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THE EFFECTS OF THE MENTOR ON THE ACADEMIC CAREER

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The mentor plays an important role in initiating a process of cumulative advantage for the student. Our analyses present a clear and systematic pattern of effects of the mentor on the careers of biochemists. The influence of the mentor begins with collaboration, which is the single most important factor affecting the student's predoctoral productivity. For those who collaborate, the effects of both eminence and performance further increase the student's predoctoral productivity. The mentor's performance has weak effects on the productivity of noncollaborating students. For those who collaborate with their mentor, the mentor continues to influence the careerwith a positive effect of the mentor's performance on academic placement, an effect not found for noncollaborators. Even though the mentor's performance affects the student's placement, the student's performances does *not* affect that placement, suggesting a process of ascription. For those who collaborate with their mentor, the mentor's performance increases the student's later publications and citations. For noncollaborators, whose mentors are much less productive during the student's period of doctoral study, the mentor's eminence has a smaller, but significant effect on later productivity. Overall, the advantages of a strong mentor are drawn upon and enhanced through processes of both achievement and ascription.

Introduction

The effects of education on the careers of scientists have been a major focus in studies of the scientific career. For the most part, education has been considered as a homogeneous, unidimensional factor within any given graduate department. While variation *among* departments has been carefully considered, variation *within* departments has been generally ignored. Yet, there are great differences in the successes of students who graduate from a given department. Even for the most prestigious departments, only a few graduates achieve eminence, while the majority remain obscure. To some extent this may reflect differences in the measured abilities of students, although these differences are thought to be small. An additional source of variation within departments is the faculty, among whom students choose a mentor. These mentors vary with respect to their eminence, the importance of their current research, and their willingness to train and sponsor a student. This paper examines the question: *How do differences among mentors affect the careers of their studients?*

In assessing the effects of the mentor, a number of conceptual problems must be resolved, at least provisionally. First, who is the mentor? What roles does he or she play? What characteristics of the mentor can be isolated that may affect the successes of their students? Second, how is the scientific career to be conceptualized? What are the major processes operating in the career which the mentor can influence? Each of these questions is considered in turn. A description of the data is then given, followed by analyses of the mentor's effects on the careers of biochemists.

Characterizing the mentor

Every Ph. D. has someone fulfilling the institutional requirements of the dissertation supervisor—the person who must certify the dissertation as meeting the requirements of the Ph. D. However, the dissertation supervisor is likely to be more than the signer of an official document. She or he is often a teacher, an advisor, a collaborator, a friend and a sponsor. To this person we apply the term "mentor."[a] Although there are variations in the roles specific mentors play, there is an overall complex of roles which should be considered: those of teacher, sponsor and collaborator.

As a teacher, the mentor instructs the student in, to borrow the often quoted phrase of Zuckerman[1] (p. 244), "what matters." In this role the mentor not only provides important technical information which could be obtained from text books, but also the tacit knowledge which is essential for scientific research[2] (see Ref. 3 Ch. 3 for a thorough discussion of this aspect of training). This tacit knowledge includes information which has not been codified; the knowledge of how science is pursued and what the norms are in fact, not just in principle. This is the learning that occurs "at the bench," through doing and watching. It is a form of apprenticeship. A major benefit of the mentor-student relationship is passing on to the student the art and craft of science, a point made by *Overington*[4] (p. 145):

> . . .the process of acquiring a grammar of scientific practice requires an engagement in research on the model of some skillful practitioner in whose person there is incarnated both the general culture of science and particular traditions within the culture. One can no more discover the culture of scientific research from its written results than one can construct a Stradivarius from measurements of an original.

The mentor is, perhaps foremost, a teacher of the tacit and technical knowledge of science.

The second role of the mentor is sponsoring the student into the social network of science. As a sponsor, the mentor may act as an employment agent (cf. Ref. 5), and a mentor with prestige and contacts is likely to be more successful in this role. The *Coles*[6] have suggested that the strong and positive relationship between the prestige of the doctoral origin and the first academic position reflects the influence of the mentor as a sponsor of the candidate. *Caplow* and *McGee*[7] commented extensively on the importance of informal contacts in the recruitment process. *Hargens* and *Hagstrom*[8] made the same point and adopted *Turner*'s[9] ideal type of sponsored mobility to characterize the academic mobility process.

More subtly, though perhaps with equal importance, the mentor can sponsor the student through introductions to important people in the field, recommendations that the recent graduate be considered for positions on editorial boards or review panels, passing on writing obligations to the student, and in general providing the student with access to and acknowledgment from the scientific community. In this way, a mentor can compress into a much shorter period of time what takes the unsponsored student years to accomplish. While the student must ultimately demonstrate ability through achievement, the mentor can provide the student with valuable opportunities with which ability can be demonstrated. Thus, sponsorship can be the first step in a process of cumulative advantage.

The third role of the mentor is that of collaborator. Collaboration may be the outcome of the mentor fulfilling the roles of teacher and sponsor. As noted above, an important aspect of teaching involves working at the bench. The student learns by actively participating in the process of research. As the student gains skills, what were initially designed as research exercises for teaching may evolves into participation in the mentor's research program. The student learns the tacit knowledge of science, while the mentor obtains highly skilled labor characterized by greater commitment and less expense than laboratory technicians.[28] If this collaboration is successful, it may lead to coauthorship on published research.

At least initially, the collaboration between a student and mentor will be an unequal partnership. The student may contribute little besides highly skilled labor. Nonetheless, by participating in the mentor's research, the student begins to receive recognition for the collaborative research. As an obligation of the role of sponsor, the mentor allows the student to be acknowledged for work that is largely that of the mentor. In the extreme case, the mentor may exhibit the extreme generosity of *noblesse oblige* by allowing the student to have sole authorship (cf. Ref. 10.).

While *noblesse oblige* represents one extreme of collaboration, exploitation exists at the other extreme. Interview data collected by *Berelson*[11] (p. 176) suggest that the research of some faculty may be largely attributable to the original ideas of their students. Other data from *Berelson*[11] (reanalyzed by *Hagstrom*[29] (p. 134) suggest that a majority of students in biological and chemical sciences feel that faculty often exploit students. Most frequently this exploitation takes the form of prolonging the duration of graduate study or forcing the student to work in areas of interest to the mentor[28], although in extreme cases mentors may use the ideas and labor of students without recognition in the form of coauthorship.

Regardless of the generosity/exploitativeness of the mentor, collaboration that leads to coauthorship should indicate a commitment on the part of the mentor to the student. All other things being equal, the student who coauthors with his or her mentor is more likely to have closer personal ties to the mentor than the student who does not. As a result of this commitment, the roles of the mentor as teacher and sponsor are likely to be enhanced, an idea that is applied in our analysis.

