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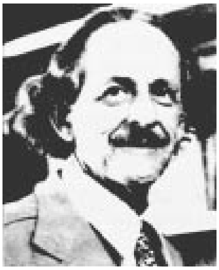

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# Is Science Only for the Young? Ray Over Examines Age and Impact in Psychology Journals

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It is generally assumed that mentors are senior to the mentored. But often, the mentors encountered in one's youth are peers only a few years older. In that sensitive stage of life, however, a few years seem like many. Most of the academics I have regarded as mentors were, or are, my seniors: Chauncey D. Leake, the pharmacologist, historian, and philosopher;[1] Henry E. Bliss, a genius of library classification;[2] and the sociologist Robert K. Merton,[3] Columbia University—among others. Another of my mentors, often mentioned in these essays, is Joshua Lederberg, The Rockefeller University. Actually, he is my senior by just a few months; we were both enrolled in Peter Stuyvesant High School, New York, in 1938, but our paths did not cross until 20 years later.[4]

## Harriet Zuckerman

Another mentor who has influenced my work significantly is in fact my junior: the Columbia sociologist Harriet Zuckerman. And this is by no means coincidental with her special knowledge of the mentoring process in many contexts, especially in the work of Nobel laureates—a topic discussed in her 1977 book, *Scientific Elite*.[5]

That book also examines the relationship between age and scientific creativity. More recently Zuckerman offers a review of this topic in the *Handbook of Sociology*, as she considers the succinctly phrased question, "Is science a young person's game?"[6] That subject has fascinated me for some time.

This fascination is part of the reason that we are reprinting the following article, by psychologist Ray Over, La Trobe University, Bundoora, Australia. In it, he reports his study of the relation between age and scientific achievement among psychologists.[7] Using the analytic methods described by Zuckerman in *Scientific Elite*,[5] as well as data from the *Social Sciences Citation Index*® (*SSCI*®) and other ISI® studies reported in *Current Contents*® (*CC*®), Over analyzes two comparisons of age and achievement in the field of psychology. As he notes, the conventional wisdom holds that scientific achievement and distinction are primarily the prerogative of the young. As he concludes, however, and as Zuckerman has also noted, this conclusion does not seem to hold up under carefully controlled analysis. We usually think of breakthrough research as primarily a product of youth. However, there *are* researchers, such as John Bardeen, who achieve several breakthroughs in the course of a career—even, as in Bardeen's case, multiple Nobel Prizes.

## Ray Over

A native of Sydney, Australia, Over completed his PhD degree in experimental psychology at the University of Sydney in 1961. After teaching at the University of Sydney; the University of Otago, Dunedin, New Zealand; Dalhousie University, Halifax, Nova Scotia, Canada; and the University of Queensland, St. Lucia, Australia, he was appointed professor of psychology at La Trobe University in 1976. Over has published widely on human perception and sexuality. He notes that over 15 years ago he became interested in the social system of science through reading my essays in *CC* and that it was in these pages that he first came to know the work of Zuckerman and Merton.[8]

The paper reprinted here is one of several by Over dealing with relationships between age, gender, productivity, and scholarly impact. In a forthcoming paper in *Scientometrics* using a similar methodology, Over demonstrates that, although the majority of high-impact journal articles have been produced by men, so have the majority of low-impact articles. At least for psychology journals, the ratio of high-impact to low-impact publication is the same for male and female authors.[9]

The following paper also demonstrates another creative use of citation analysis. I say this mindful of the admonitions I repeated last month at a conference in Toronto, Ontario, Canada, concerning evaluation of research.[10] Inevitably, there will be mindless uses of citation data and even indiscriminate uses of journal impact data to short-cut peer review of individual accomplishments. However, as Over demonstrates for the field of psychology, comparative analyses are possible for a variety of cohorts.

As Zuckerman and Over would agree, much more needs to be learned about age and its influence on scientific creativity, productivity, and scholarly impact. In a letter in *Physics Today*, economists Paula E. Stephan, Georgia State University, Atlanta, and Sharon G. Levin, University of Missouri, St. Louis, discuss age and productivity among US physicists. As they point out, research productivity is inherently difficult to measure, and there are numerous factors to consider. Among these are what Stephan and Levin term "vintage effects," which can refer to the state of science in general or to a given specialty in particular. For example, scientists who had their training after a major theoretical or technical advance might have an advantage over those educated before the advance. The employing organizations must also be taken into account, since some institutions seem to confer significant advantages in resources and thus foster greater productivity.[11] Clearly, there is much more to be understood.

