Research in Higher Education, Vol. 47, No. 4, June 2006 (© 2006)
DOI: 10.1007/s11162-005-9003-2

DOES ADVISER MENTORING ADD VALUE? A LONGITUDINAL STUDY OF MENTORING AND DOCTORAL STUDENT OUTCOMES

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This study of the impact of doctoral adviser mentoring on student outcomes was undertaken in response to earlier research that found (a) students with greater incoming potential received more adviser mentoring, and (b) adviser mentoring did not significantly contribute to important student outcomes, including research productivity [Green, S. G., and Bauer, T. N. (1995). *Personnel Psychology* 48(3): 537–561]. In this longitudinal study spanning 5 1/2 years, the effect of mentorship on the research productivity, career commitment, and self-efficacy of Ph.D. students in the 'hard' sciences was assessed, while controlling for indicators of ability and attitudes at program entry. Positive benefits of mentoring were found for subsequent productivity and self-efficacy. Mentoring was not significantly associated with commitment to a research career.

KEY WORDS: mentors; doctoral students; research productivity.

INTRODUCTION

Mentoring has been defined as "a nurturing process in which a more skilled or more experienced person, serving as a role model, teaches, sponsors, encourages, counsels and befriends a less skilled or less experienced person for the purpose of promoting the latter's professional and/or personal development" (Anderson and Shannon, 1988, p. 40). The mentor–protégé relationship has attracted a considerable amount of scholarly interest over the years, mostly in corporate and academic settings, and spanning a diverse set of research questions. For example,

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in the workplace, researchers have examined how the mentor–protégé relationship changes over time (Kram, 1983), differences between formal and informal mentorships (Chao, Walz, and Gardner, 1992; Ragins and Cotton, 1999), and the relationship between protégé gender and mentoring (Dreher and Cox, 1996; Lyness and Thompson, 2000). Mentoring topics in academic contexts have included senior faculty's mentoring of junior faculty (Bullard and Felder, 2003; Quinlan, 1999), characteristics of effective faculty/student mentoring (Anderson and Carta-Falsa, 2002; Cronan-Hillix, Gensheimer, Cronan-Hillix, and Davidson, 1986; Luna and Cullen, 1998; Rose, 2003), adviser mentoring and women's doctoral degree progress (Maher, Ford, and Thompson, 2004), the evaluation of faculty in their mentor roles (Cesa and Fraser, 1989), and even using the Internet to help students gain access to mentors (Whiting and de Janasz, 2004).

An impetus for investigating mentoring in both industry and academia is the popular notion that this nurturing process results in positive outcomes for the protégé. Indeed, in the business world, several studies have found positive relationships between mentoring and subordinates' promotions and compensation (e.g., Fagenson, 1989; Lyness and Thompson, 2000; Scandura and Schriesheim, 1994; Whitely, Dougherty, and Dreher, 1991), career satisfaction (Riley and Wrench, 1985), and organizational commitment (Douglas and Schoorman, 1988). In academia, mentored undergraduate students have been found to have a higher GPA, more units completed per semester, and a lower dropout rate than their non-mentored counterparts (Campbell and Campbell, 1997).

As indicated above, a substantial amount of research on mentoring has taken place in business contexts. Given this article's focus on mentoring in doctoral programs, is it reasonable to consider industry findings when studying mentoring in academia? The mentoring literature suggests there are similarities between the role of supervisor–mentors in the socialization of new hires in work organizations on the one hand, and the role of faculty advisers in entering doctoral students' training experiences on the other. Researchers in work organizations have labeled supervisory mentors as key individuals in the newcomer socialization process, exerting a significant effect on newcomers' development (Jablin, 1988; Louis, Posner, and Powell, 1983; Schein, 1968). Supervisors help facilitate newcomers' development by offering psychosocial support and career mentoring (Douglas and Schoorman, 1988; Scandura and Schriesheim, 1994). Likewise, in graduate education, "the adviser is correctly seen as the 'significant other' for the student's journey..." (Bargar and Mayo-Chamberlain, 1983, p. 420). The faculty adviser provides critical mentoring to students in a variety of ways. For

instance, early on, the adviser can demonstrate a caring interest in the students' welfare, helping them deal with the anxiety and culture shock that may accompany undertaking a new endeavor in an unfamiliar place. As well, the adviser can help students make contacts and gain exposure to other faculty, advanced students, and members of the professional community (Bargar and Mayo-Chamberlain, 1983). These types of mentoring seem compatible with the psychosocial support and career help that supervisors provide junior employees in industry settings. The aspect of mentoring in the graduate school environment that is most different from mentoring in corporate settings is doctoral advisers' encouragement of, and often collaboration with, students in publishing and presenting research. In sum, with this important exception fully noted, we believe the similarities between mentoring in industry and academia make it reasonable to allow the literature derived from industry settings to help shape and inform our thinking about the 'supervisory mentoring' doctoral advisers do, and its effects.

Research with graduate students highlights the significant role students believe mentors play in their training, as well as the perceived benefits that mentoring confers. In one study, 90 of 109 graduate students surveyed (83%) said that it was important for graduate students to have mentors; all but four reported they had had at least one mentor during graduate school. Among the mentoring benefits reported by these students were role modeling, guidance and support, listening, enhanced self-confidence, and career advice (Luna and Cullen, 1998). In doctoral student samples, those who reported having a mentor had a more positive overall evaluation of their graduate school experience (Lyons and Scroggins, 1990), and finding a particular faculty mentor was part of the profile of early-finishing female doctoral students (Maher et al., 2004). Certainly, an important outcome for Ph.D. students is research productivity and publication success; evidence suggests these may be enhanced by faculty mentoring (Cronan-Hillix et al., 1986; Green, 1991; Reskin, 1979).

