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There is, it seems to us,
At best, only a limited value
In the knowledge derived
from experience.
The knowledge imposes
a pattern, and falsifies,
For the pattern is new in every moment
And every moment is a new and shocking
Valuation of all we have been.
—T.S. Eliot, *Four Quartets*


JOSHUA FRANZOS

In a recent *New Yorker* article, Jonah Lehrer delves into a puzzling issue: Many well-established scientific findings look increasingly uncertain. The reproducibility of the results—reproducibility being the keystone of modern science—wanes over time. The truth seems to turn soft. This problem has been witnessed in a wide range of fields, from psychology to ecology—even physics. We can point to a few factors that, in all likelihood, have led us to this uncomfortable place.

For one, results that seem statistically sound in a sample of 100 may look very different when the hypothesis is tested again among thousands. You might, for example, give 100 carefully selected patients Vioxx and find that it is a safe and excellent painkiller. But when released in the general population, trouble arises if it's taken by a small cohort of people carrying a genetic mutation or polymorphism that puts them at risk for cardiovascular disease when exposed to the drug. (This takes the drug off the market even though it may be very beneficial for most people.) In medicine, such statistical hiccups can mean unexpected deaths. Alternatively, if the hiccups appear first in the smaller sample, they skew the results to the negative until you approach the mean—which may well be positive.

We also know there is publication bias. As a finding becomes popular and establishes a new paradigm, momentum builds in the community of scientists to find more such results. Further, positive results are the ones that tend to get published—and not just when the results are from pharmaceutical companies with a strong interest in favorable results. As Lehrer noted, one statistician in 1959 revealed that 97 percent of all published statistically significant psychological studies found the effect they were looking for!

Scientists themselves contribute to this selection bias, even when they have the very best of intentions to be rigorous in their studies. Consider the preeminent Linus Pauling (with two Nobel Prizes), who was convinced that megadoses of vitamin C prevented colds, having so dosed himself and being free of colds. Yet Dr. Pauling overlooked the fact that he had reached an age whereby he was hardly ever exposed to cold viruses.

Just as people with a heroic view of themselves may go to medical school, people may get PhDs to "cure cancer" or contribute to our body of knowledge in some other "evangelical" way. An investigator's own desires and beliefs can subtly shape the way he or she measures a mouse's whisker or chases statistical significance.

This is not so different from what happens at the bedside. Doctors tend to give more optimistic prognoses than is warranted. Our patients are, unintentionally of course, complicit in this. When breaking the news to a patient with cancer that he is likely to die in a few months, a doctor might hear a response like, "Between you, me, and God, I'll beat the odds, won't I?" We may find ourselves interpreting our patients' deaths, at some level, as personal failures, rather than happenstances of biology.

Though we cannot immediately explain all of the statistical conundrums that contribute to what seems to be a decline in reproducibility across fields, we can become stricter with ourselves as scientists, deeply questioning our biases, especially when they are not explicit. We should also come to terms with the idea that it is not only okay to report bad (or mundane) news—nonconfirming results—it is crucial if we hope to better understand our world.

Arthur S. Levine, MD
Senior Vice Chancellor for the Health Sciences
Dean, School of Medicine