CURRENT RESEARCH IN SOCIAL PSYCHOLOGY
http://www.uiowa.edu/~grpproc/crisp/crisp.html

Volume 14, No. 10
Submitted: March 17, 2009
First Revision: March 25, 2009
Accepted: May 20, 2009
Published: June 10, 2009

TEN YEARS ON: DOES GRADUATE STUDENT PROMISE PREDICT LATER SCIENTIFIC ACHIEVEMENT?

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ABSTRACT

We examined publication records of 60 social psychologists to determine whether publication record at the time of the PhD (t0) predicted scientific achievement (publication quantity, quality, and impact) ten years later (t10). Publication quantity and quality each correlated moderately across this time-span. Productivity and impact at t10 were best predicted by number of first-authored articles at t0, and also by number of later-authored articles and doctoral program status. Publication quality at t10 was predicted only by publication quality at t0.

INTRODUCTION

Predicting the future success of junior scholars is of great concern to academic hiring committees. Recent PhDs are hired into faculty positions in the hope that their early achievements are a sign of things to come. Given the importance of research in academic work, and the costs to academic institutions of poor hiring decisions, it is important to know whether early promise translates into later research accomplishment. How strong is the relationship between earlier and later research achievement, and are some indicators of early achievement particularly diagnostic of later success?

These questions are also important for fledgling researchers and those who train them. Research students wish to know whether their achievements indicate an aptitude for an academic career. Supervisors wish to know whether certain achievements are especially predictive of later success, so that they can promote these achievements in their students. Both have an interest in identifying high, and perhaps low, potential.

Indicators of early promise might include standardized test scores, graduate coursework grades, competitive scholarships, and completion of prestigious graduate programs. Academic publication may be a particularly good indicator. Research students are strongly encouraged to publish, and early success in achieving this goal is a plausible predictor of later research accomplishment because predictor and outcome reflect the same behavior and are measured in the same currency.

It is therefore reasonable to predict that publication success during graduate school may be associated with publication success later in people's academic careers. Hiring committees compare applicants' CVs on this assumption. However, publication success in graduate school may not be unidimensional. Bibliometric researchers usually distinguish between publication *quantity*, assessed by number of publications, and *quality*, assessed by publication in more or less prestigious outlets. A journal's impact factor (IF) is often taken as a proxy for the quality of its articles. PhD graduates may vary in the quality and quantity of their published work, and it is unknown which dimension is more predictive of future publication success. Graduate students are counselled to publish in high quality journals, but publication quantity may be an equally good predictor of later achievement.

In addition to publication quality and quantity, the authorship of publications produced during graduate school may also be relevant to the prediction of later publication success. First-authored works may be especially predictive because they represent evidence of independence, initiative, and originality. Alternatively, later-authored works, which are often graduate students' first tastes of publication, may be highly predictive because they reflect skill in collaboration and belonging to a productive research team or program. There is ample evidence that collaborative research tends to be especially influential, and that it is growing in social psychology (Quinones-Vidal, Lopez-Garcia, Penaranda-Ortega, & Tortosa-Gil, 2004; Wuchty, Jones, & Uzzi, 2007).

If quality, quantity, and authorship are important dimensions of junior researchers' early publication achievement, publication impact is a particularly important dimension of achievement for more senior scholars. Impact is generally defined as the combined influence of

an author's published work on subsequent work. It is often assessed bibliometrically by the author's total citation count (i.e., the number of times their work has been cited) or by their *h*-index (Hirsch, 2005), which represents the highest number of publications that have been cited at least that number of times (e.g., an *h*-index of 8 implies that 8 publications have been cited ≥8 times). The *h*-index is a function of both publication quantity and quality, as high values require authors to write many, well-cited publications. In principle, the index, and other measures of scientific impact such as citations, places an equal weight on publication quality and quantity, as scientists who publish a few high-quality (i.e., likely to be well-cited) articles can achieve the same overall impact as those who publish many articles of relatively modest quality. The *h*-index and citation counts are increasingly used to guide decisions about hiring, promotion, and competitive awards.

In asking whether early evidence of promise is predictive of later academic success, several more specific questions now arise. First, can publication records later in researchers' careers be predicted from their earlier publication records? For example, are there consistencies over time in their publication quantity and quality? Second, is later publication impact predicted better by earlier publication quality or quantity? Third, is later publication impact predicted better by earlier first- or later-authored publications?

We addressed these questions in a study of a cohort of academic social/personality psychologists who received their PhDs in a two-year period and were still identified with their field ten years later, as demonstrated by a faculty position and membership in a professional network. We examined their publication records from the year of their PhD graduation to ten years afterwards, deriving earlier and later measures of publication quality, quantity, authorship, and impact. In the absence of previous research, our study was exploratory, making no specific predictions beyond the general expectation that early promise, as reflected in dimensions of early publication record, would be predictive of later accomplishment, reflected in indices of publication impact.