RESEARCH PLAN AND OBJECTIVES

In this study, a closer look is taken at the benefits that accrue to doctoral students as a result of their relationships with mentors during their training. Specifically, through a longitudinal investigation of adviser mentoring and doctoral student outcomes extending over 5 1/2 years, the impact of mentoring on student research productivity, career commitment, and self-efficacy is assessed. In so doing, this research is

intended to contribute to our knowledge of the mentoring process in three ways.

First, questions have been raised by an earlier phase of this long-term research program about the true added value of mentoring (Green and Bauer, 1995). Specifically, results showed that the amount of mentoring provided by doctoral program advisers during students' first year could be predicted by the students' incoming potential, as measured at entry by their attitudes, objective abilities, and prior research-related experience. One explanation may be that advisers were targeting the best-qualified candidates upon which to bestow their mentoring attentions. Alternatively, students with greater incoming potential may have been more likely than their peers to proactively seek out a mentoring relationship with a faculty member early in their programs. Another interesting finding from this study was that the amount of mentoring received in students' first year did *not* contribute positively to students' research productivity at the end of year two, after controlling for incoming potential. Neither did adviser mentoring positively influence students' commitment to a research career at the end of their second year, after controlling for level of commitment at program entry. Relatedly, in a subsequent study of doctoral student socialization, Weidman and Stein (2003) reported that the frequency and intensity of student–faculty interactions were not significantly correlated with participation in research and other scholarly activities. Taken together, these results call into question the popular belief that mentoring adds value, as well as emphasizing the need to control for relevant variables at the start of the mentor–protégé relationship when assessing the influence of mentoring on student outcomes.

Second, much of the prior research work on mentoring has been cross-sectional or retrospective in nature (e.g., Cronan-Hillix et al., 1986; Luna and Cullen, 1998; Lyons and Scroggins, 1990; Maher et al., 2004). As such, the causality of relationships discovered between mentoring and other variables in these studies cannot be unraveled (Cook and Campbell, 1979). Specifically, findings from these research designs are subject to the alternative explanation that mentoring is a *response* to better performance or attitude rather than a cause of it, as intimated by Green and Bauer's (1995) findings. This concern points out the need for research in which the order of causality can be determined.

In this study, we take a second look at the important question of whether or not mentoring adds value through an extension of the prior research project (Green and Bauer, 1995). We recognized that the initial study, in which the amount of mentoring was measured at the end of students' first year in their doctoral programs and productivity

(i.e., research publications and submissions) was assessed at the end of year two, may not have incorporated a long enough timeframe for the positive influence of mentoring to be revealed. Indeed, others have stressed the importance of longitudinal research in examining mentorship, given the duration and interpersonal dynamics of these kinds of relationships (Hunt and Michael, 1983). Therefore, for this extension, data on the amount of adviser mentoring were collected at the end of students' second year in their doctoral programs, and research productivity and commitment measures were obtained 5 1/2 years after the start of their programs. As well, measures of students' abilities and attitudes at entry were controlled for in the analysis. These research design characteristics enabled a strong test of the incremental predictive validity of adviser mentoring on doctoral student outcomes.

Third, this research introduces another outcome variable to our examination of the added value of mentoring. In addition to research productivity and commitment to a research career, doctoral students' self-efficacy for research-related tasks is expected to be affected by adviser mentoring. Self-efficacy is an important determinant of motivation and performance, and, as discussed later, its formation is subject to social influence (Bandura, 1977, 1986; Gist and Mitchell, 1992). Thus, while much research on mentoring has focused on distal outcomes such as promotions and pay (e.g., Dreher and Ash, 1990; Scandura and Schriesheim, 1994; Whitely et al., 1991), this study incorporates three more proximal outcomes upon which mentoring is expected to exert influence: productivity, career commitment, and self-efficacy.

This study's setting affords a number of advantages for the investigation of mentoring. Working closely with Ph.D. students on research projects is a role expectation for doctoral program advisers; these experiences offer numerous opportunities for mentorship. As well, the setting for this project allowed us to capture a large number of potential protégés at the very beginning of their training, with corresponding objective indicators of their incoming aptitudes (i.e., GRE scores) and comparable productivity measures (i.e., research paper submissions and acceptances). Finally, this study's sample consisted solely of students in the 'hard' sciences, such as chemistry, physics, and engineering. While focusing attention on Ph.D. students in these disciplines limits our ability to generalize findings to other academic fields, this choice was intentional. In 1987, Sigma Xi, the scientific research society founded in 1886 to honor scientists, recognize research, and promote scientific cooperation, published 'A New Agenda for Science'. In this report, Sigma Xi called for increased attention to the training and education of future scientists, noting their dwindling numbers in the U.S. (Sigma Xi, 1987).

Doctoral students in training at major research universities represent the major source of the next generation of scientists, both in academia and industry. As well, some of these students' potential industry employers, R&D and engineering departments within firms, are attempting to develop their own supervisory mentoring programs (Hissong, 1993; Kerres, 1994; Marien, 1992; Parson, 1991). In short, while recognizing the generalizability trade-off, we believe our study's sample offers significant potential benefits in terms of gaining a better understanding of the professional development of Ph.D. students who are being groomed to take on critical R&D roles in our nation's workforce.

CONCEPTUAL FRAMEWORK

After reviewing prior research and writing on mentorship in both industry and academic contexts, we elected to work from the conceptual groundwork laid by Kram and her colleagues (Kram, 1983, 1985; Kram and Isabella, 1985), for two reasons. First, we wanted to find a conceptualization of mentorship that closely fit the kind of mentoring that occurs in the adviser–student relationship, and second, we wanted to work with a construct definition that had validated measures associated with it. Our review of the literature on mentoring in academic contexts revealed fairly limited construct development and measurement work, compared to that found in the organizational behavior literature. For example, prior work on the socialization experiences of graduate students has considered the *supportiveness* of the faculty adviser, measuring this with bipolar adjective scales of distant–close, inefficient–efficient, nonsupportive–supportive, etc. (Green, 1991). Other work in academia has investigated the influence of the doctoral 'sponsor' on student productivity, using measures of the sponsor's eminence or prestige, his or her publications, and the number of papers he or she co-authored with the student (Reskin, 1979).

