading, since the relatively senior have more time to establish lengthier records than the relatively young. To control for the effects of age, the sample is divided by professional rank: assistant, associate, and full professor, which were the exclusive ranks held by the physicists. The ranks establish a temporal base on which to compare productivity levels across the professional age cohorts. The number of physicists by rank, and the average ages of the physicists by rank, are presented in Table 2.

Table 3 presents the number of physicists in the sample by productivity stratum and rank. The table represents a means by which to differentiate or control, for the effects of rank on productivity.

Notice that all of the top stratum and almost all of middle stratum is comprised of full professors. It is in the bottom stratum where more variety in rank is found. While this is expected simply because a majority of scientists will tend to publish less rather than more (Gust, 1973; Zuckerman, 1970, 1988), it does raise the question of how scientists—various ranks grouped in the same stratum—perceive their accomplishments. That is, being among the least productive as a budding assistant professor may be one thing, and that as a full professor quite another, a point to which I will return when discussing the accounts provided by physicists in this stratum of science.

Physicists' perspectives on their career success are operationalized in this work by their stated self-doubts about performance and self-perceived levels of accomplishment. Specifically, indication of self-doubt is based on responses to the question asked of each of the physicists: "What major doubts have you had about yourself?"

There are alternative means to understanding scientists' perspectives on attainment and recognition. For example, one could ask them directly; how satisfied they are with their accomplishments, and responses to this question could yield important insights. The present tact is adopted in order to explore how recognition interplays with any critical and/or

### Table 1. Physicists by Publication Stratum

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<thead>
<tr>
<th>Stratum</th>
<th>Number</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Top Stratum (100–324 articles)</td>
<td>11</td>
<td>18.3</td>
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<tr>
<td>Middle Stratum (37–89 articles)</td>
<td>18</td>
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<td>Bottom Stratum (6–33 articles)</td>
<td>31</td>
<td>51.6</td>
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<td>Total</td>
<td>60</td>
<td>100</td>
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### Table 2. Physicists by Rank and Average Age

<table>
<thead>
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<th>Rank</th>
<th>Number</th>
<th>Percent</th>
<th>Average Age</th>
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<tr>
<td>Full</td>
<td>35</td>
<td>58.3</td>
<td>55.8</td>
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<tr>
<td>Associate</td>
<td>11</td>
<td>18.3</td>
<td>44.4</td>
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<tr>
<td>Assistant</td>
<td>14</td>
<td>23.3</td>
<td>34.6</td>
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<tr>
<td>Total</td>
<td>60</td>
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### Table 3. Physicists by Stratum and Rank

<table>
<thead>
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<th>Stratum</th>
<th>Full</th>
<th>Associate</th>
<th>Assistant</th>
<th>Total</th>
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<tbody>
<tr>
<td>Top (100–324 articles)</td>
<td>11 (100%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>11 (100%)</td>
</tr>
<tr>
<td>Middle (37–89 articles)</td>
<td>15 (83.3%)</td>
<td>1 (5.5%)</td>
<td>2 (11.1%)</td>
<td>18 (100%)</td>
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<tr>
<td>Bottom (6–33 articles)</td>
<td>9 (29.0%)</td>
<td>10 (32.3%)</td>
<td>12 (38.7%)</td>
<td>31 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>35 (58.3%)</td>
<td>11 (18.3%)</td>
<td>14 (23.3%)</td>
<td>60 (100%)</td>
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negative self attributions about one's own accomplishments, thus attempting to establish what "nags" scientists at various productivity levels. Highly productive scientists, for instance, may be correlated with a determinable level of satisfaction. Exploration of their self-doubts (and those of all other scientists) offers a different and arguably more private lens through which to see how scientists experience accomplishment. In this sense, emphasis on self-doubt achieves a level of candor about attainment that satisfaction may fail to tap.

The paper proceeds to examine physicists' self-doubts through their possible relationships to recognition. Specifically, it may be postulated that: as productivity rises, self-doubts about accomplishment dissipate because scientists' standing in the scientific community has been affirmed through publication. Taking publication as a form of recognition, we may predict that the most recognized are in turn the most doubt-free. By contrast, we may assert that: where productivity is low, self-doubts will be intense because scientists' standing in the scientific community has yet to be fully affirmed. Thus, we would expect the least productive to exhibit the greatest self-doubt because they have yet to make their mark.