METHOD

In July 2008, we searched the 1452 profiles of doctoral-level social/personality psychologists in the Social Psychology Network (SPN) for those listing a PhD awarded in 1996 or 1997 and currently occupying full-time faculty positions. We restricted the search to psychologists educated and based in the USA. Sixty psychologists (35 men, 25 women) met these criteria. We then searched the Web of Science (WoS) database of journal publications for publication and citation data on each psychologist from three years before their PhD award year (t-3) to ten years after (t10). All publication types other than standard and review articles were excluded (e.g., book reviews, editorials). When authors shared a surname and first initial with others in the database, articles were attributed to them only after disambiguation in WoS by later initials, first names or author affiliations, and/or by information provided in the psychologists' SPN profile or institutional homepage. Data were recorded on each article and each author.

We coded every article published by an author in the 14-year period of interest for the journal, the journal's impact factor (IF: a WoS-derived mean impact factor across the years 2003-2007) as a proxy for article quality, publication year, number of authors, authorship rank, and number of citations accrued in each year. We used SPN profiles to extract information about each

author's gender and PhD-granting institution, including whether it featured in the 1997 Gourman ranking of top US social/personality psychology programs. We derived several author characteristics from the publication data: number of articles, number of citations, *h*-index, mean IF of journals in which the author's articles appeared, and number of first- and later-authored articles. All indices were computed at the time of the PhD award (t0) and 10 years after (t10).

RESULTS

Descriptive statistics are presented in Table 1. On average, the sample had published two articles at t0, with later-authored articles outnumbering first-authored articles. At t10, mean publication quantity was approximately seven times what it had been at t0 and was evenly split between first- and later-authored articles. Mean publication quality (IF) at t0 was somewhat lower than at t10, but was suppressed by 13 psychologists with no publications (i.e., IF=0). When they were omitted, mean IF did not differ from t0 to t10. Publication quantity and citations were positively skewed and were therefore subjected to square-root transformations prior to further analysis.

Table 1. Descriptive Statistics for Study Variables

	Mean	SD	Range
Articles (t0)	2.08	2.08	0-10
First-authored	0.75	1.17	0-5
Later-authored	1.33	1.47	0-5
Articles (t10)	14.80	10.76	1-70
First-authored	7.28	5.55	1-34
Later-authored	7.52	6.45	0-36
Articles (t1-t10)	12.72	9.71	1-60
First-authored	6.53	4.85	1-29
Later-authored	6.18	5.98	0-31
Mean IF (t0)	1.92	1.40	0.00-4.27
Mean IF (t10)	2.11	0.94	0.29-4.78
Mean IF (t1-t10)	2.06	1.02	0.29-4.87
Citations (t0)	3.83	8.44	0-55
Citations (t10)	232.90	193.73	0-920
Citations (t1-t10)	229.07	188.84	0-865
h-index (t10)	6.68	3.49	0-15

Correlations between t0 predictors and t10 publication outcomes are presented in Table 2. t10 publication impact (citations and *h*-index) was predicted most strongly by t0 publication quantity, but publication quality and PhD program status also correlated with one or both indices. t10 publication quantity was strongly predicted by t_0 quantity, demonstrating moderate longitudinal stability, and especially by the number of first-authored articles at t0. t10 publication quality was predicted most strongly by quality at t0, again showing good consistency over time. All findings were essentially unchanged when the analysis was restricted to psychologists with at least one t0 publication. In summary, later quantity was best predicted by earlier quantity, later quality by earlier quality, and later impact by earlier quantity more than by earlier quality.

Table 2. Correlations between t10 Publication Indices and t0 Predictors

t0 predictors	t10 citations	t10 *h*-index	t10 articles	t10 mean IF
Articles	.54***	.51***	.55***	.17
First-authored	.44**	.49**	.54***	.05
Later-authored	.41**	.34**	.34**	.20
Articles (if >0; *n*=47)	.56***	.54***	.66***	.03
First-authored	.45**	.52***	.63***	-.05
Later-authored	.38**	.29	.36*	.08
Mean IF	.34**	.24	.17	.46***
PhD program status	.26*	.32*	.22	.19

*** $p < .001$, ** $p < .01$, * $p < .05$

To assess the independent contribution of the t0 indices to the t10 publication outcomes, a series of multiple regression analyses was conducted (see Table 3). Non-redundant predictors were included and gender was entered as a control variable. Number of citations at t10 was predicted only by t0 publication quantity. The *h*-index was predicted best by t0 publication quantity and to a lesser extent by PhD program status. Publication quantity at t10 was predicted only by publication quantity at t0, and publication quality at t10 was predicted only by quality at t0. In every case where t0 publication quantity predicted later outcomes, the number of first-authored articles had a stronger effect than the number of later-authored articles. Gender was unrelated to all outcomes.