In each of these roles, the effectiveness of the mentor will depend on the mentor's characteristics. A mentor whose grant applications are not funded and whose papers are routinely rejected is unlikely to be good at teaching "what matters", at sponsoring the student into the scientific community that has not yet accepted the mentor, or at providing advantages through collaboration. On the other hand, as illustrated by *Zuckerman*[10] for Nobel laureates, successful mentors can be valuable in the successes of their students. They teach "what matters", they sponsor the student into the profession, and allow the student to participate in research at the cutting edge.

How then might we distinguish among mentors? *Reskin*[12] has made a useful distinction between the *eminence* and the current *performance* of the mentor. Eminence corresponds to a scientist's standing in the scientific community. Indicators include election to prestigious societies and receipt of prizes for scientific achievement. Performance corresponds to current contributions to the body of scientific knowledge. It is perhaps best indicated by a scientist's publications and the utilization of those publications by others. While performance generally leads to eminence, eminence may endure after performance declines (Refs 13, 14). Conversely, eminence may lag performance. For example, the Nobel Prize is granted conservatively, often long after the work leading to the prize has been completed (Ref. 10).

Eminence and performance are differently related to the mentor's roles of teacher, sponsor and collaborator. A scientist with eminence, independent of *current* performance, may be extremely successful in sponsoring a student. The mentor can use his or her eminence to make contacts for the student, hopefully leading to an attractive job placement. To the extent that a scientist is currently doing research, and to the extent that performance has been translated into recognition by the larger community, the mentor's performance should also aid in sponsoring the student. If the same time, performance should enhance the training of the student. If the tacit knowledge of a science can best be conveyed in a process of apprenticeship, the current performance of the mentor should have a stronger effect on the quality of the education provided than should the mentor's past performance (which may or may not have lead to eminence). Finally, collaboration leading to coauthorship is necessarily tied to performance. No matter how eminent the mentor, if that mentor is no longer doing research, collaboration is an impossibility. Further, the more productive the mentor and the more recognition the mentor's research is receiving, the more beneficial the collaboration will be. Collaboration with a scientist whose work is relatively unknown and of little impact is unlikely to benefit the education of the student.

The nature of the effects of eminence and performance differ. *Reskin*[12] has argued that to the extent that a mentor's eminence influences the success of a student independently of the mentor's performance, processes of ascription are indicated. To the extent that the mentor's current performance affects the careers of the student, it is more likely to be an effect based on achievement.

Thus, the mentor can affect the career of his or her student as a teacher, a sponsor and a collaborator. While the eminence of the mentor may aid his or her effectiveness as a sponsor, current performance is likely to be of primary importance in the role of teaching. To the extent that "what matters" can be best conveyed by example and apprenticeship, the quality of the teaching depends both on the level and quality of current performance and the existence of collaboration with the student. The effects of both sponsorship and teaching are dependent in part on the closeness of the student and the mentor. To the extent that they collaborate, the effects would be expected to be greater.

Career processes in science

How and at what points can the mentor affect the student's career? An answer to this question requires a conceptualization of the scientific career which provides the structure for our analyses. The career can be thought of as series of ongoing processes broken up by significant events. Cross-sectional analyses focusing on a group of scientists in a given year and at different stages of their careers necessarily misrepresents the nature of the career. Accordingly, our analysis is broken into a number of steps, tracing the development of the career over time.

The first step involves predoctoral productivity. While still in graduate school, the student has the opportunity to publish and to have his or her publications recognized by the scientific community. The mentor may influence the predoctoral productivity of the student both by actively collaborating and by providing the instruction and opportunities necessary to do competent research. The second step is entrance into the scientific marketplace. Alternative organizational contexts of employment must be evaluated, and employment in some context must be obtained. For those entering faculty positions in research universities (either directly after the Ph. D. or after a postdoctoral fellowship), there is competition for prestigious appointments. The mentor may be expected to influence these outcomes as a sponsor through a process of ascription and as a teacher through a process of achievement. As a third step, the student must demonstrate ability through contributions to the body of scientific knowledge. After the period of graduate training ends and collaboration with the mentor becomes increasingly unlikely, the *direct* effect of the mentor will come from the mentor's role as a teacher rather than as a sponsor. To the extent that learning what matters has a lasting impact, the training provided by the mentor will continue to affect the professional productivity of the student.

Our analyses are developed along these lines. First, the relationships between the doctoral department and the characteristics of the mentor are examined. This clarifies the extent to which the prestige of the doctoral department and the eminence and performance of the departmental faculty are distinct. Second, levels of publication, citation, and collaboration for students are described. Third, determinants of pre-doctoral productivity are explored. Fourth, entrance into the profession is considered. What determines the first sector of employment, and for academic scientists what determines the prestige of the academic appointment? Fifth, and finally, factors influencing later productivity are examined within the academic sector.

For each stage of the career, the focus is on the effects of the mentor. Detailed analyses of many of the specific processes of the career may be found elsewhere (Refs 16–18). A description of the data and details on the operationalizations of key concepts are now presented.

Data and measurement

Analyses are based on the population of male biochemists who obtained their doctorates in the fiscal years 1957, 1958, 1962 and 1963. Females were excluded due to their relatively small numbers and difficulties in obtaining complete biographic information.[b] Biographic information was coded from the 10th through 13th editions of *American Men (and Women) of Science.*[19] Data on educational and occupational experiences were obtained for 557 (83 percent) of the 668 males who obtained their degrees during this period. Prestige of the doctoral department was measured with the three-digit ratings of faculty quality of biochemistry departments, a partial listing of which appeared in *Cartter.*[20] The prestige of postdoctoral appointments in graduate departments was based on a weighted average of the *Roose* and *Andersen*[21] prestige scores for bioscience departments in the fellowship institution.[c] An average was used since the specific department of the postdoctoral appointment was not always known. This measure of prestige was also used for faculty positions obtained in research universities. Scores for departmental prestige range from a low of 1.00 to a high of 5.00.

Astin's[22] measure of the selectivity of the scientist's baccalaureate institution was used. This variable, which has been interpreted by some as a crude indicator of intelligence and by others as a measure of the quality of undergraduate education, has often been a successful predictor of future success. *Astin*'s index has values ranging from one to seven, with seven being the most selective category. Duration of graduate study was measured as the time between the receipt of the baccalaureate and the year the doctorate was awarded, excluding periods of time during which graduate study was not being pursued. Examples of activities whose durations were excluded are military service and extended faculty employment after the receipt of the Masters degree.

