Military science as a social institution and social aspects of the organization of scientific activity by the example of the military Academy

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The article provides an analysis of the status and prospects of sociological research of military science. Key problems of social studies of science are considered by the example of the military Academy. The features of social status of military-men scientists and specificity of the organization of scientific work in a military institution are established. The impact of recent reforms on the structure and status of the military scientific schools are studied.

Keywords: military science, military sociology, military-men scientists.

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Peak Performance in Academic Science

Do careers in science have peaks? It is often thought that they do, and that they are especially likely among the young. Using a sample of academic physicists, this study examines performance in science by determining whether peaks mark scientific careers, how common they may be, and how they might vary organizationally. Two different types of career peaks are examined and compared with each other: those established subjectively by scientists' *perceptions* and those established objectively by scientists' *performance*. The article uses career peaks as a means to examine the construction and maintenance of status orders. Subjective and objective status orders operate as differing means by which legitimation is established in stratified fields of activity, as emblematic in science and scholarship.

Keywords: Careers, Stratification, Productivity, Status.

An ideology of achievement pervades modern societies (Dahrendorf, 1979; Grusky and Hauser, 1994; Lenski, 1964; Lipset and Bendix, 1959; McClelland, 1961; Urton, 1981). The ideology is institutionalized such that it is now commonplace to identify a rhetoric that speaks variously of a drive "to be number one" (Best, 2011; Goode, 1978), a quest "to be at the top" (Frank, 1985), among "the best" (Cookson and Persell, 1985; Khan, 2010), and, at root, "to win" (Duina, 2010).

In modern societies, professions — business, medicine, law, engineering, architecture, art and science — have served as the most vaunted locales for achieving this celebrated success, for it is in the professions, as Bledstein (1976) has argued, where middle-classes are able to realize status gains through aspiration (also Ben-David, 1963). But, as Fox and Ferri (1992: 257) have observed, of all the occupational settings in which individual achievement is most firmly institutionalized and idealized, science and scholarship, the stalwarts of academe, are socially situated above the rest.

The reason is fundamentally bibliometric. In science and scholarship, work contributions are carefully recorded and archived through publication. This practice serves a goal of growth based on a rational arrangement of cumulative understanding. Achievements are made incrementally by drawing upon and citing individual names that compose a work genealogy such that, in principle, a professional community is able to identify and assign appropriately apportioned credit when and to whom recognition is due.

Recognition is central to science and scholarship because it is the prime indicator that a scientist or scholar has fulfilled the institutional goals of academe, to extend certified knowledge (Merton, 1973a). It is for this reason that scientists embark on quests to discover: it is their job to generate new knowledge, but new knowledge is understood to have been generated only when individuals are recognized by competent peer-judges for having done so. It is for this reason also why scientists register concern about priority, that is, who is the first to make a given contribution and who is, by the same token, "scooped" by others working competitively as part of a professional community guided to solve collectively-generated research problems (Merton, 1973a; 1973b). Modern parlance may speak of a widely apparent drive to be "number one." But in science this general goal is the *raison d'etre* of the professional role (Ben-David, 1971).

While publication productivity is well-documented, few have ventured to ask what scientists think about their careers in light of this vast production. For a profession predicated on achievement and recognition, this absence is notable: its members likely possess strong beliefs about their accomplishments (and lack of accomplishment). Do scientists believe they perform in accord with these lofty aims?

This article examines whether and when scientists are at their best in the course of their article output, the staple of their work. The discussion explores the following questions: 1) Are there peaks in a scientific career and, if so, how frequent are they? 2) Do they vary organizationally? 3) How might subjective and objective peaks, so differentiated, vary empirically? Answers to these questions cast light on the rewards, real and imagined, of embarking on a scientific career.

Performance in Science: Context and Contribution

What do we know about performance in science? A body of work has examined processes of social stratification in this institutional domain. Research publication is typically used as the proxy of performance because it is thought to best capture behavior in accord with institutional goals (as discussed above), because it is thus a highly standardized component of academe, and because, therefore, it is readily measureable. Two common beliefs surround productivity as measured by publication. First, people do their best work when they are young. Second, productivity declines with age.