We wanted to find a more comprehensive conceptualization of the nature of mentoring relationships in graduate school, and so we turned to the organizational behavior literature for help. (As discussed earlier, we believe there is sufficient overlap between mentoring in academic and industry settings to justify doing so.) Kram and her colleagues have done some of the most in-depth work on defining the mentoring construct, through content analysis of interviews with mentors. Their research identified *psychosocial* and *career* functions of mentorship, which have been the subject of subsequent measurement development and validation work (Noe, 1988). These two functions are consistent with the doctoral adviser's role as described by Bargar and Mayo-Chamberlain

(1983), as well as the kind of guidance graduate students report valuing from their advisers (Luna and Cullen, 1998). Specifically, *psychosocial mentoring* contributes to the protégé's sense of competence, confidence, and effectiveness in his or her role. Mentor behaviors that fall in this category include role modeling, conveying respect and acceptance, counseling when fears and anxiety emerge, and offering informal friendship. *Career-related mentoring* involves those activities that help prepare the protégé for career advancement, such as challenging assignments, introductions and exposure to professional colleagues, and protection from risks (Kram, 1983, 1985; Noe, 1988). These activities are conceptualized as a range of functions, rather than as discrete, 'either-or', forms of mentoring. For example, as a mentor–protégé relationship reaches a mature or 'cultivation' phase, the range of psychosocial and career-related functions provided by the mentor expands to a maximum (Kram, 1983).

In addition to these two mentoring functions, we added a third—*research collaboration*. As mentioned earlier, this is an aspect of mentoring unique to the graduate school setting that should be included in order to form a more complete picture of the mentoring that occurs in adviser–student relationships. Inviting students to work with the adviser on research projects is a well-established aspect of mentoring in doctoral programs that is believed to be important to protégés' success (Bargar and Mayo-Chamberlain, 1983; Busch, 1985; Cameron and Blackburn, 1981). It is a context-specific activity that complements the career-related function, above. Advisers invite Ph.D. students to work jointly with them on research projects that typically have a published journal article as the final goal—the key that opens the door to job placement for those pursuing a research career.

HYPOTHESES: ADVISER MENTORING AND STUDENT OUTCOMES

Mentoring can positively influence protégé performance, measured in this study by research productivity, in a number of different ways. For example, through the *psychosocial* mentoring function of role modeling, advisers can demonstrate productive work habits and attitudes, providing protégés with an example from which to model their own working styles. As well, the adviser's sharing of his or her own early experiences in dealing with the frustrations and challenges of conducting academic research can help students persevere and develop resilience. In addition, offering friendship, encouragement, and a sympathetic ear to new doctoral students may help them get past transition challenges that are

standing in the way of fully focusing on skill development and effective performance.

With respect to *career-related* mentoring and its influence on productivity, advisers may provide introductions to more advanced students and to faculty within and outside the home institution who are working in similar research areas. This exposure can stimulate new research projects and collaboration opportunities. Advisers can also assist in preparing students for their research careers by assigning them challenging research assistant assignments, such as a literature search on a particular issue, which helps them develop and hone important skills. In some programs, advisers serve a critical mentoring role in protecting their students from risks (e.g., intradepartmental faculty conflicts, excessive teaching assistant obligations, etc.) that could hinder their advancement and productivity. Finally, mentoring through *research collaboration* gives students co-authorship opportunities, and perhaps access to data, to help them achieve productivity results in the form of conference papers, grant proposals, and journal article submissions.

In addition, we propose that doctoral adviser mentoring should enhance protégés' commitment to their research careers. By helping students acquire the critical skills they need to be productive researchers in the ways described above, students are likely to be more optimistic about their 'fit' with the profession and their potential for having a successful career. Then too, observing a faculty role model who enjoys and seems to be stimulated and fulfilled by his or her research endeavors should enhance students' desire to follow a similar path. Together, these experiences are expected to lead to greater commitment to pursuing a research career.

Although much of the mentoring literature focuses on more distal outcomes, there have been a few studies in corporate settings that have addressed the proposed relationships between mentoring, productivity, and commitment. With respect to productivity, employees who were provided with more psychosocial and career-related mentoring by their supervisors exhibited higher performance levels (Douglas and Schoorman, 1988). Chao et al. (1992) reported an association between career-related mentoring and self-reported performance proficiency. In contrast, another study did not support the proposed link between career mentoring and performance (Scandura and Schriesheim, 1994). Less empirical evidence exists regarding the predicted relationship between mentoring and career commitment. Prior research has shown mentoring to be associated with other affect variables, however, such as satisfaction (Chao et al., 1992; Dreher and Ash, 1990; Fagenson, 1989).

Also, mentoring has been positively linked with *organizational* commitment in the workplace (Douglas and Schoorman, 1988).

Compared with much of the research cited above, the current study provides a rigorous test of the effects of mentoring on these two outcomes. In examining mentoring's effect on subsequent productivity, for example, indicators of ability and research self-efficacy perceptions (to be discussed next) at program entry are controlled for in the analysis. Likewise, research career commitment at program entry is controlled for in testing mentoring as a predictor of career commitment 5 1/2 years later. Through these means, this study more effectively isolates the impact of adviser mentoring on productivity and commitment, over and above students' own initial talents and attitudes.

Hypothesis 1: After controlling for indicators of students' initial ability to perform and research self-efficacy, adviser mentoring will be positively related to productivity 5 1/2 years after they begin their doctoral programs.

Hypothesis 2: After controlling for students' initial level of research career commitment, adviser mentoring will be positively related to career commitment 5 1/2 years after they begin their doctoral programs.