Using the American Chemical Society's *Directory of Graduate Research, Dissertation Abstracts,* and inquiries to specific universities, the name of the dissertation supervisor, hereafter referred to as the mentor, was obtained for all but two members of our sample. Bibliographic data were available for each mentor, while biographic data were unavailable for two individuals. Following the ideas presented in the discussion above, attempts were made to measure three characteristics of the mentor: professional eminence, scientific performance, and collaboration with the student.

Several measures of the mentor's research productivity near the time of the student's doctorate were collected; these are referred to as measures of *current* productivity or performance. Of primary importance are the number of publications (including both junior and senior authored papers) by the mentor during the three-year period following the student's receipt of the doctorate. Citations to these publications were coded from the 1961 and 1966 volumes of *Science Citation Index.*[23] The period immediately following the doctorate, rather than during doctoral study, was used due to limitations in *Science Citation Index.* Rather than using the same period of productivity for all mentors, for example 1959 to 1961, which would artifactually inflate the research productivity of some mentors, the priod immediately following the doctorate of the student was used. A measure of productivity based on the years 1957 to 1960 was also examined, with no significant differences in results. In order to assess the recognition received by the mentor's publications, citations to the publications were counted. The measure based on citations was correlated with the publication measure at the level of 0.78. Due to the skewed nature of the measures of performance, square root transformations of the article and citation counts were applied.

A number of indicators of eminence were coded from *American Men and Women of Science.*[19] These included award of the Nobel Prize, election to the National Academy of Sciences, receipt of honorary degrees, number of prestigious fellowships (such as the Fullbright or Guggenheim), participation in government committees, and honorary awards, prizes and medals. The measure of eminence used in the following analyses is a weighted count of prestigious awards (weighted 4), honorary degrees (weighted 3), prestigious fellowships (weighted 2), and less prestigious awards such as the Borden and Vaughan Awards (weighted 1). While more refined weightings based on the scientific community's assessment of the prestige of the various honors, such as that presented by *Cole* and *Cole*[6] (pp. 270–5) for physics, would have been preferable, such a list is not available for biochemistry and there were too many differences in the specific awards received by biochemists compared to physicists to usefully apply the *Coles*' list. In order to test the success of our measure in capturing the dimensions of eminence found in the various indicators, regressions were run comparing the predictive ability of the composite measure to the indicators entered into the regression without weightings. No significant improvements in fit were found, and accordingly the composite measure was used throughout. Finally, due to the highly skewed nature of the eminence measure, the square root of the measure was used in the regression analyses.

Productivity of the sample members was measured using counts of both publications and citations. *Chemical Abstracts* (1955–1973) was used to locate the articles published by the sample members, whether or not they were the senior authors. Citations to these articles were coded from *Science Citation Index*[23] (Volumes 1961, 1964, 1966, 1968, 1970, 1972 and 1974). On multiple-authored papers where the cohort member was not the first author, the name of the first author was used to locate citations to junior authored papers (cf. Ref. [24] for details on this problem); thus downward bias in counts for scientists who were predominantly junior authors was avoided. For a given year in the scientist's career, the publication measure reflects publications in a three-year period ending in that year. The citation measure for that year is restricted to citations to papers published in that three-year period. Since coverage of *Science Citation Index* and *Chemical Abstracts* increased during the period covered by our analyses, counts were standardized within years of the Ph. D. For further details, see Ref.[15].

Departmental prestige and characteristics of the mentor

Past studies have found strong effects of the prestige of the doctoral department on the scientist's later career. Given that a department's prestige is based largely on characteristics of its faculty (or past faculty) and that a faculty consists of many individuals with different characteristics, the prestige of the doctoral department may be be only a rough indicator of characteristics of the student's mentor. Accordingly, before examining the effects of the mentor along with those of the prestige of the doctoral department on the later careers of graduates, it is useful to analyze the relationship between departmental prestige and characteristics of the mentor.

Table 1 presents regressions of the prestige of the mentor's academic affiliation on characteristics of the mentors.[d] Four characteristics are considered: the weighted number of awards to the mentor; the number of publications authored in a three-year period; citations to those papers; and the prestige of the mentor's doctoral department. In Eq. (1), thirty-five percent of the variation in departmental prestige is shared in common with variation in the characteristics of the mentors. The strongest effect is that of the mentor's doctoral department's prestige, followed by approximately equal effects of citations and awards. Publications have a smaller effect. Since the effect of the mentor's doctoral department may reflect the twin phenomena of inbreeding and silvercording (Ref.[25]), in Eq. (2) mentors who are teaching in their doctoral departments have been excluded. Five percent less variation is now shared, with citations becoming the strongest variable, followed by the measure of eminence. The doctoral department remains a significant factor, albeit a much weaker one.

What is important about these analyses is how much of the variation in departmental prestige is *unaccounted* for by characteristics of the faculty. In assessing this finding, several points must be kept in mind. First, not all of the faculty in a department are included in these analyses. Those faculty who did not have students or whose students were not found in *American Men and Women of Science*[19] are excluded. Over 80 percent of the population (*not* sample) of students obtaining degrees are represented, and those faculty without students are unlikely to be major influences on the prestige of the departments. Consequently, it is unlikely that the exclusion of faculty without students significantly affects the results. Second, mentors who have more than one student are included more than once in the regression, although their values of the independent variables will vary if their students obtained degrees in different years. Regressions similar to those presented in Table 1 were performed (regressions not shown) using only unique faculty members produced similar results.

A major reason for the lack of common variation between characteristics of the mentor and the prestige of his or her departmental affiliation is suggested by Fig. 1, which plots the prestige of the department against our measure of the citations received by the mentor. These two variables, which have a correlation of 0.45, show a triangular pattern of points. The more prestigious a department, the more variation in the performance of the faculty. Simply stated, mentors who receive many citations do not teach in departments with low prestige, but those who receive few citations may be located in departments with any level of prestige. A similar pattern is observed

Table 1
Regressions relating characteristics of the mentor to the prestige of the doctoral department

	Equation 1 (N=557):			Equation 2 (N=390):		
	All mentors			Inbred mentors excluded		
	b	b_s	r	b	b_s	r
Intercept	100.8	–	–	179.2	–	–
MCIT	8.88	0.231*	0.446	14.3	0.392*	0.429
MPUB	4.99	0.070	0.378	−7.65	−0.107	0.267
MAWARD	20.2	0.236*	0.312	24.0	0.295*	0.421
MPHDPRST	0.409	0.296*	0.422	0.163	0.128	0.234
R^2	0.347			0.294		

Variable identifications are: MCIT=square root of the number of citations to the work published by the mentor during the three-year period beginning the year of the student's doctorate; MPUB=square root of the number of publications authored by the mentor during the three-year period beginning the year of the student's doctorate; MAWARD=square root of the weighted number of awards received by the mentor up to the time of the student's doctorate; MPHDPRST=Cartter prestige ranking of the mentor's Ph.D. department. Dependent variable is the Cartter prestige rating of the student's doctoral department.

b=unstandardized regression coefficients; b_s=standardized regression coefficients; r=zero-order correlation coefficients with the dependent variable. + indicates one-tailed significance at the 0.10 level; * indicates one-tailed significance at the 0.025 level.