With regard to the first belief, Zuckerman (1988) explained why it might be tempting to suspect that there is a relationship between age, creativity, and achievement. A pantheon of great figures is customarily invoked (Hermanowicz, 1998). This enables one to turn to the Newton at twenty-four for the invention of calculus, to the Einstein at twenty-six for the elaboration of relativity, to the Darwin at twenty-nine for the theory of natural selection, and so on (Zuckerman, 1988, 533–534; also Merton and Zuckerman, 1973 and S. Cole, 1979). But rarely are historic events, or the historic individuals who bring them about, generalizable to others, despite the inspiration that such events and individuals engender. What is more, we know that a substantial fraction of the scientific community goes on to produce (Bayer and Dutton, 1977; S. Cole, 1979; Reskin, 1979) and to produce work of high quality (Hermanowicz, 2009; Simonton, 2004), well after their twenties.

To consider the second belief — that productivity declines with age—we may turn to cumulative advantage and disadvantage, a theory developed by Merton (1977) and elaborated by others to explain inequality in science. The theory explains how increasing disparities come to characterize the "haves" and "have nots" over the course of a career. "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: 59–60).

Allison and Stewart (1974) incorporated the theory of cumulative advantage to account for productivity differences among scientists. They noted that publication productivity among scientists tends to be highly skewed. Productive scientists maintain or increase their productivity, while scientists who produce little go on to produce even less later on. We note the major implication: the distribution of productivity becomes increasingly unequal as a cohort of scientists ages. The magnifying inequality over time is associated with change in the amount of time that scientists spend on research. These patterns have been corroborated elsewhere (Allison, Long, and Krauze, 1982).

Likewise, Cole (1979) explains change in productivity as scientists age by the operation of the scientific reward system. The reward system encourages scientists to continue publishing when their (early) work is favorably received and, by contrast, discourages those whose work is not favorably received. Consequently, over time, the reward system works to reduce the number of people who are actively publishing. "Those who continue to publish throughout their careers are a 'residue' composed of the best members of their cohort. Increases in productivity through the thirties and into the forties are shown to be a result of command over the resources necessary to be highly productive," (Cole, 1979, 958), an empirical manifestation of cumulative advantage (also Blackburn, 1979; Stern, 1978).

A related body of work has examined the organizational bases of stratification in scientific careers. Crane (1965) found that scientists at major universities are more likely to be productive and garner recognition than scientists at minor universities. "Scientists trained and later hired by minor universities had difficulty developing continuity in their research activities and tended to be differently motivated than scientists trained and hired by major universities" (Crane, 1965, 699). This finding is consistent with patterns of cumulative advantage discussed above. Major universities may not only recruit highly motivated personnel, but they also confer resources that further fuel productivity (Hermanowicz, 1998; 2009). Long (1978) found that the effect of departmental prestige on productivity is demonstrably positive over time. One's work stands a greater chance of being recognized when the author is located in a prestigious department or university. Cole and Cole (1967) concluded that prestigious departments concern themselves more with quality than with quantity in the evaluation of scientific work, and that publication quality best predicts the accrual of recognition in the form of awards, positions in prestigious academic departments, and renown among colleagues. The conversion of these organizational conditions into output is reinforced over the career, helping to account for why academics at elite institutions tend to out-produce academics employed elsewhere.

These patterns in turn bear on the work of Long and McGinnis (1981), who found that individual productivity conforms to the characteristics of the context in which a scientist works, a finding elaborated by Braxton (1983). Allison and Long (1990) reinforced this observation by concluding that the effect of department affiliation on productivity is more important than the effect of productivity on departmental affiliation. Thus, productivity gets conditioned by where one works in academe (Fox and Mohapatra, 2007; Hermanowicz, 1998; 2009). The career is formatted organizationally. This reality calls attention not only to the patterns of a career arc, but also to how an arc gets established. The first academic position bears extraordinary consequence: it structures the entire career, playing a prominent role in a stratification process that intensifies over time (Long, Allison, and McGinnis, 1979). This sequence is especially pronounced when academic jobs are scarce and mobility low (Allison and Long, 1987; Long, Allison, and McGinnis, 1979), a condition generally characterizing academe (particularly arts and science fields) since the mid 1970s (Bowen and Sosa, 1989; Breneman and Youn, 1988).

We may conclude that extant work on performance in science establishes two modes by which careers are differentiated: career phase and organizational base. Studies of cumulative advantage convey how research performance is stratified over time, that is, over a set of phases in an academic career in which scientists age. Early success spells continued productivity; lack of recognition brings about productivity decline. Studies of scientists working in departments and universities convey how organizations condition research performance. Advantage lies in the elite, where scientists are socially controlled by immediate peers to produce and where their productivity benefits from organizational resources, fiscal, physical, and symbolic.