One hopes that scholars in other fields will follow Over's lead. The greater ease of access to *Science Citation Index*® and *SSCI* data, made possible through CD-ROM, ought to make their tasks easier.

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Reprinted with permission from *Psychol. Aging* 4(2):222-5, 1989. Copyright 1989 by the American Psychological Association. (Editor's note: For this reprint, the author provided minor corrections to the data in the "Results" section of Study 1—page 7, left-hand column, lines 11-19 of the second paragraph.)

Back to Introduction

# Age and Scholarly Impact

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The claim that older scientists generate research of lower quality than do younger scientists was tested through two analyses in which the age distribution of authors of frequently cited articles in psychology journals was compared with the age distribution of authors of low-impact articles published in the same journals. Most high-impact articles were published by relatively young psychologists, but so were most low-impact articles. When allowance was made for relative numerical representation, there was no evidence that publications from older scientists have less impact. Results are discussed in the context of methodological issues in evaluation of relations between age and scientific achievement.

Lehman[1] undertook statistical analyses of the relation between age and achievement by using entries in histories of science to identify individuals who have made outstanding contributions to knowledge. He established the age of each person in the year in which their contribution was first published and then counted the number of times scientists from within specific age ranges (typically five-year periods) were represented in the sample. Within every discipline, Lehman found that it was scientists under the age of 40 who had produced the highest number of what historians had come to recognize as important contributions. The curvilinear function found by plotting age against achievement was relatively independent of which particular histories were used to identify important contributions.[2]

Lehman countered the charge that his data were biased because of his failure to allow for the possibility that scientists who had achieved at an early age and then died would have made significant further contributions had they survived.[1] The relation between age and achievement proved to be much the same in a sample of scientists who had lived beyond age 70 as within a sample of scientists who had a varied life span. Although he acknowledged that outstanding contributions have come from older as well as younger scientists, Lehman concluded from the manner in which frequency of achievement varied with age that "genius does not function equally well throughout the years of adulthood. Superior creativity rises rapidly to a maximum which occurs usually in the thirties and then falls off slowly."[1] (p. 330-1).

This claim by Lehman has been questioned on the grounds that the majority of outstanding contributions may have come from younger scientists not because the young are more creative but because at any point in time there have been more younger than older scientists.[3,4] At least until the 1970s, the number of persons training and working as scientists increased exponentially over time, doubling every decade.[5,6] For example, universities in the United States produced 545 PhD graduates in psychology in 1930-1934, 2,754 in 1950-1954, and 11,939 in 1970-1974. As a consequence of this growth in numbers, individuals faced many more competitors for recognition when they were older than when they were younger. As a further factor, historians habitually give disproportionately high levels of attention (relative to the numbers of scientists at different points in time) to earlier periods in the development of a discipline. Scientists are more likely on this basis to be cited in the history of their discipline for a contribution made early in their career than late in their career.

Lehman assessed the relation between age and achievement by asking what numbers of outstanding contributions have come from older as opposed to younger scientists.[1] To allow for differences in numerical representation, it needs to be asked whether the proportion of older scientists who make outstanding contributions matches the proportion of younger scientists who make outstanding contributions. In an analysis that adopted this perspective, Zuckerman compared the age distributions of American Nobel laureates in science and American scientists in general.[7] Although the majority of Nobel laureates were relatively young when they had made their prizewinning discoveries, so were the majority of American scientists. Because the two age distributions were similar, Zuckerman concluded that younger scientists are not the more likely to be creative. However, because of their greater numerical representation, younger scientists are responsible for a higher frequency of important contributions than are older scientists.

This research was supported by funding under the Australian Research Grants Scheme. Thanks are due to Betty Hardie, Sandra Lancaster, and Jan Rowles for their assistance in data collection and analysis.

The age at which scientists produce outstanding contributions also needs to be considered in the context of the relation between age and research output. There is longitudinal as well as cross-sectional evidence that the rate at which a scientist publishes declines with age.[3,8,9] If fewer outstanding contributions come from older scientists, it may not be just because older scientists are fewer in number but because they have reduced research output. Although older scientists publish less often than younger scientists and their publications attract fewer citations overall,[3] there is basically no difference between the two groups in terms of citations per article.[10,11] Simonton has contended that despite the general drop in research output with age, the ratio of high-quality to low-quality publication remains relatively constant over the professional life span.[12,13]