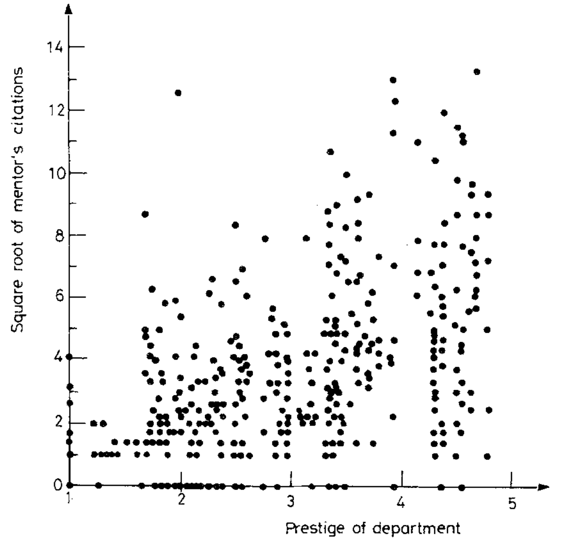

Fig. 1. Mentor's citations by department prestige

when other measures of the performance and eminence of the mentors are plotted against departmental prestige.

The prestige of the doctoral department is most closely related to the performance or eminence of the most productive or eminent member of the department. If we consider only the most cited faculty member of each department and correlate departmental prestige with the citations received by this faculty member, the common variation between departmental prestige and faculty citations increases from 20 percent ($r=0.45$) to 43 percent ($r=0.66$). This is true even though our sample does not include all members of a department's faculty, which will attenuate the amount of common variation.

Thus, while the prestige of a department may ultimately depend on the productivity of its faculty, the prestige of a department is a poor indicator of the characteristics of any *individual* faculty member, particularly in more prestigious departments. It is unreasonable to equate the effect of departmental prestige that persists after controlling for characteristics of the mentor with the quality of training received. To do so requires the assumption that the general training provided by the requirements of a graduate program is more important than the apprenticeship of a student with his or her mentor. Given the greater importance attributed to the process of learning what matters from the mentor, effects of departmental prestige that persist after controlling for characteristics of the mentor are largely attributable to ascriptive processes. This argument is important for the conclusions drawn below.

Productivity and collaboration

Biochemists publish frequently. The students in our sample who pursue academic careers average 1.4 articles per year during the three-year period ending with the sixth year after the Ph. D. The mentors in our sample average 3.5 articles per year during the three-year period following their student's receipt of the doctorate. Collaboration is also extremely frequent. By the fifth year after the degree, less than 20 percent of the students who publish at least one paper in a three-year period average less than 2 authors per paper.

Publication and collaboration are also common while completing the doctorate. For the students, the average number of publications for the three-year period ending the year after the degree is obtained is 1.9.[e] Twenty-seven percent of those graduating have no publications. Of those who do publish during this period, 5.3 percent write only single authored papers, while 9.5 percent average less than 2 authors per paper. As indicated in Table 2, most of the collaboration during this period is with the mentor. By the year after the Ph. D., 55 percent of all *publications* are written in collaboration with the mentor and 53 percent of all *students* collaborate at least once. Of those who publish, 76 percent collaborate with the mentor. Similar results are found for citations, where 54 percent of all citations are to papers in which the mentor is a coauthor.

Collaboration with the mentor declines rapidly after the degree is obtained. At the same time the average number of publications in a three-year period increases from 0.63 per year in the first year to 1.1 per year by the sixth year. In the sixth year less than 7 percent of the published papers (for the period from career year four to six) are in collaboration with the mentor. Whereas collaboration with the mentor declines, there is virtually no change in the frequency of collaboration observed in the publications at this time, with 4.6 percent now writing only single authored papers and 19.7 percent averaging less than 2 authors per paper. Similarly for citations, less than 5 percent of the citations during the three-year period ending six years after the degree are to papers coauthored with the mentor during this period.

Collaboration occurs frequently in biochemistry. In analyses not presented here (Ref.[26]), collaboration was found to be largely associated with the number of articles the mentor had published. This is not surprising since the more papers written, the greater the opportunity to collaborate. Yet, collaboration was found to be associated less with the mentor's publications than would be expected on the basis of a fixed probability of collaboration for any given paper. The mentor's performance had a significant independent effect on the student's chances for predoctoral collaboration. Collaboration itself had a major impact on predoctoral productivity, a topic we now consider.

Table 2
Descriptive statistics for total and non-mentor productivity measures for career years one and six
(N=557)

	Mean	Std. Dev.	md	CV	%0	%Mentor
Panel A: Publications in the three-year period ending in a given year						
Year 1						
Total counts	1.93	2.28	1.34	0.67	27.5	55.4
Non-mentor counts	0.86	1.72	0.37	1.69	57.4	–
Year 6						
Total counts	3.39	3.87	2.38	0.86	20.3	6.8
Non-mentor counts	3.16	3.70	2.15	0.89	21.7	–
Panel B: Citations to publications in the three-year period ending in a given year						
Year 1						
Total counts	4.59	11.04	0.90	3.83	46.9	53.6
Non-mentor counts	2.13	8.75	0.17	10.88	74.7	–
Year 6						
Total counts	11.13	21.09	3.44	3.03	31.6	4.4
Non-mentor counts	10.64	21.00	2.98	3.26	33.8	–

Mean=arithmetic mean; Std. Dev.=sample estimate of standard deviation; md=median; CV=maximum likelihood estimate of coefficient of variation; %0=percent of sample with count of zero; %Mentor=percent of total counts for which mentor is an author.

Determinants of predoctoral productivity

Table 3 examines the factors affecting publications during the three-year period ending the year after the Ph. D. was received; similar analyses of the citations to these publications are presented in Table 4. The year after the degree is included to allow for the lag time between completion of work and publication of results. Explanatory variables include the prestige of the doctoral department, the performance and eminence of the mentor, whether the student and mentor collaborate, duration of graduate study, and selectivity of the baccalaureate institution.

