A conversation with Ferric Fang on 03/01/13

Participants

- Ferric Fang — University of Washington, Professor of Laboratory Medicine and Microbiology
- Alexander Berger — GiveWell, Senior Research Analyst

Note: This set of notes was compiled by GiveWell and gives an overview of the major points made by Ferric Fang.

Summary

Ferric Fang coauthored a study on the fraction of retractions that result from misconduct, as opposed to errors.

GiveWell spoke with Dr. Fang as a part of our investigation of the cause of meta-research. The subjects discussed included:

- The problems caused by insufficient funding for biomedical research, and Fang's view that the biggest problem with biomedical research is lack of funding.

- Aspects of the practice of scientific research that would be desirable to study.

Insufficient funding for biomedical research

Professor Fang believes that the biggest problem in biomedical research is that there's not enough funding available. This gives rise to many problems:

- Because scientists have to compete for grants, they spend a very large fraction of their time fundraising, sometimes more than 50% of their working hours.

- Scientists feel stronger pressure to optimize their activities for getting tenure and grants than for doing good science.

- There is a paucity of jobs, and this makes biomedical research an unattractive career path. In the long run, this could greatly reduce the number of talented people who pursue careers in biomedical research.

A paucity of jobs

There are too few jobs in biomedical research to meet the supply of scientists in training.

It is now common for the candidates for tenure-track positions at top tier institutions to have a first author paper in a top journal (e.g., *Nature, Science, Cell*) before being invited for an interview, even though such papers represent only about 0.25% of total scientific research articles. This is an unreasonable hurdle for an entry level academic faculty position.

The paucity of jobs makes biomedical research a less attractive career path, and this could result in fewer high quality biomedical researchers in the coming years.

There's been big push for increasing the number of young people who go into science. This is the case despite the fact that there are too few jobs for existing scientists to fill. There should be more discussion of the relative proportion of resources that should go into training scientists vs. supporting research.

Incentive problems that are caused by a lack of funding

There are several incentive problems that are caused by the level of funding for biomedical research (together with structural features of the biomedical research community):

- Scientists may feel pressure to oversell the significance of their work in order to get funding. This is bad for the epistemology of the scientific community.

- Scientists feel pressure to publish papers in the most prestigious journals, because their number of publications and the prestige of journals that they publish in determine their career success.

- Because the ultimate accuracy of results doesn't play a major role in whether papers are accepted for publication in these journals, scientists have insufficient incentive to do careful experiments. As a result, many published research findings are not reproducible.

- Scientists feel rushed because if they don't publish their results before others publish the same results, other scientists may publish first and get the credit. This may lead to sloppy experiments which yield results that are not reproducible, and may occasionally even lead to fraud.

Funding for biomedical research and its history

During the 1960's, the fraction of the US GDP that the government used to fund research and development was reasonably high (nearly 2%). The National Health Institutes (NIH) was able to fund about 65% of research proposals it received at the time.

The fraction of GDP spent by the federal government on research has subsequently declined to below 1%. The NIH budget was doubled for 5 years during the Clinton administration, but then dropped down to its previous level. The recent stimulus package provided some relief, but was a one-off event.

Putting the stimulus package aside, NIH is currently only able to fund 18% of research proposals. Many of the proposals are renewals of past proposals, and the payline for new proposals has fallen below 10%.

The current situation in biomedical research is unsustainable. Economist Paula Stephan wrote a book titled *How Economics Shapes Science* in which she argues that if the biomedical research budget remains fixed, the number of working scientists may need to be substantially reduced.

Politicians are currently averse to increasing biomedical research spending, because of the current economic situation. Former US Senator Arlen Specter and former US Representative John Porter were strong advocates of funding for scientific research, but they're no longer in office (Sen. Specter passed away last year).

Private sources offer some funding, but the amount of funding is not sizable relative to the NIH budget. Moreover, the funding from private sources such as the Howard Hughes Medical Institute (HHMI) often goes to very prominent researchers who are already well funded. Industry is an important alternative source of R&D funding but the projects tend to be translational, so that investigator-initiated basic science is now inadequately supported. Furthermore, industry support is usually short term and targeted and not conducive to the type of research that produces fundamental breakthroughs. This is likely to have detrimental long-term consequences because basic research often provides the raw material for transformational new applications.