Yet we do not know how scientists themselves experience these permutations. Are there points in the career when scientists are especially satisfied with their productivity, and is such satisfaction patterned by the type of organization in which they work? The present study examines whether "peak points" arise in scientific careers and how they may be patterned by career phase and organization. In light of the literature, this article is guided by the following three propositions:

Proposition 1: Scientists will subjectively register peaks at their most advanced career stage to date.

Scientists will assign peaks at their most advanced career stage to date, since productivity, for many, continues with age. Even though other scientists produce less with time, only a subset stops producing altogether. Consequently for all scientists, even the less productive ones, the greatest accumulation of work provides a basis on which to register an "all-time high."

Proposition 2: The greatest share of subjective and objective peaks will be found in elite (research-oriented) departments.

Elite departments will possess the greatest share of peaks because organizational conditions predispose their members to success. Their publication productivity is greater, and thus the probability of subjectively experiencing "a high" more likely. Moreover, the greatest proportion of people continuing to publish are in elite departments; thus it is in their records where the most objective peaks will be found.

Proposition 3: Objective peaks will parallel subjective peaks in number.

Research and publication are staples of the scientific life, a belief sustained by the scientific community independent of individual variation in output. Notable productivity in a scientist will therefore engender notable self-sentiment about it.

Data and Methods

Data for this article were generated by a larger study of scientists' careers (Identifying Reference). As part of the study, scientists were interviewed about their perceptions of their careers, including ideas about success and failure, satisfactions and dissatisfactions, aspirations, and continuities and changes in career progress. The data sought to place scientific careers in context by obtaining fine-grained, detailed views about how scientists experience their work and make meaning of their careers as they unfold over time. To serve these goals, fifty-five scientists were interviewed about their qualitative career understandings. All of the scientists were physicists. Interviews averaged sixty minutes in length. All were conducted by the author. The response rate of the study was 93 percent.

Subjective data on scientists' career peaks are derived from the question: "At what age would you say you have been the most satisfied in your career?" The question was followed by the probe: "Why then?" Scientists fielded the questions in terms of their research performance. Responses were coded into career phases. That is, the question was nestled in a discussion about their research careers (for the interview protocol, see Identifying Reference, 275–278). The question is an indication of a research "high." The career phases follow a convention of speaking of academic careers in terms of "early," "middle," and "late." Scientists often used these labels themselves in discussing their careers and could readily understand the meaning of the labels in discussion.

Scientists were sampled by institutional type and by career phase. Thus, the present data allow a comparison of peak points by the types of settings in which scientists work and the points in their careers from which scientists have provided their views. The institutions, and more specifically the departments of physics from which the individual scientists were sampled, were selected on the basis of their ranking in the national assessment of programs conducted by the National Research Council (hereafter NRC; Jones, Lindzey, and Coggeshall, 1982; Goldberger, Maher, and Flattau, 1995). Top-, middle-, and bottom-ranked departments were selected in order to maximize a variety of scientific careers forged in academic sectors of employment.

The institutional types are situated along a research-teaching continuum. One type emphasizes research in the presence of teaching. These institutions, mostly private but some public, are elite research universities, such as, Princeton University, Johns Hopkins University, or the University of Michigan and have departments of physics ranked at or near the top of the NRC assessment. A second type emphasizes teaching in the presence of research. These institutions, mostly public, are regional comprehensive universities, such as the University of Toledo, the University of Tulsa, or Wichita State University, and include departments of physics that are ranked near the bottom of the NRC assessment. The third type constitutes a hybrid of these organizations in which there is a dual emphasis on research and teaching. These institutions are predominantly large state schools, such as the University of Missouri, the University of Kansas, or the University of Florida, and have departments of physics ranked in the middle of the NRC assessment.

For clarity of data presentation and explanation, I will refer to these institutional types as "research oriented," "teaching oriented," and "research/teaching oriented." All of the institutions in the sample offer graduate degrees in physics (though two of three institutions composing the "teaching oriented" type offer only masters degrees). Thus, it is understood that research and teaching are found in all three institutional types. The labels are intended to convey the preponderant "center of gravity" of work in, and the overriding organizational identity of, the institutions.

The scientists in the departments were sampled by three general career phases: mid, late, and post, this latter-most phase including those who had retired. Thus, in the present work, all of the scientists are at least at mid career. This ensures a sufficient length of time in which to identify and speak reasonably about a "peak" in a career. Table 1 summarizes the research design.