The third outcome variable that adviser mentoring is expected to influence is self-efficacy. Self-efficacy is defined as the conviction that one can successfully execute the behavior required to produce desired outcomes (Bandura, 1977, p. 193), and is operationalized in this study as self-perceived capabilities in the academic research domain. Self-efficacy is a central construct in Bandura's (1986) social cognitive theory, in which it is described as a potent influence on the initiation, intensity, and persistence of behavior. Specifically, people get involved in activities that they judge themselves capable of handling; once engaged, their efficacy beliefs influence how much effort they devote to the task and how long they persist in the face of obstacles (Bandura, 1977). Ultimately, differences in self-efficacy show up in performance levels; people who *think* they can do well on a task perform better than those who expect to fail (Gist and Mitchell, 1992). Indeed, prior work examining influences on faculty research productivity has found self-perceptions of competence to be a significant predictor of publications (Blackburn and Lawrence, 1995).

The hypothesis proposed below is grounded in the sources of self-efficacy information articulated by Bandura (1986). Specifically, vicarious learning, personal mastery experiences, and verbal persuasion are three ways an individual's assessment of self-efficacy develops. Potentially, adviser mentoring can influence each of these mechanisms. For example, through vicariously observing advisers as they model research skills and

overcome obstacles (i.e., *psychosocial* mentoring), students can gain confidence that they can perform these behaviors as well. Psychosocial mentoring also can include various forms of verbal persuasion that enhance students' efficacy perceptions. For instance, advisers can boost students' confidence through expressions of support when they doubt themselves, and by sharing personal experiences the adviser has had that are similar to students' current challenges. *Career-related* mentoring may include providing the protégé with 'stretch' assignments that stimulate the development of knowledge and skills, i.e., mastery experiences. Certainly, *collaborative* mentoring provides students opportunities for personal mastery, as well as vicarious learning.

As before, a baseline measure needs to be controlled for in order to most effectively assess the influence of adviser mentoring on research self-efficacy. In addition, successful research achievements reflect personal mastery experiences, and thus may be a potent contributor to subsequent self-efficacy judgments. Therefore, protégés' number of accepted research papers (e.g., to a journal, conference, or granting agency) midway through their doctoral programs is incorporated into this hypothesis.

Hypothesis 3: After controlling for students' research self-efficacy at entry and productivity midway through the doctoral program, adviser mentoring will be positively related to research self-efficacy 5 1/2 years after they begin their doctoral programs.

METHOD

Sample

Doctoral students in 24 academic departments at a Class 1 research, land-grant university in the Midwest, who began their doctoral studies in the same semester, comprised the sample. Departments were chosen using three criteria: each had a doctoral program, emphasized research as part of students' training, and were classified as a "hard" science (Biglan, 1973). These criteria ensured that research activity was an integral component of these students' graduate school experiences. They also limited the sample to a set of sciences where a relatively homogeneous set of doctoral training experiences would exist, while still maintaining adequate sample size. Assessment of departments on these criteria was based on statements in the university catalog describing the programs and upon personal verification of the departments' operations. Twenty-four of 29 departments identified in this manner agreed to participate by furnishing names and addresses of all of their incoming

Ph.D. students. This study is an extension of, and examines the same student cohort as, previous research on newcomer socialization (Bauer and Green, 1994) and supervisory mentoring (Green and Bauer, 1995). However, data from a final survey administration, which were collected 5 1/2 years after the students' initial entry into their doctoral programs, are unique to the present paper. In addition, data for the mentoring variables used in the present analysis were collected a year later than those used in the hypothesis tests in the previous mentoring article (Green and Bauer, 1995).

In order to ensure that faculty mentoring was an expected and valued characteristic of the doctoral programs in the selected departments, a separate data collection was conducted at the start of this research program. For each department, a survey was sent to the department head (83% response rate), two faculty members (93% response rate), and two upper-level doctoral students (i.e., not part of the entering student sample; 71% response rate). Respondents agreed that advisers were expected to "sponsor, protect, and provide challenging tasks, exposure, and visibility for the Ph.D. students" (94% yes response) and "provide counseling, acceptance, confirmation, and coaching" (93% yes response). Responding to the specific question, "Are faculty advisers expected to mentor Ph.D. students they advise?", 96% answered *yes*.

A total of 357 entering doctoral students were sent surveys during the first 3 weeks of their first semester of doctoral training (Time 1). Questionnaires were coded to enable matching of responses across data collections, and respondents were assured of confidentiality. Participants were told that the purpose of the study was to examine the experiences of doctoral students during their training. 233 questionnaires were returned at Time 1, for a response rate of 65%. Data were collected again at the end of the students' second academic year (Time 2). One-hundred-sixty-one surveys were returned, for a response rate from eligible respondents of 69% (161/233) at Time 2. A final survey was administered 5 1/2 years after the students began their programs (Time 3). We scheduled the final data collection at this point for two reasons. First, as discussed earlier, we wanted to allow enough time to elapse for the positive influence of adviser mentoring on research productivity to be revealed. Second, we wanted to ensure an adequate response rate from our sample, and felt that waiting *too* long would jeopardize this. Five-and-half years seemed a reasonable compromise. After several follow-up attempts, the sample size for the final data collection was 130, for a response rate from eligible respondents of 81% (130/161) at Time 3.

Of the sample, 77% were male, 62% were White, and 60% were U.S. citizens. At the time of the final data collection, 50% had graduated

with the Ph.D. degree, 19% had left with a Master's degree, and 30% were still enrolled in their graduate programs.

Measures

As noted in the descriptions of individual measures in this section, established measures with known psychometric properties were used where possible and adapted for the academic context. In other cases, new measures were created based on literature reviews and pilot testing of items and scales. All measures, except those that were simple summations of research activity (e.g., prior research experience), were factor analyzed using principal factors analysis with varimax rotation. Factors were determined using a combination of decision rules: theoretical rationale, eigenvalues greater than one, examination of the scree plot, and high loadings with the absence of cross loadings (Ford, MacCallum, and Tait, 1986). Specific cases of dropped items are reported where they occurred. In all but one case (see discussion of the mentoring measures, below), one factor was obtained for each measure. All coefficient alphas for the scales exceeded the .70 level and are reported where applicable on the diagonal in Table 2.