ACROSS THE STRATA

To organize the discussion, I will report findings from the data in terms of clusters into which physicists' self-doubts coalesced. This means of organization follows a version of the comparative method outlined by Ragin (1987), in which a qualitative analysis proceeds by identifying substantive patterns among cases, in this instance, cases of physicists' accounts of self-doubt. Discussion of clusters enables one to see how and in what ways self-doubts correlate with productivity. Ultimately, these patterns can be used to see if self-doubt and recognition work together in ways as might be predicted by the premises outlined above.

At the Top

We may begin comparison by examining the characteristic self-doubts arising for the most productive physicists, those who have published between 100 and 324 works. Eleven physicists—exclusively full professors—comprise this echelon in the sample. Their self-doubts cluster into just one area: self-doubts related to work accomplishment \((n = 11)\). In particular, doubts about work accomplishment centered on the themes of whether one would succeed in the course of one's long-term projects and activities; whether one has the capability to satisfy aims or goals of work, and; whether one has been accorded due recognition for achievements.

Several excerpts from the interview data presented below illustrate these widespread doubts.

\#58: There are doubts about whether one will succeed. When you get a series of two or three rejections on proposals and things, you worry about whether you can actually cut the mustard anymore or maybe your ideas are really wrong after all.

\#14: I always have doubts about myself. I'm always plunged into a situation that I feel totally unqualified, unprepared to do, and somehow you have to rise to the occasion. I say two things to myself, and that helps me overcome this awful feeling that I'm not qualified to do x,y,z. One, somebody else thought I was qualified, because otherwise they wouldn't have appointed me to it; and second, in most cases this is the first time a woman has been asked to do this, and not only do I have to make myself qualified, but I have to do a good job. Because if I don't, there will not be another one so soon. I really feel this burden on me all the time—to not only perform, but perform at a relatively above average level.

\#3: Insecurities... drive a lot of us. [Insecurities about] how good you are. How well you are doing. Whether you measure up. It probably shows in my reaction to not getting what I want or need professionally. One of my reactions has been to get upset.

\#7: I'm still trying to prove myself, that I can do this or that. I don't want to get out of the trenches too long. I worry that I'm not really on top of things. I always worry about the things I'm doing... It's so difficult to come up with something new... People here are typically ambitious people, overachievers. And they frequently feel that they have not achieved their full level; they feel that their colleagues are not respecting them. A lot of people want to command respect from their peers, from their colleagues.

In each of these passages, as in each of the interviews with top-echelon physicists, self-doubts bearing on accomplishments—and in particular the ability and rate at which they are made—take center stage. High achievement collectively characterizes physicists in this echelon; perhaps ironically, so do doubts about very achievement. The preponderant message struck in the above passages, as in the other accounts provided by top echelon physicists, appears to echo questions that the physicists routinely ask themselves in conjunction with their performance: "Am I good enough?", "Will I succeed?", "Do I have what it takes to be successful?" The premise outlined at the outset suggested that high recognition would bring a sense of strong professional security and affirmation, yet the passages convey a different reality, one to which I will return later in the article.

At the Bottom

Thirty-one physicists—9 full professors; 11 associate professors; and 14 assistant professors—comprise the bottom productivity echelon.
Self-doubts arising for these physicists, those who have published between 6 and 33 works, cluster into two core areas: self-doubts related to work accomplishment \((n = 20)\), and; self-doubts related to personal and family life \((n = 11)\).

Thus, clustering of self-doubt becomes somewhat more differentiated among the least productive than among the most productive physicists. Those doubts related to work accomplishment among the least productive parallel—in substance—the ones found among their most productive counterparts. Yet while the work doubts are parallel in substance between the top and bottom echelon physicists, the physicists who voice these doubts diverge in rank between the echelons. Recall that physicists in the top echelon were exclusively full professors. Those in the bottom echelon voicing preponderantly work-related doubts about performance are primarily assistant professors. A passage from one of the physicists, an assistant professor, in this productivity echelon highlights the trend:

\#56: I have a lot of doubts... I’ve had episodes of depression going through my career, especially at major turning points, like going from graduate school to postdoc, and then finishing my post-doc and finding a permanent position. Both of those times I had fairly major episodes where I was pretty depressed about my role in physics and what I was going to accomplish.