Table 1

Number of Scientists, by Career Phase and Institutional Type

Career Phase	**Research Oriented**	**Research/ Teaching Oriented**	**Teaching Oriented**	**Total**
Mid	8	6	7	21
Late	6	4	5	15
Post	9	5	5	19
Total	23	15	17	55

Copies of each of the scientist's complete curriculum vitae were obtained. In the present work, subjective data from scientists' interviews can be compared with "objective" data from each vita. Careers in science, and in academe generally, typically last 30 years; 40 years or more is considered very long and, where it occurs, is most frequently found among elites habitually engaged in a routine of research (Clark and Hammond, 2001; National Research Council, 1991). A "peak" connotes not simply a discrete point in time, but a general time period in which one is "at one's best" in the context of a broader career. Almost never do scientists speak of a specific year in identifying a peak, but rather to a period of time (e. g. "when I was in my early thirties," or "toward the end of my career"). Thus, a peak incorporates an idea of phase. Moreover, a peak is notable, a significant deviation from the norm. It therefore possesses remarkable quality to distinguish it from ordinary performance. A peak then also incorporates an idea of magnitude. These conventions guide a construction of an "objective peak."

A universal means by which to measure career peaks does not exist. Rather, it must be specified for the given work (Galenson and Weinberg, 2000; 2001; Simonton, 1988; 1991; Weinberg and Galenson, 2005). Two means of measuring objective career peaks are used in the present study. Multiple measures allow us to compare results generated by one against the other for similarities and/or differences.

To incorporate the idea of magnitude, the first measure of an objective peak is: two standard deviations above the average number of publications per year written by a given individual scientist. The second measure of an objective peak is: two standard deviations above the group average of publications. "Group" refers to the other scientists in the sample who work in the same department.

The period of publication extends from the onset of publication, usually in graduate school, to the time scientists were interviewed as part of this study. Only peer-reviewed articles are included in the measure. This is so because peer-reviewed articles constitute the standard medium of publication in physics, and throughout the physical and biological sciences, mathematics, and engineering. Books, reviews, conference proceedings, and other publication genres, even if peer-reviewed, are excluded here because they fall outside the modal publication format for physics.

Objective peaks are thus operationalized endogenously (measured against one's own history of productivity) and exogenously (measured against the departmental group history of productivity), which further satisfies an aim of comparing results generated by alternative measures. With regard to the endogenous measure, fields contain scholars who publish in a variety of ways, as "mass producers," for example, or as "perfectionists" — those who publish relatively little but of high quality (Cole and Cole, 1967). By an endogenous measure, peaks are not biased by voluminous productivity; it is not just ultra-productive scientists who may enjoy a peak or who may be deemed outstanding. Scientists producing at varying levels of output can, in principle, register a career peak relative to their own career-span performance. With regard to the exogenous measure, discussion of the literature highlighted how a scientist's productivity tends to reflect the productivity in the organization in which the scientist works. Members of academic departments tend to be grouped at the time of membership entry according to principles of shared goals, including goals about productivity. Group performance can be used as a condition against which to assess individual performance.

It is noted that, so defined, objective peaks are operationalized by publication quantity independent of publication quality. Consequently, the measure is insensitive to very low-volume but high-quality output. If a quality measure were used, a majority of the population of scientists would be excluded from analysis, since the bulk of their work does not appear in what the scientific community defines as the "top" journals (Cole and Cole, 1973). But because their work has been published, it has been judged through peer-review to constitute a contribution to the stock of knowledge and therefore, however voluminous, to the advancement of science. Consequently, quantity of output serves as a more inclusive indication of peak performance than output quality.

To incorporate the idea of phase as part of a peak, objective peaks are operationalized to include a 10 year period of time from the onset of the peak (i. e., that year in which a scientist's publications were at least two standard deviations above the mean). If there is a gap in time between one ten year period of peak performance and other, we may speak of multiple peaks in a career.

To designate where in a scientific career an objective peak occurs, data from each scientist's vita were coded by the following six phases: graduate school, post-doctoral appointment, early career, mid career, late career, and retirement. The span of time encompassing scientists' graduate education and post-doctoral appointments is indicated on each scientist's vita. "Early career" is defined as the first eight years of a regular faculty appointment. This period customarily includes the entry academic rank of assistant professor and may straddle the rank of associate professor. "Mid career" is defined as years 9 thru 20 of a regular faculty appointment. This period customarily includes the rank of associate professor and the rank of full professor. "Late career" is defined as years 21 to the time of retirement. Unless academics have not been promoted, all are customarily full professors in this time period. In using a sample of the present size, the discussion is exploratory and intended to identify suggestive, not definitive, patterns of objective and subjective career peaks.

Publication data for the scientists in the sample are presented in table 2. Two patterns are noteworthy. First, in general, publications increase as institutional research orientation increases, a pattern consistent with processes of cumulative advantage and disadvantage discussed earlier.