Initial Ability to Perform

Three indicators of incoming students' potential abilities in the research setting were obtained at Time 1. Verbal and quantitative GRE scores were provided to the researchers by the university's Registrar's Office. Despite the ubiquity of GRE scores in the graduate school admissions process, we note that the research is not conclusive as to their predictive validity for graduate school success. Some studies have found that scores are positively related to passing the preliminary exams (Dollinger, 1989), faculty ratings of students (Dollinger, 1989; Robertson and Nielsen, 1961), and completion of the Ph.D. degree (quantitative score only; Hackman, Wiggins, and Bass, 1970). Other research has resulted in contrary findings (e.g., Holmes and Beishline, 1996; Thacker and Williams, 1974). We considered other potential markers of incoming students' cognitive abilities, such as undergraduate grade point average or selectivity of undergraduate or master's institution, but rejected these as having more serious flaws. In the end, we settled on GRE scores as standardized, widely used measures of ability, for which we could obtain data on all incoming Ph.D. students in our sample.

The third indicator of incoming potential was a measure of research experience prior to entering the doctoral program. Prior work has

shown that research experience before entry is significantly related to research activity during doctoral students' first year (Green, 1991). This construct was measured by asking participants to report how many times (1 = *never*; 5 = *many times*) they had engaged in 10 research-related activities before entering the graduate program. Responses were summed to create a frequency measure of prior research experience. Specifically, participants were asked how many times they had done the following: (a) worked with a faculty member on a research project, (b) worked with another student on a research project, (c) conducted a research project alone, (d) submitted a grant proposal/convention paper/journal article, (e) had a grant proposal/convention paper/journal article accepted, and (f) had a book or book chapter published. The range of responses was 10–41, with a mean of 17.7.

Ph.D. Intention

Recognizing that students who left with a Master's degree by Time 3 may never have intended to see their program through to Ph.D. completion, and that this might impact our outcomes, we included a control variable to capture students' intentions at entry. Specifically, this variable consisted of responses to the following Time 1 survey item, "*Is it your intention to earn a Ph.D. from this program?*" Responses were coded as 1 = 'yes', 0 = 'no' or 'undecided at this time' (88% answered in the affirmative).

Career Commitment

Commitment to a research career was assessed at Time 1 (control variable in Hypothesis 2) and Time 3 (outcome variable) with a scale specifically developed for this study. This measure assessed the degree to which respondents valued pursuing a research career now and in the future. Examining the factor pattern matrix for the new scale led to dropping one item with a low factor loading, resulting in six items that were averaged to create the measure of career commitment at Time 1. At Time 3, one of these items was no longer applicable for many participants ("Quality research is the most rewarded activity in this program") and was dropped. In addition, some wording changes were needed at Time 3 to reflect the different context 5 1/2 years later. For example, "After graduation, I want a job with a strong research orientation," was changed to "I want work that has a strong research orientation." The final five-item scale used at Time 3 is shown in Table 1.

Self-efficacy

A measure of research self-efficacy was obtained at Time 1 (control variable) and Time 3 (outcome variable). The 10-item scale was adapted from a measure used by Bandura (1977). It asked respondents to rate their degree of confidence that they could successfully handle a series of research tasks. The identical set of 10 items was used in both data collections; responses were averaged to form the self-efficacy measures. The scale items are shown in Table 1.

Adviser Mentoring

The mentoring variables used as predictors in the hypothesis tests were measured at Time 2 (end of second academic year). As noted earlier, three mentoring functions were assessed. The 21-item scale developed and validated by Noe (1988) was used to measure the *psychosocial* and *career-related* functions. Some minor wording changes were required to adapt these items to the academic setting, for instance, ''my mentor'' was changed to ''my adviser'' throughout the scale to eliminate any confusion as to which relationship was the focus. As another example, the scale item, ''[My] mentor has encouraged me to try new ways of behaving in my job,'' was changed to ''My adviser encourages me to try new ways of behaving in my role as a graduate student.'' In addition, one item that dealt with future advancement (item 19; Noe, 1988, p. 469) was judged not relevant to the academic context and was dropped from the scale. The resulting *psychosocial mentoring* scale consisted of 14 items that assessed the extent to which the adviser engaged in coaching, acceptance, confirmation, role modeling, and counseling. The *career-related mentoring* scale consisted of six items that measured the protection, exposure and visibility, sponsorship, and challenging assignments provided by the adviser. Scores were created by averaging each scale's items. The scales are shown in Table 1.

The third mentoring function, *research collaboration*, was measured with a scale adapted from Green (1991). These items measured the extent to which the adviser invited the student to co-author five different types of research projects: a research paper, a paper to be submitted to a convention, a paper to be submitted to a journal, a grant proposal, and a book or book chapter (1 = *never*; 5 = *many times*). Responses were averaged to form the collaborative mentoring score.

Factor analysis of the mentoring items produced results that required a judgment call about how to proceed. Specifically, while the collaborative mentoring items loading cleanly on one factor, there were several

TABLE 1. Survey Measures

Career commitment (T1 and T3) 1 = strongly disagree; 5 = strongly agree.
1. I am committed to a research career.
2. Nothing else is more important than the research aspect of my career.
3. I would be happy working in a position that doesn't emphasize research. (R)
4. I have a great desire to contribute to knowledge about how things work.
5. I want work that has a strong research orientation.

Note. (R) = reverse-scored. These items are from the T3 data collection. As noted in the text, some adjustments were made to the T1 scale to accommodate the different context of many participants 5 1/2 years later.