Another physicist, also an assistant professor whose account exemplifies this preponderant form of doubt about work, progress, and accomplishment, put it this way:

\#23: [I have] daily doubts [about myself]. Daily, I don’t have doubts about my technical abilities. I have doubts about whether I will ever have another idea. Will I ever come up with a new problem? My wife says that—we’ve known each other for nine years—she says it’s perfectly clear: there is this cycle where at the low point I’m just miserable and I can’t think what I’m ever going to do, and it may last a couple of days. Then some ideas will come up or other problems will begin to emerge, and then I will rise, and there will be this frenetic activity as things take shape and a paper emerges and concepts develop and everything builds. Out comes a paper, and then down [I go] again. She says it’s absolutely clear, and she doesn’t worry anymore because she has seen it and she knows with every trough there will be a peak. At the bottom, there is this terrible fear that I will never think of anything ever worth doing, that I’ve published my last paper.

In substance, it is difficult if not impossible to distinguish the above accounts with those of their senior counterparts, who similarly stress the imperative to publish and the anxiety that inheres in that drive.

Yet a notable group of physicists focused not on doubts related to work, but to those related to life outside of work, dealing with personal and family issues. The issues centered on relationships: marriage, friends, and children as significant causes of worry. Physicists in the bottom echelon voicing this type of doubt were primarily full or associate professors, people who had been in academia typically in excess of 8 years, and most much longer. The physicists quoted below illustrate the characteristics of this clustering. The first physicist is an associate professor, the second a full professor.

\#27: I would like to be able to develop a relationship with another person, a woman, that had any lasting power to it. None of my relationships last very long... This is my second marriage, and that’s coming apart at the seams. I’ve known many women. I don’t have any friends either. As far as female relationships go, none of them have lasted. I’ve had some intense ones, and I’ve had numerous ones, but none of them have lasted very long. There’s something wrong with that. I have a defect in the machinery somehow.

\#34: The doubts about myself have had more to do with personal things, with my wife, and with my children. My wife and I have some very fundamental disagreements over things that have lasted many years. What restrictions we put on our children. The way they might get punished when they got in trouble. We had differences about the way we would spend money or not spend money. These things have been over a long period of time had a very heavy impact. I’m unhappy about the fact that in some sense at least two of my children don’t really seem to be mature yet. The other thing that bothers me is to be—I’m fifty-one now—and to have as much debt as I have... When I total it up, there is all kinds of debt... I would say in the last few years [all of this] has affected me greatly... I have found it much more difficult to concentrate.

The accounts above differ substantively from the one below, provided by an assistant professor, who speaks not of personal problems or personal situations gone awry but of professional/domestic challenges, principally involving the negotiation of time between work and family.

\#9: I have doubts about how I spend my time. I think particularly as a woman there are also overwhelming feelings of guilt. You have to learn to reconcile. Guilt concerning whether you should be home with your children, you shouldn’t be here. And your relatives will be happy to tell you that in no uncertain terms. [My doubts are about whether] I am causing my children to become psychopathic murderers or something because I’m here at the office rather than at home. I feel torn. It’s been difficult.

Thus, physicists who discussed self-doubts relating to the quality of marriage and life outside of work tended to be older; they were almost always associate or full professors. Those who discussed self-doubts relating to children as they bear on work/family time concerns, such as the one immediately above, tended to be younger. Yet these latter self-doubts were not widespread. Self-doubts about children and time were voiced less often than doubts about other personal and family concerns and/or perceived dysfunctions. This may be partly due to a small sub-sample of women \((n = 4)\), which nevertheless constituted an over-sampling of
females in this work relative to their composition in the population of U.S. physicists. Women may be more likely to voice anxieties about time and its management in light of role conflicts and strains, although other research involving larger samples of women scientists has found that married women with children tend to be more productive than either married-childless women or single-childless women (Cole and Zuckerman, 1987). That research has suggested that women with children, while strained, also are compelled to be more organized and efficient in their time use, resulting in more consistent productivity.

Thus, overall, it is among the middle-aged and most senior least productive physicists where self-doubts are found to concentrate outside of work. This is the only notable group where self-doubts departed from what has proven to be the dominant pattern of self-doubts related to work accomplishment. Trends among the middle productive physicists reinforce this trend. For these physicists, almost all of whom are full professors who have published between 37 and 89 works, self-doubts cluster into just one area, mirroring that of the most productive physicists: self-doubts related to work accomplishment (n = 18). The substance of their self-doubts mirrors that presented in the above passages. One of the physicists—a full professor—in the middle echelon put it poignantly:

#12: [My doubts are] the same doubts that every physicist has. People in physics tend to compare themselves to people you can’t compare with—Einstein or Gel-Mann or Feynmann. In some sense that’s the standard and even though it’s a ridiculous standard you’re always wondering whether you’re a good physicist. So certainly I’ve had doubts about how good a physicist I was, but I don’t know any other physicist who hasn’t had those doubts.