Table 2

Quantity of Publication, by Career Phase and Institutional Type

Career Phase		Institutional Type		
		Research Oriented	**Research/Teaching Oriented**	**Teaching Oriented**
Mid-Career Scientists	Max	124	68	94
	Min	41	27	17
	Mean	73.0	44.0	50.0
Late-Career Scientists	Max	330	260	76
	Min	46	53	6
	Mean	148.0	128.0	35.2
Post-Career Scientists	Max	536	116	111
	Min	44	19	9
	Mean	159.1	82.4	52.0

Second, publications increase across career phases for scientists at research oriented institutions, constituting an ascending linear publication pattern, which is also consistent with processes of cumulative advantage and disadvantage. At research/teaching oriented institutions, however, the pattern of publication is an inverted U-shape: publications rise between mid and late career, but then fall between late and post career. This pattern may not be inconsistent with processes of cumulative advantage and disadvantage: it suggests that advantage exists through a comparatively long portion of the career, but does not extend as far as it does for scientists at fully research oriented institutions. At teaching oriented institutions, scientists' publication patterns are U-shaped: publications decrease between mid and late career, but then increase between late and post career. This pattern is inconsistent with processes of cumulative advantage and disadvantage. Scientists in the mid career cohort received their Ph.D.'s after 1980 and entered the job market at a particularly competitive time. The pattern suggests that teaching oriented institutions were in a position to hire particularly productive scientists who compose the mid career cohort. Many of these younger scientists were trained in elite graduate programs equivalent to scientists in the same cohorts who got jobs in more research oriented universities.

Scientists At Their Best

<u>Subjective Peaks</u>

Given the difficulty of science, the low likelihood of lasting influence and recognition, and the permutated patterns of productivity among cohorts of academics as they age, are there "peaks" in a scientific career? Scientists <u>believe</u> so. Of the fifty-five scientists interviewed, only two claimed their careers to have had no peak whatsoever. Eight reported that their careers were "consistent" or "uniform," underscoring a constancy of engagement.

The remaining forty-five scientists interpret their careers to have peaked at particular times. But the attribution of when in the career this occurs is notably various. Fourteen of them (or 25.5 %) believe their careers to have peaked in their early careers. Another fourteen claim a peak to have occurred in their mid careers. Nine (16.4 %) identify a peak in late career phases. Together, thirty-seven (67.3 %) of the scientists understand their careers to have peaked at some point in the course of their academic career.

Eight (14.5 %) of them believe their careers peaked outside of the academic career proper: 2 (3.6 %) in retirement, 6 (10.9 %) in a post-doctoral appointment. The post-doctoral appointment constitutes the first phase in which scientists believe their careers could peak; none attributed peaks to any prior point in time (graduate school one possibility). The post-doctoral appointment, thus, is understood at least by some to commence the professional scientific career. Scientists are morally oriented to publication and, despite a continuation of training typically a part of post-docs, the phase is cognitively set apart from the more formal educational regime of graduate school.

These data are summarized in table 3. At base, the data indicate the prevalence of beliefs about career peaks in science. Peaks are more common than not, this despite the ardor of work and despite the low probability of achieving "ultimate" levels of success (Zuckerman, 1977). Peaks are also felt to occur at varying times. In the minds of scientists, a peak has an equal chance of occurring in early or mid career, and a non-trivial chance of occurring in late career (and even after the formal career has ended).

Table 3

Distribution of Subjective Peaks, by Career Phase

	N	**Percent**
No Peak	2	3.6
Uniform/Consistent	8	14.5
Post-Doc	6	10.9
Early Career	14	25.5
Mid Career	14	25.5
Late Career	9	16.4
Retirement	2	3.6
Total	55	100.0

By the same token, a sizeable fraction feels their peak to have occurred even before they became an assistant professor: their work subsequently has not matched in subjective satisfaction what they experienced as post-doctoral researchers. Over one-third (36.4 %) of the sample believe their careers to have peaked by the end of their early career. For a somewhat greater portion (41.9 %), a peak arrives between the mid and latter phases.

A component of these temporal identifications, however, involves the phase of the career in which scientists provide the identifications. All have an equal chance to identify phases up to and including mid career as a peak, but not all are equally able to specify phases that come after this point (a mid career scientist cannot attribute a peak to late career, etc.). Thus, it is instructive to consider scientists' identifications of career peaks by the career phases in which they are rendered. Table 4 presents the results.