My aim is to assess the relation between age and achievement in psychology by using Zuckerman's method of analysis.[7] An initial concern is to define what constitutes an outstanding achievement. A possible source [is] publications that have been frequently cited in the literature over a period of time. If older scientists produce research of lower quality than younger scientists, they should be underrepresented among authors of highly cited publications (such as those featured as *Citation Classics®* in *Current Contents®*). A problem in such an analysis is to determine appropriate baseline conditions. Because research output declines with age, it may be more valid to compare the age distribution of authors of *Citation Classics* with the relative frequency with which younger and older psychologists publish than with the age distribution of all doctoral graduates in psychology who are still alive or who trained within a specific period. As a further complicating factor, mean citation rates differ markedly across journals within the same discipline,[14] and younger and older scientists may seem to differ in impact because they have published in different journals.

The two comparisons reported in this article assess relations between age and achievement within psychology when control is exercised over place of publication and allowance is made for differences in research output between younger and older scientists. In each analysis, the age distribution of authors of frequently cited articles in psychology journals is compared with the age distribution of authors of low-impact articles published in the same journals. The two distributions should differ if achievement is related to age.

## Study 1

### Method

Garfield identified 161 highly cited articles that had been published in psychology journals.[15,16] Each article attracted 75 or more citations during the period from 1961 to 1973. As evidence that most of these publications had been frequently cited because of their contributions to data or theory, rather than because they reported widely used tests or methods, more than one half had appeared in *Psychological Bulletin*, *Psychological Review*, *Journal of Experimental Psychology*, *Journal of Comparative and Physiological Psychology*, or *Journal of Abnormal Psychology*. Furthermore, more than one fourth of the articles had been published by psychologists who by 1975 or later were honored for research achievement by either election to the National Academy of Sciences or receipt of a Distinguished Scientific Contribution Award from the American Psychological Association (APA).

The volume of the psychology journal in which each high-impact article had appeared was inspected to identify an article with the same number of authors and produced by the first-listed author closest alphabetically by surname to the author of the high-impact article. This publication was taken as the low-impact article matching the

Table 1
*Percentage Frequency Distributions of Professional Ages of Authors of High-Impact and Low-Impact Articles*

| Professional age (in years) | Single-author articles: High-impact ($n$ = 73) | Single-author articles: Low-impact ($n$ = 73) | Multiple-author articles: High-impact ($n$ = 41) | Multiple-author articles: Low-impact ($n$ = 41) |
|---|---|---|---|---|
| 0–4 | 38.4 | 41.1 | 41.5 | 46.3 |
| 5–9 | 21.9 | 31.5 | 34.1 | 26.9 |
| 10–14 | 20.5 | 6.9 | 12.2 | 21.9 |
| 15–19 | 8.2 | 9.5 | 7.3 | 2.4 |
| 20–24 | 6.9 | 5.5 | 2.4 | 2.4 |
| 25–29 | 2.8 | 5.5 | — | — |
| 30 and over | 1.4 | — | 2.4 | — |

high-impact article, provided that it had been cited three or fewer times in 1972 and 1973 (as evidenced from entries in the *Social Sciences Citation Index*® [*SSCI*®]) and the professional age (number of years between PhD graduation and publication) of the first-listed author could be established. Entries in the APA Membership Register, *American Men and Women of Science*, and *Dissertation Abstracts* were used in identifying professional age. The chronological age of authors was also determined whenever possible. The age comparisons that follow are based on 73 matched pairs of single-author articles and 41 matched pairs of multiple-author articles. In the remaining 47 cases, either matched pairs could not be established or information on age was not available.

### Results

Professional age correlated +.87 with chronological age across the 188 psychologists for whom both measures were available. Because complete data were available for professional age but not for chronological age, the analyses were based on the former measure. Table 1 shows percentage frequency distributions of professional age for the first-listed authors of high-impact and low-impact publications. Values are reported separately for single-author and multiple-author publications. Mean professional age in the case of single-author publications was 8.92 years ($SD$ = 7.37 years) for high-impact articles and 8.08 years ($SD$ = 7.63 years) for low-impact articles, $t(72) = 0.65, p > .05$. In the case of multiple-author publications, the means were 7.00 years ($SD$ = 7.44 years) for high-impact articles and 6.20 years ($SD$ = 5.56 years) for low-impact articles, $t(40) = 0.57, p > .05$. Because the distributions in Table 1 are skewed, the data were also analyzed by the Kolmogorov-Smirnov two-sample test. Cumulative distributions of professional ages were compared across authors of high-impact and low-impact articles. The difference in age distributions was not significant for either single-author publications ($D = 0.12$, $p > .05$) or multiple-author publications ($D = 0.07$, $p > .05$).