Self-efficacy (T1 and T3). 0 = not at all confident; 10 = very confident.
1. Be an effective contributor to a research project.
2. Successfully conduct a research project by yourself.
3. Submit a paper to a convention that will be accepted.
4. Be an effective co-author on a paper.
5. Submit a paper to a journal that will be accepted.
6. Effectively conduct data analyses.
7. Identify and pose research questions that are worthy of study.
8. Complete a literature review and summarize the important issues.
9. Design and conduct effective research.
10. Be an effective and successful scientist.

Psychosocial mentoring (T2). 1 = to a very slight extent; 5 = to a very large extent.
1. My adviser shares history of his/her career with me.
2. My adviser encourages me to prepare for advancement in this program.
3. My adviser encourages me to try new ways of behaving in my role as a graduate student.
4. I try to imitate the work behavior of my adviser.
5. I agree with my adviser's attitudes and values regarding education.
6. I respect and admire my adviser.
7. I will try to be like my adviser when I reach a similar position in my career.
8. My adviser demonstrates good listening skills in our conversations.
9. My adviser discusses my questions or concerns regarding feelings of competence, commitment to advancement, relationships with peers and faculty or school/family conflicts.
10. My adviser shares personal experiences as an alternative perspective to my problems.
11. My adviser encourages me to talk openly about anxieties and fears that detract from my work.
12. My adviser conveys empathy for the concerns and feelings I have discussed with him/her.
13. My adviser keeps feelings and doubts I share with him/her in strict confidence.
14. My adviser conveys feelings of respect for me as an individual.

TABLE 1. (*Continued*)

Career-related mentoring (T2). 1 = to a very slight extent; 5 = to a very large extent.

1. My adviser reduces unnecessary risks that could threaten the possibility of my advancing in my program.
2. My adviser helps me finish assignments/tasks or meet deadlines that otherwise would have been difficult to complete.
3. My adviser helps me to meet new colleagues.
4. My adviser gives me assignments that increase my written and personal contact with influential faculty in the school.
5. My adviser gives me assignments or tasks that prepare me for a research position after I graduate.
6. My adviser gives me assignments that present opportunities to learn new skills.

cross-loadings among the psychosocial and career-related mentoring items. Theory and measurement development work have argued that these two functions are different constructs, and the measures have been previously validated as such (Noe, 1988). The separate scales have been so used in other research (e.g., Chao et al., 1992). In addition, in our regression analysis the effects of one function are always controlled for when testing for the effects of the other function. Therefore, we decided against reforming the measure based upon our single sample results, and elected to go forward with the original tripartite construction of the mentoring variables.

Productivity

Students' research productivity was measured at Time 2 (control variable in Hypothesis 3) and Time 3 (outcome variable). In the first case, the cumulative number of conference papers, journal articles, book chapters, and grant proposals that the student had had accepted by the end of year two, both single- and co-authored, was used as an indicator of performance midway through the doctoral program. At the end of the second year, 53% had one or more 'acceptances'; the range was 0–14. Next, to test the contribution of adviser mentoring in predicting research productivity (Hypothesis 1), the number of cumulative submissions at Time 3 (5 1/2 years after beginning the doctoral program) was used. Respondents indicated the number of conference papers, journal articles, book chapters, and grant proposals they had submitted since the beginning of their doctoral studies (both single- and co-authored). The mean number of submissions at Time 3 was 8.6 (SD = 8.8; range = 0–48). It was felt that submissions, which should be relatively

unaffected by differences in the peer review process across fields and journals, were a better indicator of raw research productivity for the purposes of testing the impact of mentoring (Hypothesis 1). In contrast, acceptances were expected to be the more appropriate variable as a potential influence on research self-efficacy (Hypothesis 3).

Analysis Plan

A correlation analysis was conducted and then the hypotheses were tested with three OLS regression models. Dependent variables were Time 3 productivity, career commitment, and self-efficacy, respectively. Depending on the particular hypothesis, baseline measures of protégés' ability, career commitment, or research self-efficacy at entry were included as control variables, enabling the evaluation of the unique, predictive effects of the mentoring variables on the outcomes of interest. In addition, students' intention to pursue the Ph.D. degree (yes/no) was included as a control in each regression model.

These tests of the added value of mentoring were conducted with a confidence level of .10, due to the relatively small sample size ($n = 108$ for hypothesis 1; $n = 111$ for Hypotheses 2 and 3) resulting from collapsing three panels of data, as well as the attenuation of effects expected in research spanning more than five years.

RESULTS

Zero-order correlations and descriptive statistics, along with reliability estimates, are presented in Table 2. Results of the regression analysis are shown in Table 3. The first hypothesis proposed that adviser mentoring, measured at the end of students' second year in their Ph.D. programs, would be positively related to cumulative research submissions 4 years later, after controlling for initial indicators of ability to perform (namely, GRE scores and prior research experience) and initial research self-efficacy. As can be seen in Table 2, GRE scores were not significantly related to Time 3 submissions. However, research experience prior to entry and the three functions of adviser mentoring all had significant zero-order correlations with this research productivity measure ($p < .05$). In the regression analysis, which exposes the unique predictive effects of the mentoring variables, prior research experience ($p < .10$) and collaborative mentoring ($p < .05$) were positive predictors of submissions, with collaborative mentoring being the more influential predictor. Thus, moving from the correlation analysis to the more rigorous