The post-doc stands a greater chance of being identified as a peak by mid career scientists than by late and post career scientists. But when examining the phases of the formal academic career — early, middle, and late — it is noteworthy to discover the distribution of identifications from scientists speaking at middle, late, and post career phases.

Table 4

Scientists' Subjective Career Peaks, by Cohort at Time of Identification

Cohort	No Peak	Uniform/ Consistent	Post-Doc	Career	Early Career	Mid Career	Retired	Late Total
Mid-Career	1	3	4	7	6	--	--	21
	5.0	14.3	19.0	33.3	29.0			100.0[2]
Late-Career	1	1	1	2	4	5	1[1]	15
	7.0	7.0	7.0	13.3	27.0	33.3	7.0	100.0[2]
Post-Career	0	4	1	5	4	4	1	19
	0.0	21.1	5.3	26.3	21.1	21.1	5.3	100.0[2]
Total	2	8	6	14	14	9	2	55
	3.6	15.0	11.0	25.5	25.5	16.4	3.6	100.0[2]

[1] A scientist in his fifties, in late career, had recently retired.
[2] Percentages do not add to 100 due to rounding.

Patterns are notably indistinctive. Across the career phases in which scientists spoke, from mid to late to post career, there is remarkably little variation in where scientists identify themselves at their prime. That is, position in the career does not appear to significantly influence where a peak is identified (an exception, again, the post-doc, where mid careerists — those least removed from that consequential stage — are more apt to identify it as a peak than others). Scientists in their post careers (n = 4, 21.1 %) are the most likely to identify their career as uniform, suggesting that length must presuppose consistency.

Do identifications of peak career vary by the type of institution in which scientists work? Are elite scientists, who work at research oriented institutions and allegedly the most likely to continue publishing well after their early careers, more apt to identify a career peak than others? The answer to both questions turns out to be no.

As the results in table 5 indicate, scientists at research oriented institutions are no more likely than those at teaching oriented or research/teaching oriented institutions to identify

Table 5

Scientists' Subjective Career Peaks, by Institutional Type

Institutional Type	No Peak	Uniform/ Consistent	Post-Doc	Early Career	Mid Career	Late Career	Retired	Total
Research Oriented	0	4	5	5	5	3	1	23
	0.0	17.4	22.0	22.0	22.0	13.4	4.3	100.0[1]
Research/Teaching Oriented	1	2	0	5	4	3	0	15
	7.0	13.3	0.0	33.3	27.0	20.0	0.0	100.0[1]
Teaching Oriented	1	2	1	4	5	3	1	17
	6.0	12.0	6.0	24.0	29.4	18.0	6.0	100.0[1]
Total	2	8	6	14	14	9	2	55
	4.0	15.0	11.0	25.5	25.5	16.4	4.0	100.0[1]

[1] Percentages do no add to 100 due to rounding.

a peak in their careers. What is more, institutional type is, insofar as these data convey, not associated with the phase in the career in which scientists identify their peak as having occurred. That is, the early career is identified about as often as a peak by scientists in all three types of institutions. The same is roughly true for mid career and for late career.

The post-doc is identified as a peak more by scientists in research oriented institutions (*n* = 5, 22.0 %) than by all others. It is noteworthy that work in such an early career phase would be regarded as the most satisfying by scientists whose publishing activity extends over the greatest portion of a career. It also suggests how instrumental a successful post-doc appointment may be for scientists who go on to have careers in the most research oriented institutions, an instance of cumulative advantage.

Finally, given the ubiquity of subjective peaks, do scientists experience more than one? While scientists of varied career phases and institutional locations were apt to identify a peak in their careers, almost all identified only one. Just two scientists identified second subjective peaks.

Scientists overwhelmingly claim to have experienced a "high" somewhere in the course of their careers. But their careers are significantly varied on many dimensions, including publication productivity. We come to the point to ask if there are indeed objective peaks in their careers, especially in light of scientists' variation in output, and in what way these peaks might coincide with or contradict scientists' subjective appraisals.

Objective Peaks

There are indeed objective peaks in scientists' careers, and they bear distinctive patterns. Beginning with the endogenous measure, in which scientists' productivity is measured against their own performance, the first notable feature of objective career peaks is their comparative lack of frequency, results of which are presented in table 6. Scientists' publication records evince one peak for twenty-seven (49.1 %) of the sample. Seven scientists produced at a rate in which their careers peaked twice; one scientist's career peaked three times, the greatest number of objective peaks established by a scientist in the sample.