By far the strongest effect on predoctoral publications is whether a student has collaborated with the mentor, reflecting the fact that collaboration requires that the student have at least one publication. The number of awards received by the mentor has a weak but positive effect on the student's publications. In Equation 2 of table 3 the effects of the mentor's eminence and performance on the student's publications are elaborated by examining the interaction between collaboration and these characteristics of the mentor. For those who do not collaborate, eminence has no effect and performance has a small negative effect. For those who collaborate with the mentors, the current performance of the mentor increases the student's publications beyond the direct effect of collaboration; the effect of eminence is small, although still significant.

Similar results are obtained for predoctoral citations. Equation 1 of Table 4 shows that collaboration has the strongest effect, followed by a slightly weaker effect of the mentor's performance. Having either an associate or full professor for a mentor will, holding all other variables constant, decreases the number of citations received. While prestige of the doctoral department is positively correlated with citations, its effect after controlling for the prestige of the mentor is negative. Finally, the selectivity of the baccalaureate institution has a small positive effect on citations.

The importance of the interaction between the performance and eminence of the mentor and whether the mentor collaborated with the student are also shown in Equation 2 of Table 4. For those who collaborate, the performance of the mentor is by far the strongest effect, with the number of awards also positively affecting citations received. For those not collaborating, the eminence of the mentor has no effect, while there is a slight positive effect of the mentor's performance. The effects of the other variables remain essentially unchanged.

These results are partially due to the necessary relationship between collaborating with the mentor and having at least one publication. Accordingly, regressions similar to those in Tables 3 and 4 were run for only those scientists with at least one publication (regressions not shown). The *direct* effect of collaboration is no longer significant; that is, simply having had the experience of collaborating with the mentor

Table 3
Regressions relating characteristics of the mentor and educational experiences to predoctoral publications
(N=557)

	Equation 1				Equation 2		
	b	b_s	r		b	b_s	r
Intercept	0.785	–	–	Intercept	0.953	–	–
PHDPRST	–0.0134	–0.018	0.064	PHDPRST	–0.0143	–0.019	0.064
MAWARD	0.0344	0.053+	0.073	Effects for Collaborators:			
MCIT	0.00894	0.031	0.206	MAWARD	0.0539	0.070*	0.169
COLLAB	0.876	0.570**	0.585	MCIT	0.0323	0.125*	0.178
MASSOC	0.0260	0.014	–0.025	Effects for Noncollaborators:			
MFULL	0.0445	0.027	0.034	MAWARD	0.00854	0.010	–0.016
BASEL	–0.00278	–0.005	0.028	MCIT	–0.0303	–0.084*	–0.088
ENROL	–0.0194	–0.036	–0.140	COLLAB	0.619	0.403**	0.585
R^2	0.348			MASSOC	0.0167	0.009	–0.025
				MFULL	0.0555	0.034	0.034
				BASEL	–0.00578	–0.011	0.028
				ENROL	–0.0231	–0.043	–0.140
				R^2	0.362		

Variable identifications: Dependent variable is the number of publications in the three-year period ending the year after the Ph.D. Independent variables are: PHDPRST=Cartter prestige rating of the student's doctoral department; MAWARD=square root of weighted number of awards received by the mentor up to the time of the student's doctorate; MCIT=square root of the number of citations to work published by the mentor in the three-year period beginning the year of the student's doctorate; COLLAB=1 if predoctoral collaboration with the mentor, else 0; MASSOC=1 if mentor is associate professor, else 0; MFULL=1 if mentor is full professor, else 0; BASEL=Astin's selectivity score of the baccalaureate institution; ENROL=number or years enrolled in graduate study before receiving doctorate.

b=unstandardized regression coefficients; b_s=standardized regression coefficient; r=zero-order correlation with dependent variable. + indicates one-tailed significance at the 0.10 level or two-tailed significance at the 0.20 level; * indicates one-tailed significance at the 0.05 level or two-tailed significance at the 0.10 level; ** indicates one-tailed significance at the 0.025 level or two-tailed significance at the 0.05 level.

Table 4
Regressions relating characteristics of the mentor and educational experiences to predoctoral citations
(N=557)

	Equation 1				Equation 2		
	b	b_s	r		b	b_s	r
Intercept	1.54	–	–	Intercept	1.95	–	–
PHDPRST	–0.141	–0.094**	0.104	PHDPRST	–0.143	–0.095**	0.104
MAWARD	0.0655	0.051	0.132	Effects for Collaborators:			
MCIT	0.158	0.275**	0.362	MAWARD	0.116	0.075*	0.206
COLLAB	0.975	0.318**	0.401	MCIT	0.213	0.414**	0.381
MASSOC	–0.443	–0.122*	–0.068	Effects for Noncollaborators:			
MFULL	–0.291	–0.089+	0.034	MAWARD	0.0007	0.000	0.026
BASEL	0.102	0.094**	0.148	MCIT	0.0640	0.089*	0.111
ENROL	–0.049	–0.046	–0.137	COLLAB	0.357	0.117*	0.401
R^2	0.250			MASSOC	–0.466	–0.128**	–0.068
				MFULL	–0.265	–0.081+	0.034
				BASEL	0.0953	0.087**	0.148
				ENROL	–0.0580	–0.054+	–0.137
				R^2	0.270		

Variable identifications: Dependent variable is the number of citations in the three-year period ending the year after the Ph.D. Independent variables are: PHDPRST=Cartter prestige rating of the student's doctoral department; MAWARD=square root of weighted number of awards received by the mentor up to the time of the student's doctorate; MCIT=square root of the number of citations to work published by the mentor in the three-year period beginning the year of the student's doctorate; COLLAB=1 if predoctoral collaboration with the mentor, else 0; MASSOC=1 if mentor is associate professor, else 0; MFULL=1 if mentor is full professor, else 0; BASEL=Astin's selectivity score of the baccalaureate institution; ENROL=number or years enrolled in graduate study before receiving doctorate.

b=unstandardized regression coefficients; $b_s$standardized regression coefficient; r=zero-order correlation with dependent variable. + indicates one-tailed significance at the 0.10 level or two-tailed significance at the 0.20 level; * indicates one-tailed significance at the 0.05 level or two-tailed significance at the 0.10 level; ** indicates one-tailed significance at the 0.025 level or two-tailed significance at the 0.05 level.

does not significantly increase or decrease the student's level of predoctoral productivity. But, the interactions of collaboration and the measures of the mentor's eminence and performance are significant. The effects of these variables on publications for those who collaborate has increased. The heretofore negative effect of mentor's performance on publications for those not collaborating has disappeared. All of the other variables have approximately the same effects. The effects for citations are also similar, again with the direct effect of collaboration becoming statistically insignificant. The only other differences are that having a full professor as a mentor has a significant negative effect (before it was almost significant) and the effect of the mentor's citations for noncollaborators is somewhat larger.