TABLE 2. Descriptive Statistics, Correlations, and Reliabilities

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Verbal GRE (T1)	122.3	25.2	–											
2. Quantitative GRE (T1)	163.8	22.8	.17*	–										
3. Research exper. (T1)	17.7	6.1	−.07	−.12**	**.82**									
4. Career commit. (T1)	3.6	.7	−.02	.07	.21*	**.73**								
5. Self-efficacy (T1)	7.9	1.7	−.01	.01	.33*	.29*	**.95**							
6. Psychosocial ment. (T2)	3.4	.8	−.07	−.10	.05	.05	.09	**.92**						
7. Career-related ment. (T2)	3.3	.8	.00	−.14**	.18*	.19*	.14**	.69*	**.80**					
8. Collaborative ment. (T2)	1.6	.7	−.18*	−.02	.22*	.09	.18*	.11	.26*	**.81**				
9. Productivity (accept.) (T2)	1.2	1.9	.00	−.11	.42*	.02	.24*	.11	.26*	.58*	–			
10. Productivity (submis.) (T3)	8.6	8.8	−.06	−.13	.31*	.09	.16**	.20*	.33*	.38*	.47*	–		
11. Career commit. (T3)	3.1	1.0	−.10	−.12	.22*	.51*	.26*	.06	.09	.05	.09	.27*	**.90**	
12. Self-efficacy (T3)	8.3	1.2	.00	−.05	.17**	.18*	.40*	.17**	.09	.04	.11	.26*	.44*	**.93**

Note. Coefficient alphas are shown on the diagonal in boldface where appropriate. *n*: T1 = 233; T2 = 161; T3 = 130.
*$p < .05$; **$p < .10$.

TABLE 3. Regression Analysis Results

	Productivity (submissions)		Career commitment		Self-efficacy	
	(T3)	VIF	(T3)	VIF	(T3)	VIF
Verbal GRE (T1)	−.06	1.097	–	–	–	–
Quantitative GRE (T1)	−.10	1.095	–	–	–	–
Prior research experience (T1)	.19**	1.379	–	–	–	–
Ph.D. intention (T1)	.10	1.074	.02	1.048	.05	1.037
Self-efficacy (T1)	−.05	1.284	–	–	.39*	1.081
Career commitment (T1)	–	–	.50*	1.084	–	–
Productivity (acceptances) (T2)	–	–	–	–	.06	1.810
Psychosocial mentoring (T2)	−.01	2.137	.09	2.079	.22**	2.048
Career-related mentoring (T2)	.20	2.369	−.08	2.337	−.14	2.252
Collaborative mentoring (T2)	.30*	1.183	.04	1.141	−.05	1.849
F	4.18*		6.90*		4.10*	
R^2	.25		.25		.19	
df	8, 99		5, 105		6, 104	

Note. Cell entries are standardized regression coefficients. VIF = Variance Inflation Factor.
*$p < .05$; **$p < .10$.

regression test, one of the three mentoring variables proposed in Hypothesis 1 remained significant as an influence on productivity.

Hypothesis 2 dealt with the impact of mentoring on students' commitment to a research career. The correlations shown in Table 2 indicate that career commitment at entry had the strongest relationship with this variable when it was measured 5 1/2 years later ($r = .51$, $p < .001$). None of the three mentoring variables were significantly correlated with Time 3 career commitment. As would be expected from this pattern, Time 1 career commitment was the only significant variable in the regression model, positively predicting Time 3 career commitment. Therefore, Hypothesis 2 received no support.

Finally, the impact of adviser mentoring on research self-efficacy at Time 3 was examined in the test of Hypothesis 3. Examining the zero-order correlations, the stability of self-efficacy perceptions was reflected in the significant correlation between the baseline measure and the reassessment 5 1/2 years later ($r = .40$, $p < .001$). Psychosocial mentoring had a modest correlation with Time 3 self-efficacy ($r = .17$, $p < .10$). The other two mentoring variables were not significantly related to this outcome measure. Cumulative acceptances at the end of year two, which we thought would be an important variable to control for in examining

mentoring's influence on research self-efficacy, turned out not to be a significant correlate.

Turning to the regression analysis that controlled for relationships among predictors, the baseline research self-efficacy measure was the strongest positive predictor of self-efficacy 5 1/2 years later. Of particular interest, however, was the finding that psychosocial mentoring positively predicted Time 3 research self-efficacy ($p < .10$), controlling for baseline self-efficacy and acceptances midway through the program. Thus, partial support was obtained for Hypothesis 3.

DISCUSSION

Briefly summarizing these findings, it was found that advisers' collaborative mentoring, measured at the end of program year two, predicted protégés' research productivity 4 years later. In addition, psychosocial mentoring positively influenced subsequent research self-efficacy. Importantly, these effects were exposed after controlling for initial indicators of ability to perform and self-efficacy at program entry in the first case, and self-efficacy at program entry in the second. No support was found for the proposed influence of adviser mentoring on students' later career commitment. Thus, in two of three tests, positive benefits to students as a result of mentoring by their advisers were discovered, 5 1/2 years after doctoral program entry.

In the research plan, three potential contributions of this study were identified. First, questions about the "value-add" of mentoring raised by an earlier phase of this research program were at least partly assuaged. In the previous regression analysis, uniformly nonsignificant results were found for the influence of mentoring at the end of program year one on research productivity and career commitment at the end of year two. The present study's examination of these variables over a longer timeframe produced significant results for the productivity outcome variable. It may be that the rather long lead time involved in bringing a research project to the point of submission to a conference or journal accounts for this result. Second, this study represents an improvement over many prior mentoring studies, in that we were able to assess the order of effects through a longitudinal design spanning 5 1/2 years. That is, student potential, career commitment, and self-efficacy at entry were measured first and used as controls in the analysis, followed by measurement of the mentoring variables, and finally the outcomes of interest. As a result, we can conclude that adviser mentoring, at least in part, was a cause of higher protégé productivity. Third, preliminary evidence was obtained that perceived self-efficacy, an important determinant of

motivation and performance, may be positively influenced by the psychosocial mentoring function.

A surprising finding was the lack of any relationship between adviser mentoring and Time 3 research career commitment. The notion of a successful senior role model who influences a protégé to follow a similar career path is a popular one in our culture. Previous research on the graduate school experience, however, suggests exposure to the realities of a professor's life during graduate study actually may be turning some students away from pursuing a research-oriented academic career. Comments from graduate students in this four-year qualitative study indicate that observing the pressures and conflicting demands of their advisers left them questioning whether it was possible to achieve work/life balance as a faculty member in a research university (Austin, 2002).