Table 6

Endogenous Objective Peaks in Scientific Careers

	N	Percent
No Peak	20	36.4
1 Peak	27	49.1
2 Peaks	7	12.7
3 Peaks	1	1.8
Total	55	100.0

Twenty scientists (36.4 %) had no objective peak (recall that only 2 said they experienced no peak). Thus a discrepancy: more scientists are apt to believe their careers had gone particularly well at a point in time than their records indicate. Scientists see themselves as successful despite objective grounds that portray a contrasting reality.

The greatest share of objective peaks are found in research/teaching oriented institutions, as shown in table 7 (80.0 %, compared to 65.2 % in research oriented institutions and 47.1 % in teaching oriented institutions). This finding is surprising, since prior literature

Table 7

Endogenous Objective Career Peaks, by Institutional Type

	Objective Peaks					
Institutional Type	0	1	2	3	Peaks 1–3	Peaks 0–3
Research Oriented	8	12	2	1	15	23
	35.0	52.2	9.0	4.3	65.2	100.01
Research/ Teaching Oriented	3	9	3	0	12	15
	20.0	60.0	20.0	0.0	80.0	100.0
Teaching Oriented	9	6	2	0	8	17
	53.0	35.3	12.0	0.0	47.1	100.01
Total	20	27	7	1	35	55
	36.4	49.1	13.0	2.0	64.0	100.01

[1]Percentages do not add to 100 due to rounding.

argues that scientists in research oriented institutions are more likely to continue publishing across their careers. Moreover, 8 (35.0 %) of the scientists in research oriented institutions had no objective peak. The patterns are suggestive of two processes at play. First, a greater democratization of science and scholarship in the contemporary era may enable opportunity for achievement. This would help to account for why scientists at a wide range of institutions can realize peaks, and why those at institutions possessing many research resources (short of comparable prestige) can compete favorably with those at the most research oriented institutions. Second, the data may convey a "victim of success" process. If one is consistently productive at high levels in an intensive research institution, it will take an especially stellar record of output to register a "peak." This would help to account for why comparatively many scientists in the sample at research oriented institutions had no peak.

Table 8

Exogenous Objective Peaks in Scientific Careers

	N	Percent
No Peak	23	42.6
1 Peak	14	25.9
2 Peaks	12	22.2
3 Peaks	5	9.3
Total	54[1]	100.0

Outlier removed — a scientist in a research/teaching oriented institution who compiled a significant portion of his record working in private industry, a non-comparable condition of productivity.

The foregoing accounts for peaks measured endogenously, but what about exogenously, that is, against the performance of the group in which scientists work organizationally?

As table 8 shows, when objective peaks are measured exogenously, slightly more scientists have no peak at all (23, or 42.6 %). Fewer have just one peak (14, or 25.9 %), but more have two (12, or 22.2 %), and 5 (9.3 %) scientists have three peaks. Thus the exogenous measure elevates non-peaks slightly, and spreads peaks (where they occur) across occurrences. In this latter regard, it is more advantageous to scientists to measure their own performance against others, because doing so stands a greater chance of generating more than one objective career peak.

Again noteworthy is the robust presence of peaks across institutional types. This intensifies when using the exogenous measure, as indicated in table 9. Democratization and "victim of success" processes may once again account for why we see dispersion of peaks across institutional types on the one hand and a counter-intuitive dampening of peaks in the most research oriented institutions on the other.

Table 9

Exogenous Objective Career Peaks, by Institutional Type

Objective Peaks						
Institutional Type	0	1	2	3	Peaks 1–3	Peaks 0–3
Research Oriented	12	6	2	3	11	23
	52.2	26.1	9.0	13.0	48.0	100.0[2]
Research/Teaching Oriented	3	5	5	1	11	14[1]
	21.4	36.0	36.0	7.1	79.0	100.0[2]
Teaching Oriented	8	3	5	1	9	17
	47.1	18.0	29.4	6.0	53.0	100.0[2]
Total	23	14	12	5	31	54
	43.0	26.0	22.2	9.3	57.4	100.0[2]

[1] Outlier removed (see note, table 8).
[2] Percentages do not add to 100 due to rounding.

Discussion and Conclusion

We have prior understanding about how publication productivity varies across career phases and organizations, but not how scientists view their performance in light of this variability. Nor have we understood how subjective appraisals correspond, if at all, with objective performance, a contribution of the present work. The data lead us to three overall conclusions, based on suggestive patterns in the data. Broadly, the consideration of career peaks informs an understanding of the rewards, real and imagined, that people derive from significant investments in their work.

First, it was proposed that scientists will register subjective peaks at their most advanced career stage to date, owing to the number of publications that accumulate with time (proposition 1). Instead, subjective peaks are spread throughout careers. This is true even for the most senior scientists.

