CEU Network Science Research Published in Science Shows How to Predict Academic Career Success

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CEU network scientists Roberta Sinatra (http://people.ceu.edu/roberta_sinatra) and Albert-Laszlo Barabasi (http://people.ceu.edu/albert-laszlo_barabasi)'s research on quantifying the success of academics in the fields of physics, economics, ecology, cognitive science, neuroscience, biology and chemistry was published today in *Science* (http://science.sciencemag.org/content/354/6312/aaf5239). Sinatra and Barabasi along with researchers at a number of other institutions in the U.S. delve into the science of success, showing that it is how society perceives achievement that defines success, not the product or performance itself. This *Nature* video (https://www.youtube.com/watch?v=qlnxM-ld4BU) explains the team's research.

“We tend to think of this equation: that if we do something good then, automatically, we'll become successful. There is a correlation, but it's not automatic,” said Sinatra, an assistant professor in CEU's Center for Network Science. “The reason is that when we do something good, we are really thinking of performance – for example, a fast runner or a well-known painting. Success, instead, is how the society perceives performance, what society thinks about the performance. So I am successful if many around me think that I've had or produced a good performance. We hope that when you are successful, there is a good performance behind it, but it's not a one-to-one correlation.”

Sinatra gives the example of DaVinci's Mona Lisa. Although DaVinci has long been hailed as an artistic genius, the Mona Lisa was largely ignored until it was stolen from the Louvre at the beginning of the 19th century. In fact, she said, it took museum employees three days to figure out it was missing. After that incident, the painting was perceived as very valuable and has now, for decades, been a “must-see” when visiting Paris. In the same way that an artist's most successful work can come at any time in his or her career (or even long after death), so too can a scientist's.

“We find that the highest impact work in a scientist’s career is randomly distributed within her body of work. In other words, the highest impact work can be, with the same probability, anywhere in the sequence of papers published by a scientist – it could be the first publication, could appear mid-career or could be a scientist’s last publication,” Sinatra and the research team wrote. “This random impact 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 recipe for success in the fields Sinatra, Barabasi and their colleagues studied, is a combination of a high “Q,” luck and productivity. The individual Q is based on the impact of a scientist’s papers, quantified through citations; essentially this number untangles an individual's ability and luck. What is Q? Sinatra explained that its name was derived from IQ as it is also measurable and does not fluctuate. Sinatra likened the abundance of published papers to buying more tickets in a lottery. If you buy more tickets, you are more likely to win. “Believe it or not, nobody has thought of this union of productivity and impact,” she said. The team used massive data sets from the American Physical Society (APS), Google Scholar and

Web of Science to count how many times scientist's papers were cited by others to assign the impact of individual papers/discoveries.

You cannot have an outstanding discovery without all three of these things, Sinatra explained. So, for example, if you are extremely productive but you don't have a high Q, you aren't going to succeed. If you have high Q but don't try (you aren't a prolific publisher), you won't succeed.

"With these three elements, we can [generate these kinds of bar codes (http://www.barabasilab.com/scienceofsuccess/)](http://www.barabasilab.com/scienceofsuccess/), we can predict in the future. So we look at a scientist for, say, 10 papers and we predict what will happen for the rest of her academic life. It also tells us that the way we design our evaluation system should build on these results. So, if you have an early, outstanding discovery, it's not necessarily the promise of taking off. On the other hand, if you haven't had a big discovery yet but you are systematically having good impact, you will have your big work in the future. This is important because, right now, the evaluation system is what determines scientific funding and awards for past achievements," she said.

There is already published literature that loosely defines peaks in career creativity but this new research seems to disprove it and there is anecdotal evidence to back it up. Decades after is was published, American theoretical physicist and mathematician Frank Wilczek won a Nobel Prize for the very first paper he wrote as a PhD student. On the other end of the spectrum, deceased American chemist John Fenn won the Nobel Prize at the very end of his career – in fact, after he was forced to retire from Yale.

"There are two important measurements that were very surprising. One result was that the best, the highest-impact work is random within a scientist's career," Sinatra said. "I can assign an impact (based on citations) for each of a scientist's papers. Some have great impact, some are a flop and some have just a little impact. We can do this for thousands of scientists and what we see is that it's not that researchers need to be more experienced to do their best work. The likelihood of their best work is not in the middle, not in the beginning and not at the end of their careers; it can be anywhere along the spectrum."

This research was also applied to check the different institutions that are cited to determine if being affiliated with well-known universities or research centers helps you more as a scientist. The team found that if you go from a little-known university to Harvard, you don't get more citations at Harvard than at your previous institution.

“That's an unexpected result, but one explanation is that to get to Harvard, you needed to be already very good when you were at the lesser-known institution,” Sinatra said. “It's not that Harvard is bringing you more citations, it's that your work brought you more citations regardless of where you were. The other way around, however, if you go from Harvard to a small university, then you do have a slight decrease in your impact, but it's not significant.”

The research will be extended in the future to specifically focus on gender and performance in the sciences. The team is also trying to understand the careers of artists in a subsequent study; they will be trying to determine what brings value into a performance.

Nature video produced by Mauro Martino (http://www.mamartino.com/). Visualization produced by Kim Albrecht (http://kimalbrecht.com/).

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