Overall, the mentor has a great influence on the initial productivity of his or her students. This influence operates through collaboration, collaboration itself being determined in large part by the current productivity (not eminence) of the mentor. The importance of collaboration is enhanced by its interaction with other characteristics of the mentor. The effects of the mentor's eminence, independent of performance, are negligible. To the extent that a scientist's earlier productivity has an important influence on later productivity (Ref. 16. p. 827), the influence of the mentor can be expected to maintain itself as an indirect effect. Whether additional direct effects of the mentor on the student's later productivity operate is considered below.

The *lack* of effect of departmental prestige on predoctoral productivity demonstrates the importance of the mentor in the training of the student. If departmental prestige (independent of characteristics of the mentor) represented a major influence on the training of a student, and if training (as opposed to ascriptive processes) had a major influence on a student's productivity, the prestige of the doctoral department should positively affect the student's productivity. Its nil effect on publications and its negative effect on citations to predoctoral publications further supports our earlier argument that characteristics of the mentor are the best indicators of the quality of a student's training.

Determinants of the first academic job

In assessing the factors determining the allocation of the first academic job, a two-step process must be considered. The first step involves the differentiation of graduates into those who obtain positions as faculty members in research universities and those who obtain positions in other organizational contexts. Second, factors determining the prestige of the academic position for those entering that context must be assessed.

The process of allocating scientists to various organizational contexts has been considered in detail elsewhere (Refs 17, 18). These results show that the mentor differentiates those obtaining positions as faculty members in a research university from those obtaining positions in other organizational contexts. First, characteristics of the mentor increase the chances that a student obtains a postdoctoral fellowship. Second, the productive mentor positively affects the productivity of the student. Both of these factors increase the chances of the student accepting a faculty position in a research university, even though characteristics of the mentor do not directly affect this outcome.

While characteristics of the mentor do not directly differentiate students entering differing organizational contexts, they significantly affect the prestige of the first position of those who obtain faculty positions in research universities. To examine the effect of the mentor in this process, Table 5 regresses the prestige of the first academic appointment on characteristics of the mentor, the prestige of the doctoral and/or postdoctoral department, and scientific productivity.[f] The effect of postdoctoral study is entered in two ways. First, the prestige of the fellowship institution is included for those who held such positions in research universities rated by the *Roose* and *Andersen* study. For those not holding such positions, this variable was assigned the value of 358, the mean for those who held such positions. Also included in the regressions, although only implicitly in the results of Table 5, is a dummy variable coded 1 if an individual held a postdoctoral fellowship in a rated graduate department, 0 otherwise. This variable is included to make the model invariant to the value (in this case 358) assigned to those cases without a postdoctoral prestige score. The impact of the fellowship is also reflected in the productivity measures, which include publications and citations to publications from the period of postdoctoral study.

Five characteristics of the mentor are used: the eminence of the mentor as reflected by our award variable; the current productivity of the mentor as measured by citations; whether the student collaborated with his mentor; and two dummy variables indicating the mentor's academic rank. Selectivity of the baccalaureate institution is also included .

The strongest effect is that of the doctoral department's prestige, followed by the prestige of the fellowship department. These effects partially reflect inbreeding (cf. Ref. 16), and are much weaker when inbred scientists are excluded from the analyses. The mentor influences the outcome in two ways. First, having a mentor who is a full professor increases the average prestige of placement of the student by 27 points on the 400 point scale. Second, the mentor's performance positively affects the prestige of the first position, increasing the expected prestige by 3.5 points for a unit increase in performance.

The extent of a mentor's sponsorship depends on the strength of a mentor's commitment to a student. This commitment may be indicated by predoctoral

Table 5
Regressions relating characteristics of the mentor, educational experiences and predoctoral productivity to the prestige of the first academic job (N=239)

Equation 1

	b	b_s	r
Intercept	10.8	–	–
PHDPRST	0.242	0.283**	0.390
FELPRST	0.303	0.187**	0.269
MAWARD	–3.49	–0.052	0.177
MCIT	3.46	0.118*	0.319
COLLAB	–0.0912	–0.001	0.061
MASSOC	11.5	0.057	–0.084
MFULL	27.5	0.152*	0.101
PUBS	–3.82	–0.036	0.143
CITS	4.18	0.096	0.221
BASEL	6.85	0.107*	0.223
R^2	0.274		

Equation 2

	b	b_s	r
Intercept	23.6	–	–
PHDPRST	0.240	0.280**	0.390
FELPRST	0.298	0.183**	0.269
Effects for Collaborators:			
MAWARD	–6.05	–0.077	0.165
MCIT	6.06	0.232**	0.388
Effects for Noncollaborators:			
MAWARD	–2.07	–0.022	0.197
MCIT	–1.03	–0.026	0.175
COLLAB	–21.4	–0.122	0.061
MASSOC	11.3	0.056	–0.084
MFULL	29.1	0.161*	0.101
PUBS	–3.27	–0.031	0.143
CITS	3.54	0.082	0.221
BASEL	6.99	0.109*	0.223
R^2	0.284		

Variable identifications: Dependent variable is the Roose-Andersen bioscience prestige score of the first academic faculty position. Independent variables are: PHDPRST=Cartter prestige rating of the student's doctoral department; FELPRST=Roose-Andersen bioscience prestige of fellowship location for fellows *in rated graduate departments, 3.58 for others*; MAWARD=square root of weighted number of awards received by the mentor up to the time of the student's doctorate; MCIT=square root of the number of citations to the work published by the mentor during the three-year period beginning the year of the student's doctorate; COLLAB=1 if predoctoral collaboration with mentor, else 0; MASSOC=1 if mentor was associate professor, else 0; MFULL=1 if mentor was full professor, else 0; PUBS=square root of standardized levels of student's publications for the three-year period ending the first year of the job; CITS=square root of standardized values of citations *to publications in the three-year period ending in the first year of the job*; BASEL=selectivity of the baccalaureate institution.

b=unstandardized regression coefficients; b_s=standardized regression coefficient; r=zero-order correlation with dependent variable. + indicates one-tailed significance at the 0.10 level or two-tailed significance at the 0.20 level; * indicates one-tailed significance at the 0.05 level or two-tailed significance at the 0.10 level; ** indicates one-tailed significance at the 0.025 level or two-tailed significance at the 0.05 level.

collaboration—everything else being equal, a mentor who collaborates is more likely to be committed then one who does not collaborate. To examine this possibility, Equation 2 considers the effects of the mentor's eminence and performance for collaborators and noncollaborators separately. As expected, the effect of the mentor's performance is substantially stronger for collaborators (even after controlling for the publications resulting from this collaboration), with the standardized coefficient increasing from 0.118 to 0.232, whereas there is no significant effect for non-collaborators. The positive effect of having a full professor for a mentor remains.