Another of the physicists in the middle echelon, also a full professor, explained the substance of self-doubt in these representative terms:

#1: Of course [I have doubts]. Nobody has a career which is just uphill. Things don’t work out; you get frustrated; nothing seems to be working. The experiments you are doing just aren’t [working]; people aren’t interested; you aren’t getting interesting results; they are not going forward, etc., etc. There are dry periods. You think at those points that you’ve lost it. You begin to wonder if you are ever going to do anything good again.

DISCUSSION

Three major conclusions may be drawn about the data. First, the primary self-doubts experienced by this sample of physicists are those related to work, particularly with regard to level and rate of accomplishment, ability, and the time necessary to succeed. Second, these self-doubts are found across echelons of science, as measured by publication productivity. What is more, across the echelons, there is relatively little variation among professional ranks in the types of doubts experienced: typically, senior physicists are as apt to feel doubts about performance as are junior ones. Third, the most variation in self-doubt is found within the lower echelon of physicists, who are more apt than other physicists to voice doubts related to personal and family lives. In the lower productivity echelon, doubts about performance (like those related by physicists in the other echelons) are most typically voiced by junior physicists. Self-doubts about personal, marital, and family lives dealing with perceived dysfunction are most typically expressed in this echelon by associate and full professors, who have decelerated in their publication output and who are focused elsewhere.

An overall pattern from the data is clear and perhaps among the most surprising of findings: self-doubt pertaining to work accomplishment does not dissipate with achievement. Indeed, based on the clustering of doubts, it appears to grow more uniform, and perhaps even more intense as people rise in science. This pattern contradicts premises set forth at the beginning of the article, wherein highly recognized scientists were postulated to suffer the least self-doubt because their standing in science had been the most affirmed. The least productive scientists were postulated to suffer more from self-doubt, in light of their relative lack of affirmation through recognition by the scientific community. On the contrary, doubts about accomplishment grip all, and continue to be felt by those even at the top. In this regard, far from being lonely, people at the top have considerable company, both nearby in their immediate echelon and throughout the community of science. In general, insofar as self-doubt is concerned, life at the top bears remarkable similarity to lives lived throughout the echelons of science.

This builds on related research. Whereas earlier work found that anxieties about work vary systematically by departmental type, this study has revealed that doubts about work begin to cluster and become more uniform as productivity rises (Hermanowicz, 1998). This pattern likely holds across departmental types, wherein highly productive scientists throughout the departmental strata of science come to profess similar doubts: those centered on their very work-related achievements.

The present findings also relate to higher education research on job satisfaction, and may provide answers to the three main questions that this literature prompted with regard to this study. First, the interview method enabled scientists to reveal self-doubts previously unknown in the research literature. This renders satisfaction as a more nuanced phenomenon, which bears on the second point: Satisfaction and self-doubt can co-exist in single individuals. Previous research discovered that grounds for overall
satisfaction are most affirmed among elites whose dedication to work is high and whose success is most recognized (Hermanowicz, 1998). This study finds that such scientists are also apt to experience the greatest self-doubts about their work accomplishments. Third, self-doubts (and a more holistic view of satisfaction) does vary across academe, particularly in the lowest echelon, where scientists more often voice doubts emanating from their lives outside of work.

The patterns of self-doubt suggest that, far from dissipating as scientists rise, they may grow more keen. Why might this be the case? The answer may flow from Merton's original formulation of recognition. Those who continue to produce are likely those who are most committed to science and thus to satisfying its institutional goals. Their investment—not only of time and energy—but of self makes their identities highly dependent on the reward system of science. Their productivity places them in the position of having the most to gain, but also the most to lose: a great accomplishment is simply a reminder that one must now accomplish something greater. This anxiety, generated by a drive to sustain if not surpass prior success, may be viewed to manifest itself empirically in the self-doubts scientists have voiced about their performance.

What is more, the point at which these self-doubts begin to intensify appears to occur early in the productivity climb. Middle-echelon physicists are uniform in their doubts and, just like those at the top, experience self-doubts that bear on the quality and magnitude of their performance. Thus, in the scheme of output, it does not take long before doubts about performance settle in. Beginning commitments to science, translated into productivity, also produce these anxieties, which do anything but go away as productivity increases. This work suggests that short of lessening with achievement, self-doubt may in fact be necessary to achieve at increasingly high levels.