Second, scientists experience subjective peaks in their careers regardless of where they work, and consequently regardless of how much they publish. It was proposed that elite departments would command the greatest share of peaks since organizational conditions predispose people to publication (proposition 2). Scientists who work in research oriented institutions are no more likely to experience subjective career peaks than scientists who work elsewhere. Put differently, it does not take a high threshold of publication in order to experience a "high." Even scientists with the most minimal publication records (and independent of any affirmation provided by elite institutional affiliation) register subjective peaks in their careers. What is more, scientists employed at research oriented universities are not more likely to have an objective career peak than scientists employed elsewhere. As the literature conveys, scientists in research oriented institutions may produce more; but this work finds that it is not at a rate that demonstrably makes those scientists different from others in the potential for their careers to peak.

Third, despite what was proposed, subjective and objective peaks do not parallel one another in number (proposition 3). Many more scientists experience subjective than objective peaks. That is, more scientists feel their work is at a "high" even though their publication records do not provide proof of high performance. What is more, scientists most commonly experience just one subjective peak in their careers. Objectively, scientists are apt to experience just one when peaks are measured endogenously, and slightly more likely to experience more than one when measured exogenously.

These findings are suggestive in accounting for the construction and maintenance of status orders, real and imagined. Status orders exist on the basis of fact on the one hand and fiction on the other. These orders correspond to objective and subjective means of evaluation. Each order relies respectively on performance and perception.

By fact, performance in a community is stratified. Members act according to varying social-organizational conditions, which produce unequal outcomes. By fiction, all (or very nearly all) perceive themselves as victors, at one time or another. Perception is more egalitarian than reality. Reality, by turn, is harsher and more exclusive than perception. Subjective evaluation thus constitutes a means by which to overcome status differences (Berger and Webster 2006). Individuals are inclined toward this behavior because in groups, particularly ones in which honor is paramount, high status individuals are shown more deference and support. Subjectively, individuals can experience these rewards in their own minds, if not in actual practice.

Part of the romance of science specifically, but of many vaunted activities generally, is that it is a "young person's game" (Wray, 2003). Embedded in this belief is the element of luck or chance (e.g., being in the right place at the right time). This is also perception. It is a perception, though, that we may interpret as helping to cushion the blow and excuse comparative failure. The reality is that in physics, as in all academic fields, a non-trivial subset continues to produce work, and work of high quality, throughout the course of their time, despite a majority doing so early on. The game may end early for some. Others, though, play it over and over again.

Why be concerned with "peak careers," and why are they of concern to scientists, who almost invariably claim to have them? To have a peak career is to have performed not only in accord with institutional goals, but to have done so above and beyond the obligations of one's role (Merton, 1973a). Thus, peaks provide testimony about the legitimacy of one's role by affirming that one has conformed to the aims and ideals of a group. Peaks mean that one's efforts have mattered and, therefore, that a human being has counted as a worthy participant. In an activity in which people are heavily invested, peak performances are a demonstrative ground of legitimation.

The construction and maintenance of status orders serve this end. Institutional roles and people are legitimated on objective grounds by performance, in accord with goals. So, too, are they legitimated on subjective grounds, but by perception. All can continue to matter in a system that embraces singularity (Schwartz, 2009) and which counts only a very few as "heroes" (Goode, 1978). In this way, subjective evaluation produces self-legitimacy in the midst of community conditions where social legitimacy (provided by colleagues both immediate and far) is uncertain, vague, or altogether nonexistent (Berger and Ridgeway, Fisek, and Norman, 1998; Ridgeway and Berger, 1986).

Perception constitutes a process by which to sustain, if not always performance, then at least survival in competitive tasks, where individuals are stratified over time. It is difficult to endure an activity in which one is committed but which objectively produces very few "winners," unless there are alternative ways to see oneself in this light. Consequently, perception can keep individuals going. But perception itself is not an individual phenomenon. It is, as seen here, socially manufactured.

Perception is thus a social structural phenomenon that keeps an activity going. Physics, said to be the most mathematically empirical field (Becher, 1990), cannot, ironically, survive in the absence of false truths. All arduous activities, such as those of the professions as noted at the outset, but also parenting, sport, and other demanding tasks, must maintain a set of illusions about performance in order for the field of activity to continue. Preservation of "greedy institutions" (Coser, 1974), let alone their advancement, are conditional upon these types of beliefs. In this essential regard, science and scholarship, conceived in rationality, are predicated on myth.

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