It is the mentor's current research performance, independently of eminence, that affects the student's job placement. How can this effect be interpreted? It is unlikely that it represents the community's evaluation of the research of the student. If this were the case, it would be more reasonable to expect that the citations received by the student himself to both the papers published with the mentor and without the mentor, rather than those received by the student's mentor, would be more influential in obtaining a job. Rather, the student gains advantages in academic placement for the *current* research of the mentor, independently of the metntor's eminence, the prestige of the doctoral or postdoctoral department, *or the student's own productivity.* This suggests an ascriptive process.

Determinants of later productivity

Characteristics of the mentor positively affect both the early productivity and the academic placement of the student. Earlier research[15] has shown that both of these outcomes positively affect later productivity. Through processes of stability and reinforcement, those who publish and are cited early in their careers publish more and are cited more later in their careers. Through contextual effects, those with prestigious placements become more productive than their counterparts in less prestigious positions. Thus, even if the direct effects of training and sponsorship operating during the period of graduate study fail to *directly* influence the later productivity of the student, substantial *indirect* effects persist. In this section the magnitude of these direct and indirect effects are examined as they operate in the academic career. Analysis is restricted to academic scientists with faculty positions in rated departments; similar analyses for nonacademic scientists are presented by *Long* and *McGinnis.*[18]

Tables 6 and 7 present analyses of 134 academic biochemists who remain in the same department for at least six years. Given the earlier findings of *Long*[15] on the effects of context on productivity, it is necessary to restrict analysis to those who do not change departments in order to avoid confounding the effects of two different contexts.

Table 6
Regressions relating characteristics of the mentor, educational experiences, early productivity and prestige of the employing department to publications six years after the start of the job (N=134)

	Equation 1				Equation 2		Equation 3		
	b	b_s	r		b	b_s	b	b_s	r
Intercept	0.283	–	–	Intercept	0.495	–	0.143	–	–
PHDPRST	0.0451	0.049	0.165	PHDPRST	0.0540	0.058	–0.055	–0.060	0.165
FELPRST	0.228	0.112+	0.185	FELPRST	0.219	0.108	0.115	0.056	0.185
MAWARD	0.0497	0.056	0.149	Effects for Collaborators:					
MCIT	0.0318	0.095	0.230	MAWARD	–0.00880	–0.008	0.0139	0.013	0.130
COLLAB	0.304	0.151*	0.181	MCIT	0.0732	0.248*	0.0642	0.217+	0.287
BASEL	0.0867	0.126+	0.166	Effects for Noncollaborators:					
R^2	0.109			MAWARD	0.116	0.100	0.168	0.145+	0.174
				MCIT	–0.0322	–0.078	–0.0241	–0.058	0.012
				COLLAB	–0.00927	–0.005	–0.132	–0.061	0.181
				BASEL	0.0978	0.107	0.0557	0.081	0.166
				PUBS			0.407	0.337**	0.333
				CITS			–0.0310	–0.064	0.244
				JOBPRST			0.280	0.228**	0.327
				R^2	0.128		0.245		

Variable identifications: Dependent variable is square root of standardized levels of three-year publications ending in the sixth year after initial employment in current department. Independent variables are: PHDPRST=Cartter prestige rating of the student's doctoral department; FELPRST=Roose-Andersen bioscience prestige of fellowship location for fellows in rated graduate departments, 3.58 for others; MAWARD=square root of weighted number of awards received by the mentor up to the time of the student's doctorate; MCIT=square root of the number of citations to the work published by the mentor during the three-year period beginning the year of the student's doctorate; COLLAB=1 if predoctoral collaboration with mentor, else 0; BASEL=selectivity of bacoalaureate institution; PUBS=square root of standardized levels of three-year publication counts for the period ending the first year of the current job; CITS=square root of standardized levels of citations to publications in the three-year period ending the first year of the current job; JOBPRST=Roose-Andersen bioscience prestige score of the first academic job.

b=unstandardized regression coefficients; b_s=standardized regression coefficient; r=zero-order correlation with dependent variable. + indicates one-tailed significance at the 0.10 level or two-tailed significance at the 0.20 level; * indicates one-tailed significance at the 0.05 level or two-tailed significance at the 0.10 level; ** indicates one-tailed significance at the 0.025 level or two-tailed significance at the 0.05 level.

Table 7
Regressions relating characteristics of the mentor, educational experiences, early productivity and prestige of the employing department to citations six years after the start of the job (N=134)

	Equation 1		
	b	b_s	r
Intercept	0.268	–	–
PHDPRST	0.142	0.066	0.241
FELPRST	0.351	0.074	0.177
MAWARD	0.284	0.137+	0.254
MCIT	0.112	0.144+	0.294
COLLAB	0.575	0.123+	0.159
BASEL	0.194	0.121+	0.190
R^2	0.176		

	Equation 2		Equation 3		
	b	b_s	b	b_s	r
Intercept	1.07	–	0.133	–	–
PHDPRST	0.165	0.076	–0.129	–0.060	0.241
FELPRST	0.299	0.063	–0.0638	–0.013	0.177
Effects for Collaborators:					
MAWARD	0.202	0.082	0.271	0.110	0.247
MCIT	0.235	0.340**	0.169	0.245*	0.375
Effects for Noncollaborators:					
MAWARD	0.376	0.139+	0.565	0.209**	0.271
MCIT	–0.0762	–0.079	–0.0581	–0.060	0.051
COLLAB	–0.510	–0.109	–0.657	–0.141	0.159
BASEL	0.156	0.097	0.0469	0.029	0.190
PUBS			0.715	0.254**	0.388
CITS			0.141	0.126	0.394
JOBPRST			0.944	0.330**	0.446
R^2	0.206		0.397		

Variable identifications: Dependent variable is square root of standardized levels of three-year citations ending in the sixth year after initial employment in current department. Independent variables are: PHDPRST=Cartter prestige rating of the student's doctoral department; FELPRST=Roose-Andersen bioscience prestige of fellowship location for fellows in rated graduate departments, 3.58 for others; MAWARD= square root of weighted number of awards received by the mentor up to the time of the student's doctorate; MCIT=square root of the number of citations to the work published by the mentor during the three-year period beginning the year of the student's doctorate; COLLAB=1 if predoctoral collaboration with mentor, else 0; BASEL=selectivity of baccalaureate institution; PUBS=square root of standardized levels of three-year publication counts for the period ending the first year of the current job; CITS=square root of standardized levels of citations to publications in the three-year period ending the first year of the current job; JOBPRST=Roose-Andersen bioscience prestige score of the first academic job.

b=unstandardized regression coefficients; b_s=standardized regression coefficient; r=zero-order correlation with dependent variable. + indicates one-tailed significance at the 0.10 level or two-tailed significance at the 0.20 level; * indicates one-tailed significance at the 0.05 level or two-tailed significance at the 0.10 level; ** indicates one-tailed significance at the 0.025 level or two-tailed significance at the 0.05 level.

