EDITORIAL

Impact, not impact factor

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When the English philosopher Herbert Spencer introduced the phrase "survival of the fittest" in 1864, he could not have imagined that it would summarize the plight of young scientists years later (1). As competition for coveted faculty appointments and research funding continues to intensify, today's researchers face relentless pressure to publish in scientific journals with high impact factors. But only a few decades ago, when I began my scientific career as a virologist in the 1970s, the common outlets in my field were journals that specialized in virology. Work that straddled disciplines was often published in journals catering to a broad readership. Most researchers read and published articles with little regard to the purported impact of the journals themselves. Faculty appointments, promotions, and the award of research grants were often largely based on perceived future impact of the work, not on whether the research was published in so-called "high-impact" journals.

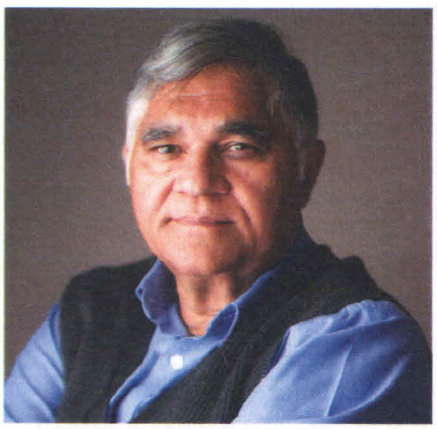
Unfortunately, the tide has since turned. Eugene Garfield, founder of the Institute for Scientific Information, which later became part of Thomson Reuters, introduced the concept of journal impact factors. Originally conceived to help guide librarians' decisions regarding journal subscriptions, this metric has long since been used to rank-order scientific journals. According to Garfield, "A journal's impact factor is based on 2 elements: the numerator, which is the number of citations in the current year to items published in the previous 2 years, and the denominator, which is the number of substantive articles and reviews published in the same 2 years" (2). That calculation has inherent limitations even when used to measure a journal's scientific impact. Determining impact by tallying up citations garnered over a two-year period can inflate a journal's overall impact if only a small number of articles, especially in prolific but rapidly changing areas of research, account for the vast majority of citations. (Consider the recent explosion of interest in areas such as stem cell biology and genome editing, for example.)

Reflecting that limitation, a 2005 editorial in *Nature* reported that 89% of the journal's impact factor of 32.2 at the time could be attributed to 25% of the papers published during the relevant period (3). Moreover, as Garfield himself observed, only 0.5% of the 38 million items cited from 1900 to 2005 were cited more than 200 times; half of the articles received no citations, and a quarter were not substantive reports of original research (2). Furthermore, the common practice of ranking journals based on vanishingly small differences in impact factor—sometimes down to three decimal points—lends the metric a semblance of precision and discriminatory power.

Admittedly, it is unrealistic to think that the choice of journal in which to publish is unimportant; exciting and important papers are often published in journals with high impact factors. But the above facts must give the scientific community pause regarding the usefulness of the impact factor as an indicator of the quality of individual articles published in high-impact journals. How, for example, can a researcher serving on an appointment/promotion/review committee be certain of the category to which an applicant's research articles belong: the majority of articles with low citations or the minority with high citations?

The scientific community must not rely exclusively on the impact factors of journals.

When it comes to judging the quality and significance of a body of work, there is no substitute for qualitative assessment. And it bears repeating that the impact factor is not an article-level metric, nor was it intended as a yardstick for comparing researchers' scholarly contributions. However, at many institutions performance assessments hinge greatly on this number, which currently wields outsize influence on the advancement of scientific careers. So much so that job applications at some universities are not even processed until applicants have published at least one paper in a high-impact journal with first authorship. At other institutions tenure is granted when the combined impact factor of the journals in which an applicant's articles were published reaches a threshold; failure to reach the threshold can influence career advancement. Some institutions even offer substantial monetary incentives to publish in journals with high impact factors (there are anecdotal reports of sliding scales!).



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To be sure, the scientific community is overburdened with responsibilities, including writing and reviewing grants and articles, teaching, and reading hundreds of applications for assistant professorships, tenure, and promotions. So it is easy to equate high-impact work with journals with high impact factors. But not all papers with high impact are or can be published in such journals. And it is equally important to bear in mind that what matters in the end is the impact of a given body of work on the development of a scientific field. At PNAS, we ask authors to write a 120-word statement of significance of the work to indicate its impact in the field. Other institutions and funding agencies are beginning to ask candidates to state the significance of their important papers, which should aid in evaluations.

As arbiters of the importance and merit of publications, the scientific community must not rely exclusively on the impact factors of journals, whose acceptance criteria can be based on an array of considerations, including trends and subject areas. I am gratified that the scientific community, concerned about the undue influence of impact factors, has begun to seriously address the issue. The San Francisco Declaration of Research Assessment—a set of guidelines forged under

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the auspices of the American Society of Cell Biology in 2012 and targeted toward researchers, publishers, and funding agencies, among other stakeholders—is an encouraging step toward a reasonable evaluation of scientific output (4). At conferences, conversations about the improper use of impact factors have begun to raise the scientific community's awareness of the issue. At the 152nd annual meeting of the National Academy of Sciences held in April 2015 in Washington, DC, a symposium organized by Randy Schekman, editor-in-chief of *eLife*, raised several of the aforementioned concerns. Sustained engagement in such efforts can help prevent the abuse of journal impact factors and curtail the community's overreliance on them. At PNAS, which is celebrating its 100th anniversary, the focus has always been on impact, not impact factors.

1 Spencer H (1864) *The Principles of Biology*, p 444. Available at https://archive.org/stream/principlesbiolo05spengoog#page/n460/mode/1up. Accessed June 1, 2015.

2 Garfield E (2006) The history and meaning of the journal impact factor. *JAMA* 295(1):90–93.

3 Anonymous (2005) Not-so-deep impact. *Nature* 435(7045): 1003–1004.

4 Anonymous (2012) San Francisco Declaration on Research Assessment. ASCB Annual Meeting. Available at https://archive.org/stream/principlesbiolo05spengoog#page/n460/mode/1up. Accessed June 1, 2015.