## Study 2

### Method

A further sample of high-impact publications was generated by searching entries in the 1985 edition of the *SSCI* to find articles from psychology journals that had attracted 15 or more citations. More than three fourths of the 583 highly cited articles that were located by this method had been published within a set of only 12 journals. The articles were produced by 433 first-listed authors, of whom 344 contributed a single high-impact article, 67 two such articles, 12 three articles, and 10 four or more articles. The methodology outlined in Study 1 was followed in matching a high-impact article with a low-impact article (one cited three or fewer times in the 1985 edition of the *SSCI*—the mean value proved to be 0.81 citations) and in identifying professional age. Matches were achieved for 243 single-author articles and 296 multiple-author articles.

### Results

Professional age correlated +.95 with chronological age for the 357 psychologists for whom both sets of data were available. Table 2 shows percentage frequency distributions of professional age for authors of high-impact and low-impact articles. The mean professional age of authors was 11.24 years ($SD$ = 9.75 years) for high-impact articles and 10.10 years ($SD$ = 10.68 years) for low-impact articles in the case of single-author

Table 2
*Percentage Frequency Distributions of Professional Ages of Authors of High-Impact and Low-Impact Articles*

| | Single-author articles | | Multiple-author articles | |
|---|---|---|---|---|
| Professional age (in years) | High-impact ($n$ = 243) | Low-impact ($n$ = 243) | High-impact ($n$ = 296) | Low-impact ($n$ = 296) |
| 0–4 | 31.7 | 42.0 | 33.4 | 39.5 |
| 5–9 | 21.4 | 20.6 | 29.4 | 30.1 |
| 10–14 | 16.0 | 9.8 | 15.6 | 15.5 |
| 15–19 | 12.8 | 12.0 | 7.7 | 5.8 |
| 20–24 | 5.8 | 6.5 | 6.5 | 6.1 |
| 25–29 | 6.1 | 2.9 | 5.7 | 1.0 |
| 30 and over | 6.2 | 6.2 | 1.7 | 2.0 |

articles, $t(242) = 1.51, p > .05$. In the case of multiple-author articles, the mean professional age for high-impact articles, 9.13 years ($SD = 8.28$ years), was significantly greater than the value for low-impact articles, 7.75 years ($SD = 7.35$ years), $t(295) = 2.32, p < .05$. Kolmogorov-Smirnov two-sample tests showed that the cumulative distributions of professional age did not differ significantly for authors of high-impact and low-impact articles in the case of single-author publications ($T = .01, p > .05$) and multiple-author publications ($T = .07, p > .05$). In neither case were the younger authors more heavily represented among the authors of high-impact articles than low-impact articles. This result is the same as that demonstrated in the Study 1.

## Discussion

In establishing the relation between age and noteworthy achievement, Lehman compared the relative frequency with which important contributions have come from individuals of different ages.[1] As can be seen from Tables 1 and 2, about two thirds of the high-impact articles in the samples used in the present study were produced by authors who were within 10 years of doctoral graduation. What needs to be called into question is not the proposition that the majority of outstanding contributions have come from younger scientists, but the implied claim that excellence in science is the prerogative of the young. Younger authors were responsible for not only the majority of high-impact articles but the majority of low-impact articles. Even though most articles in psychology journals are generated by relatively young authors, the likelihood that an article will be cited frequently or infrequently seems independent of the age of the author.

The present finding that scholarly impact is independent of age when control is exercised over rate and place of publication is consistent with reports that articles published in the same journal by younger and older scientists attract similar rates of citation.[10,11] The data also are consistent with the constant-probability-of-success model proposed by Simonton.[12] In an analysis of eminent psychologists, Simonton demonstrated that the ratio of high-impact to low-impact publications remained relatively stable over a person's career, despite variation in level of research output over time.[13] Although rate of publication by psychologists considered as a group declines with age, some individuals maintain high output over substantial periods.[3,8,9] In establishing the bases for decrement, the mediating influence of role changes (with priorities shifting from direct research involvement to teaching, administration, supervision, and mentorship), obsolescence in knowledge and skills over time, and access to resources need to be considered.[17] If younger and older scientists differ not in their likelihood of producing a high-impact rather than a low-impact publication but in their relative rates of publication, the question of interest is whether there are interventions (such as staff development programs, resource reallocation) that will increase the research output of older scientists without adversely affecting the quality of what they produce.


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