Indeed, our regression results showed protégés' baseline career commitment at program entry to be the only significant predictor of this outcome variable 5 1/2 years later. It could be that there was some degree of misfit in applying mentoring measures developed in an industry context to our academic setting. Alternatively, this finding may simply reflect an overwhelming self-selection effect. Doctoral study, which typically requires a time commitment of four or more years with minimal financial rewards, may be undertaken mostly by those who thoroughly explore beforehand what the training and subsequent career will be like, in the process developing a strong and unwavering commitment to their choice. Subsequent contact with a faculty mentor may have little reinforcing effect, and, as noted above, for some students even a negative effect, on their attitude about their career choice.

Reviewing the pattern of results across the correlation and regression analyses, it was noted that both psychosocial and career-related mentoring had significant zero-order correlations with protégés' research submissions at Time 3, yet neither was significant when relationships among predictors were controlled for in the regression analysis. One explanation may be that the high correlation between these two mentoring variables ($r = .69$, $p < .001$) sapped the strength of each variable's unique predictive power. We investigated the effect of multicollinearity on the reliability of the coefficient estimates by producing variance inflation factor (VIF) data, shown in Table 3. Briefly, for the regression model with research submissions as the dependent variable, our analysis indicates that any predictors with a VIF greater than $1.338[1/(1 - R^2) = 1/(1 - .2524) = 1.338]$ are more closely related to the other predictors in the model than they are to the dependent variable. This threshold was exceeded for the psychosocial and career mentoring variables (as well as prior research experience), suggesting these variables may have been useful predictors if they had not

been involved in multicollinearity (Freund and Littell, 1991). [Parenthetically, while all VIF statistics are provided in Table 3 for the sake of completeness, reviewing the correlation and regression results in tandem indicates multicollinearity is a potential explanation for nonsignificant findings only for the regression model predicting research submissions.]

We note, however, that measurement development and evaluation work on the mentoring instruments found support through factor analysis for two interpretable factors, representing psychosocial and career-related functions, as well as high internal consistency reliability estimates for the two scales (Noe, 1988). In this prior work, after scale scores were calculated by averaging each group of items, an intercorrelation of .49 was found (Noe, 1988), somewhat lower than our results. It may be that these mentoring functions are especially intertwined in mentor–protégé relationships in the graduate school context. This suggests an area where further research is needed.

Some limitations of this research should be noted. First, in terms of research design and measurement, it would have been desirable to obtain independent measures of prior research experience and protégé productivity, rather than relying on self-reports. However, self-report measures of specific events, such as number of conference papers submitted, have been argued to be more reliable than other kinds of self-reports (Ericsson and Simon, 1980; Smith and Miller, 1978; White, 1980). Another concern is that response bias may have inflated some of the within-person correlations. Separating the data collections over a fairly long time period should have reduced these consistency effects (Podsakoff and Organ, 1986). While one of the strengths of our study is its 5 1/2 year longitudinal span, we should acknowledge a trade-off here—the final Time 3 sample ($n = 130$) represented 36% of the originally identified population of entering doctoral students. The subset of participants who continued responding to our surveys throughout the study period may be different in some respects from the pool of potential participants at Time 1.

The modest size of the R-squared's in the regression analyses reflects in part the attenuation of effects expected with longitudinal research. Range restriction may also be a factor, as these students were selected for admission to doctoral programs because their applications indicated they possessed the potential to be productive scholars. Certainly, we need to acknowledge that this study investigated only some of the possible influences on protégé productivity, career commitment, and self-efficacy. For instance, doctoral students may have experienced valuable mentoring from other individuals besides their official adviser. Also, research reported after this study was concluded has identified qualities

of doctoral students' ideal faculty mentor that were not captured here as discrete mentoring variables, namely, communication effectiveness and provision of honest feedback (Rose, 2003). And, in terms of unmeasured variables that may have influenced outcomes such as research productivity, a myriad of factors including students' home life events, extent of teaching commitments, redirection of research interests, and the adviser's research skill may have come into play. As with all field research, constraints on survey length and the kinds of variables that could be effectively measured impacted our ability to explain more variance.

Lastly, focusing exclusively on students in the 'hard' sciences limits the generalizability of our results to students in other academic disciplines. Ph.D. students in psychology, English, business, and history, just to name a few areas, may have substantially different graduate school experiences than those in chemistry, physics, and engineering. Cultural norms concerning the extent and nature of faculty–student interaction may differ across departments, and certainly the settings in which students conduct their research activities are quite diverse. As noted earlier, however, our relatively narrow focus gave us a valuable opportunity to study students entering similar settings with similar measures of entering potential and subsequent productivity. Our goal was to better understand the professional development experiences of these future scientists, who are preparing for important research and development positions in academia and industry.

In terms of implications, our results and the limitations discussed above point to the need for future research focusing on construct definition and measurement development for mentoring in academic contexts. We chose to use existing measures of psychosocial and career-related mentoring derived from industry studies, modifying them slightly for the academic context and supplementing them with a research collaboration variable. While this approach enabled us to use two previously validated mentoring measures, our findings indicate there may be some potential for measurement misfit or unmeasured aspects of mentoring in academia. Along with construct definition work, the development and testing of strong measures of academic mentoring would improve this research stream.

To conclude, this article's title summarizes our motivation for examining the mentor–protégé relationship in academia over more than 5 years: does adviser mentoring add value? Considering our modest findings, as well as the possibility of sample-specific results, an answer to this question cannot be set forth definitively as yet. However, results from this long timeframe study are more encouraging than previous findings from a shorter period, specifically with regard to the influence

of adviser mentoring on students' research productivity and self-efficacy. Continued investigation of the incremental predictive validity of mentoring, using longitudinal designs and appropriate control variables, seems warranted.

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Received June 29, 2004.