Equation 1 of each table presents the effects of doctoral and fellowship prestige, characteristics of the mentor, and selectivity of the baccalaureate institution on productivity six years into the first job; prestige of the current department and productivity at the time the job was obtained are excluded. These are reduced form equations (see Ref.[27]) which allow us to assess the total effects of the variables included in the model. Eleven percent of the variation in level of publication six years into the academic job is explained; 18 percent of the variation in citations is explained. While the mentor's performance is most strongly correlated with future publications, the strongest effect is that of collaboration with the mentor. Citations are most strongly affected by the performance of the mentor, followed by the eminence of the mentor.

These results do not, however, take into account the suggested interaction between characteristics of the mentor and collaboration with the mentor. This possibility is considered in Eq. (2) of each table. Collaboration no longer has a direct effect on publications. Instead, the effect of the mentor's performance for those who collaborate with the mentor almost triples, while no effect exists for noncollaborators. Similarly for citations, the effect of the mentor's performance for collaborators has more than doubled with a standardized coefficient of 0.340. A smaller, although statistically significant, effect of the mentor's eminence has emerged for noncollaborators.

These results present evidence on the total effects, both direct and indirect, of the mentor on later productivity. Past research[15] has shown that both predoctoral productivity and the prestige of the job placement influence later productivity. Given that characteristics of the mentor influence both of these variables, Eq. (3) in each table presents regressions which control for earlier productivity and academic prestige. As past research has found, earlier productivity and the prestige of the job have the strongest effects. Nonetheless, the mentor remains a significant influence for both those who collaborate and those who do not. For those collaborating with the mentor the performance of the mentor during the period of doctoral study significantly affects both publications and citations, with the effect being somewhat stronger for citations. For those who do not collaborate, the performance of the mentor has no influence, but the eminence of the mentor emerges as a significant effect.

The mentor continues to positively affect the student's productivity, independently of the indirect effects of the mentor that operate through earlier productivity and the prestige of the job placement, the mentor continues to positively affect the student's productivity. The most reasonable interpretation of the effect of the mentor s performance for collaborators is one of teaching and selection. Those collaborating with a productive mentor gain the abilities to be more productive reserachers, independently of the prestige of their academic placement or their earlier productivity. At the same time, students with greater potential may select or be selected by more productive faculty. The positive effect of eminence for those who do not collaborate is more likely to reflect selection of or by a mentor than teaching received from the mentor. The lack of collaboration indicates the absence of the apprenticeship leading to a coauthored publication. On the other hand, students with more eminent mentors may be more talented than those with less eminent mentors. This greater talent would then be reflected in their greater, later productivity. It is unlikely that the effect of the mentor's eminence reflects sponsorship so late in the career.[g]

Summary and Conclusions

The influences exerted by mentors on their graduate students are many and subtle. Even the few relatively crude indicators that we have analyzed for a set of biochemists show clear, strong and enduring patterns of influence. Among the three primary roles of the mentor–teacher, sponsor and collaborator–we have no evidence about the effect of the first, at least weak evidence about the second, and rather convincing evidence about the third.

Within the confines of our data, collaboration in publication appears to be the most influential act that mentors can perform on behalf of the careers of their graduate students. The single most important factor influencing predoctoral publication is collaboration with the mentor, a relationship that is reflected in more than 50 percent of all predoctoral papers published by the biochemists in our sample. Moreover, a mentor's performance and eminence have additional effects on predoctoral productivity. These factors operate only weakly in the absence of collaboration.

Among those who enter academia, the mentor's performance is a significant factor in determing the prestige of a student's appointment, although this effect operates only for those students who collaborated with their mentor. This is true despite the fact that predoctoral productivity has little effect on initial employment outcomes.

As would be expected, collaboration with a mentor rapidly decreases as a direct influence as students become professionals and move into their careers. Nonetheless, indirect effects of the mentor continue to play an important effect on the productivity of their students. These indirect effects operate through early productivity and highly rated academic placements, both of which have substantial influence on later productivity.

Finally, let us return to our initial concern with ascription versus achievement in the academic career. While it is clear to us that the performance of mentors has more to do than their eminence with their students acquiring prestigious academic placements, ascription nonetheless appears to play an important role. It is significant to note that while a mentor's performance affects the student's placement, the student's own performance has no significant effect upon the outcome. This suggests that ascription plays an important role in the academic marketplace. The ascriptive advantages of one's mentor are then drawn upon and enhanced through the joint effects of reinforcement and context. This, in part at least, is how cumulative advantage operates.

*

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Notes

[a]As the origin of the term from Greek mythology implies, the mentor is not simply a teacher, but someone who also looks after the general well being of the student. While there are certain to be instances of a mentor who is simply someone to sign an official document with no affective relations with the student, these are likely to be exceptions.

[b]The senior author is currently extending the sample by collecting comparable information for a sample of female biochemists obtaining degrees from 1950 to 1967.

[c]The complete *Roose* and *Andersen* prestige scores were kindly provided by Charles J. *Andersen.*

[d]By regressing departmental prestige on characteristics of the mentors in our sample, we are not presenting this as a causal model of the determinants of a department's prestige. Rather, our intention is to examine the extent to which the characteristics of individual members of a department (those who are mentors) and the prestige of the department covary. *Hagstrom*[30] was able to explain nearly 80 percent of the variation in departmental prestige in terms of *aggregated* measures such as department size, mean time on research, and geometric mean of faculty publications. This does not contradict our finding, since we are interested in the relationship between characteristics of *individual* faculty members and departmental prestige.

[e]The year after the degree is included to allow work completed during graduate studies to find its way into print.

[f]More detailed analyses of the allocation of academic scientists to departments of varying prestige are presented in Ref.[16] The model used here summarizes the basic findings of that paper, adding new data on the effects of the mentor.

[g]We are indebted to Warren O. *Hagstrom* for his comments on the importance of selection.

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