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Paper: creativity doesn't have to decrease with age, scientists have unique kind of IQ that predicts career success

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Critics of the tenure system often say that scholarly productivity declines over time. While that's true, according to a new study in *Science*, creativity, or a shot at a big breakthrough, doesn't have to wane -- as long as one keeps working.

"We offer empirical evidence that impact is randomly distributed within the sequence of papers published by a scientist," the paper says, "implying that impact variations during a scientific career can be fully explained by changes in productivity" -- not age.

The paper also points to something that's perhaps more significant: a predictor, called Q, of how successful one scientist will be throughout his or her career, in terms of citations. And because Q doesn't appear to change with time (though it can only be determined over time), it might -- with further study -- be something to consider going forward in personnel decisions.

"What we know right now is that tenure and promotion cases are often decided by numbers that are truly inappropriate and time dependent," said co-author Albert-László Barabási, distinguished professor and director of Northeastern University's Center for Complex Network Research. "So anything better than that would be fresh air."

Unlike paper and citation counts, he said, Q, for example, is time independent and specific to an individual -- something like a scientific IQ.

The paper, "The Randomness of Your Big Hit: Quantifying Patterns of Individual Scientific Impact [1]," builds on Barabási's earlier research suggesting that future paper citation rates can be predicted based on existing citation patterns. It's also inspired by literature on "geniuses" suggesting that artistic and scientific breakthroughs happen around age 40.

Barabási and his co-authors wanted to know whether scholarly impact also followed a predictable pattern and if, as for geniuses, the timing of an ordinary scientist's peak achievement could be predicted.

"I wanted to know if I'm done, or if I can still hope for more," Barabási joked.

Never Stop Trying

“Can we untangle the role of impact, productivity and luck within a scientific career?” the paper asks, noting that while productivity and impact -- number of papers published and citations received, respectively -- are often used to gauge a scientist’s performance, science over all has no quantitative understanding of how those figures will change over a career.

To answer their questions, the researchers explored two kinds of data sets: the publication records of physicists publishing in *Physical Review* and related journals from 1893 to 2010, and the combination of 24,630 Google Scholar career profiles with Web of Science data. Over all, they gathered some data on some 514,000 publications in six disciplines, including biology, chemistry and economics.

In each data set, they reconstructed the publication profile of scientists and associated each of their publications with an impact, or the number of citations 10 years after publication. The results in the paper refer to 2,856 physicists whose careers span at least 20 years with at least 10 publications, at a publication rate of at least one paper every five years.

The researchers next identified each researcher’s most cited paper, finding that only 5 percent had 200 citations or more and that, therefore, most scientific careers have “limited peak impact.”

Regarding productivity, the lowest-impact scientists average a steady but modest increase in their productivity, but the increase -- nearly threefold over their career -- is much higher for high-impact researchers.

The trend is about the same for impact, but impact doesn’t increase before or after a scientist’s most cited paper, making it impossible to predict when a career scientist will produce his or her “big hit.”

Through various calculations, the researchers determined that timing of peak impact is fully explained by changes in productivity throughout one’s career. In other words, those who defy the trend of diminished productivity after 20 years past initial publication and keep writing have as good a chance as any earlier-career scientist at making a major impact. Luck is also a factor.

“Taken together we arrive at a rather unexpected conclusion, representing our main empirical finding: impact is randomly distributed within a scientist’s body of work, regardless of publication time or order in the sequence of publications,” the paper says. “We call this the random impact rule, as it indicates that the highest-impact work can be, with the same probability, anywhere in the sequence of [papers] published by a scientist.”

The rule holds for scientists in different disciplines, with different career lengths, working in different decades and publishing solo or with teams, and whether credit is assigned uniformly or unevenly among collaborators, the paper says.

Scientific Je Ne Sais Quoi

Next, the researchers sought to answer what role, if any, a researcher’s own ability plays

in scientific excellence. Through different models, they ruled out that productivity or overall impact outside of the peak achievement paper begets success.

The authors developed another model that could account for the greatly varying impact between scientists, which revealed a hidden parameter -- a unique value for each scientist that they called Q.

“The parameter captures the ability of [a scientist] to take advantage of the available knowledge in a way that enhances or diminishes the impact of a paper,” the study says. “We take this parameter to be constant throughout a scientist’s career. … This prompts us to call the hidden parameter Q, like a scientific IQ, as it captures a scientist’s differentiating ability to take random projects and systematically turn them into high- (or low-) impact publications.”

Beyond that, Q remains something of a mystery, for now. Career length, time period and team effects, as well as the analysis of different disciplines and data sets, all failed to offer a simple, straightforward explanation for the origin of the different Q values scientists have, according to the paper.

Most likely, the Q parameter is the result of a combination of multiple factors, rather a single one, the paper says. “A scientist needs multiple high-impact papers to ensure a high Q. Uncovering the origin of the Q parameter is a promising future goal, which could not only offer a better understanding of the emergence and evolution of scientific excellence, but might also improve our ability to train and nurture high-impact scientists.”

Links:
[1] http://science.sciencemag.org/content/354/6312/aaf5239

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