Why do self-doubts among the least productive physicists evidence more than one pattern? Two plausible explanations are suggested. First, the personal and family doubts experienced by these physicists may be so intense as to overwhelm those related to work. This explanation assumes that these physicists have self-doubts about work, but they are buried in relation to graver ones about life outside work. Yet this explanation would not account for why more productive physicists would stay silent about such doubts, particularly when their investment in science would seemingly exert more strain on their non-occupational roles.

Second, personal and family doubts may be most experienced by physicists who have disengaged from work. Doubts about life outside of work may be more intense because workplace controls have ineffectively sustained physicists’ commitment and productivity. This explanation assumes that these physicists have self-doubts about life outside work, because work has been made less salient in light of social-organizational features that, in effect, facilitate distancing from work roles. They identify more strongly with non-work lives and concerns. The two explanations are not necessarily mutually exclusive: in principle, both can operate simultaneously in a given academic department.

Are the results generalizable to other academic fields? A prior line of work suggests that fields may vary in how members define success and failure (Braxton and Hargens, 1996; Hargens, 1988; Hargens and Hagstrom, 1982). This line of work has investigated the level of consensus and/or paradigmatic development in fields, which shape how members of given disciplines define accepted theories for phenomena, the importance of specified problems for research, and appropriate methods for conducting research, among other conventions that characterize fields. Among the principal findings in this literature is that low-consensus fields (such as English and sociology) may use more particularistic criteria in awarding recognition than do high-consensus fields (such as physics and chemistry), where criteria used in awarding recognition may be more universalistic (Beyer, 1978; Biglan and Trowler, 2001; Hargens, 1988, 1990; Pfeffer et al., 1977; Zuckerman and Merton, 1971).

If these premises are true, then in fields where one finds success defined more universalistically (and thus more strictly), one might expect to find people whose self-doubts are both more specific (rather than diffuse) and more intense. In other words, when criteria for success are clear, so then may be the sources of self-doubt. When clear and limited in number, the sources of self-doubt may fuel an intensity in the doubts that arise when individuals believe they fall short. Correspondingly, in fields where one finds success defined more particularistically (and thus more loosely), one might expect to find people whose self-doubts are more diffuse (having many referents) and possibly less intense. In other words, when criteria for success are less clear, sources of self-doubt can be more numerous. This may mute an intensity in self-doubt because individuals do not use a well-established baseline against which to measure themselves and others. At the same time, this reasoning holds that members of fields marked by low overall consensus, but who work in sub-specialties marked by high consensus (e.g., demography within sociology; experimental social psychology within general psychology; biological anthropology within general anthropology) might exhibit self-doubts that run parallel to those in other high consensus fields. In short, looking across academic fields, the type and intensity of self-doubt may systematically differ based upon the stringency with which disciplinary members define success.
CONCLUSION

This work has investigated physicists’ perspectives on attainment across strata of science. It has examined these perspectives via physicists’ self-doubts in their roles. Like other working professionals, physicists also undoubtedly have professed satisfactions, which also inform their sentiments about attainment, big and small. Self-doubt has been used in this work as an additional lens with which to see how success looks to those having reached various levels of achievement. While joys may be found in various ways and degrees across these echelons, they do not come without costs, some of which are found in anxieties bred by very achievement.

Merton spoke of the Matthew Effect, named after the Gospel, wherein already recognized scientists receive disproportionate recognition for their contributions, while relatively unknown scientists tend to get disproportionately little recognition for comparable contributions. “For unto everyone that hath shall be given and he shall have abundance: but from him that hath not shall be taken away even that which he hath” (Merton, 1968, p. 443, 445). Based on the present findings, we may speak of an ancillary effect wherein the recognized—however great or small—are disproportionately plagued by feelings that their contributions should continue at an accelerated rate: From those who have given, more is expected.

Such a dynamic may not be peculiar to science, but found particularly in those lines of work, such as business and sports, where success is morally construed as an occasion to seek something more. People can indeed rest on their laurels, but the costs are high. The fruits of winning the league championship last only from the end of one season to the beginning of the next. In physics as in other arenas, life at the top brings rewards, but also reminders of what it takes to stay and to move up the strata of science.

REFERENCES