Table 3. Summary of Regression Analyses (standardized beta coefficients) Predicting t10 Publication Indices with t0 Indices

t0 predictors	t10 citations	t10 *h*-index	t10 articles	t10 mean IF
First-authored articles	.33*	.40**	.47***	-.03
Later-authored articles	.27*	.23	.26*	.00
Mean IF	.12	.00	-.08	.45**
Gender	.03	.06	.08	-.10
PhD program status	.16	.25*	.15	.08
R	.59	.60	.61	.48

*** $p < .001$, ** $p < .01$, * $p < .05$

DISCUSSION

Our findings imply that early promise does indeed predict later scientific achievement as assessed by standard bibliometric indices. Publication record at the time of the PhD was moderately associated with publication record ten years later, when members of our sample were seasoned academics. However, these associations did not reflect a unidimensional tendency for better earlier records to predict better later records. Researchers who later published a large quantity of articles had earlier been relatively productive, but they had not produced work of relatively high quality. Similarly, researchers who later published work of relatively high quality had done the same ten years earlier, but had not been unusually productive. Publication quantity and quality were consistent over time, but relatively independent.

Impact, whether assessed by citations or the *h*-index, is perhaps a more important publication outcome. It is usually taken as a summary of a researcher's scientific influence that combines quantity and quality. The same impact can be achieved by publishing many lower-quality items or fewer higher-quality items. However, our findings suggest that quantity plays a much larger role in predicting impact. Publication quality at the time of the PhD had no independent association with later citations or *h*-index, whereas publication quantity was strongly associated with both. Thus, although PhD students are often advised to publish in highly selective journals, their later scientific impact may be more potently predicted by how much they publish, not where they publish. Status in the field may be primarily a function of publishing in high-quality journals, and beginning researchers may strive to achieve it, but our findings suggest that this striving may sometimes be counterproductive or even self-defeating. Long-term impact may be better achieved by publishing more rather than publishing "better".

It also appears to matter not just how much PhD students publish, but what roles they play in their publications. Although being a later author is a more common experience for social psychology PhD students who go on to become faculty members, the articles on which they are first author are more indicative of their later scientific impact. Number of later-authored articles at the time of the PhD contributed independently to total citations ten years later but not to the *h*-index, and in both cases the number of early first-authored articles was more strongly associated with later impact. Graduate students' participation in projects with multiple collaborators, and the social and scientific networking that this involves, may therefore be effective primarily to the extent that it affords opportunities to take the lead on publications rather than taking minor roles in them. Arguably, attempts to collaborate should focus selectively on enlisting others' help with self-initiated projects.

Early first-authored work may be especially predictive of later scientific impact because it reflects the beginning scientist's creativity, initiative, or drive to a greater extent than later-authored work. It may equally represent the quality of mentoring given to the student, with more supportive advisors giving more opportunities for first authorship and the confidence and recognition that it brings. A third possibility is that PhD students who have first-authored papers are more likely to be hired into research-intensive departments that enable and expect later productivity. It is important to remember that scientific impact reflects social and institutional environments as much as personal dispositions, and that the work environments of our sample (e.g., research- or teaching-focused) are probably confounded with their early publication records.

The nature of our sample imposes some limitations on the study. It is essentially backward-looking, starting with researchers who have succeeded in entering and remaining in academic employment and tracing their publication histories. An advantage of this approach is that all members of our sample have a shared trajectory of academic study and employment, and they are all professionally identified with their field. A disadvantage is that real-life predictive exercises are forward-looking. Many PhD graduates are not in academic employment 10 years post-PhD, and do not remain members of the research community. Different findings might emerge if a cohort of PhD graduates were followed prospectively for a decade, with many stepping off the academic path along the way. The logistical difficulties of this option, and the

lack of comparability of participants by the end of the study, would present serious problems for researchers. Moreover, the prediction of subsequent academic success is often most important among those who are highly likely to eventually obtain academic positions (e.g., candidates short-listed for such positions). Nevertheless, it is important to note that our findings point to predictive associations between earlier and later publication records only among the subset of PhD graduates who identify professionally with their field and occupy faculty positions within it ten years afterwards.

Our findings have several practical implications. For the selection committee hiring at junior levels they provide a measure of confidence that applicants' publication records are somewhat predictive of their later scientific impact, and that their styles of publication (e.g., high quality and/or high quantity) also show some consistency over time. For the PhD student aspiring to academic employment, they reinforce the importance of publishing in graduate school, but suggest that publication in high impact factor journals is not the only route to later success as a researcher and that first-authored publications may be especially valuable. For the recent PhD graduate embarking on a faculty position, our findings suggest that the pattern of scientific production that they established in graduate school has a good chance of persisting well into their scientific career.

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