The need for research on the scientific enterprise

There's relatively little study of science as a process. Some important policy questions are:

- How large the scientific enterprise should be to provide a steady stream of innovation that sustains economic growth.
- What the expectation should be for the size of a research group and the number of papers that are produced.
- Whether the peer review process is effective for selecting good science.
- How long the period of scientific training should be.
- How effective ethics training is.
- Whether the current system of grant peer review sufficiently promotes innovation.

- The factors that lead to scientific misconduct.

Some of these questions have been studied a little bit, but warrant further investigation.

A lack of information concerning the functionality of peer review

There's been very little study of how well the peer review system works. It's unknown how much consistency there is across reviewers. The NIH has recently started analyzing data related to peer review. Some data suggest that the grant peer review process is not statistically rigorous. This subject warrants more investigation.

Uncertainty concerning the effectiveness of ethics training

Graduate students and postdoctoral fellows receive ethics training, but it's unclear whether it improves researchers' ethical standards. The few studies that have been on this subject suggest that the ethics training has low impact. It would be worth studying whether ethics training is effective, and how it might be made more effective.

A lack of information concerning misconduct

The National Science Foundation (NSF) investigates allegations of misconduct, but doesn't publish information about researchers identities, thus limiting insights into the motivations behind misconduct, the contexts in which it occurs, and the demographics of those who engage in it. It would be valuable to have this information so as to better understand how scientific practice could be improved.

The HHS Office of Research Integrity (which oversees NIH-supported research) does release the names of and details concerning those grantees who engage in misconduct.

While the retraction rate for biomedical research papers is only about 0.01%, surveys of scientists find that ~2% of scientists admit to engaging in serious misconduct and that 15% of scientists report having observed misconduct. This suggests that there is significantly more misconduct than the retraction rate indicates.

The optimal size of a laboratory

Jeremy Berg published a study of about 3,000 biomedical research labs finding that (roughly speaking) the average publication productivity of labs (as a function of the amount of their funding) increases until $750,000/year and then decreases. This suggests that it might be optimal for research labs to structured to be middle sized rather than small or large, but further research would be helpful. However, this was a very simple study and much more work needs to be done to identify how to promote efficiency in scientific research.

Disciplines that have have studied the practice of science

Library scientists have a lot of exposure to retractions, and some library scientists have analyzed large databases of papers and the retractions therein.

Some psychologists study the motivations of scientists and the factors that lead them to commit misconduct.

Miscellaneous topics

Replications

- The fact that a lot of the research literature does not replicate causes problems. For example, scientists in training often rely on the published literature to inform the experiments that they do, basing their work on previously published papers. Having papers that don't replicate in the literature can waste their time and damage their careers.

- It's generally the case that some scientists replicate very important findings because they want to use them as building blocks for their own research. So the scientific community eventually learns whether these findings reproduce.

- Most journals don't publish replications. A few do — for example, PlOS One states that it is willing to publish papers reporting on failed replications.

- Doing replications is sometimes infeasible because doing them often requires a lot of specialized training and multidisciplinary collaboration, and some studies take a long time to perform.

Insufficient public discussion of the structural features of science research

Scientific journalism tends to focus on health news, lifestyle advice, exciting breakthroughs and scandals. Individual cases of scientific misconduct are not as important as scientific misconduct as a sociological phenomenon.

There's too little public discussion of structural problems with the current practice of science and how they might be addressed.

Undesirably short timelines for researchers

It's currently the case that when a researcher gets a four year grant, he or she will often be expected to write four or five papers supported by the grant by the time the grant comes up for renewal. This discourages researchers from pursuing long-term projects. Some very influential and important papers have required ten years of research to come to fruition.

A need for statistical analysis

Most biologists don't have adequate statistical training. There's a need for more biostatisticians. There are useful statistical tools that could be more widely used to analyze subjects such as retractions, misconduct, the peer review process and the publication process.

Ideas for reform

Ferric Fang and Arturo Casadevall have written several papers describing possible structural changes that they believe would improve the scientific enterprise (e.g., Infect Immun 80:891, 2012 and Infect Immun 80:897, 2012).

People for GiveWell to talk to

- John Ioannidis: A professor of medicine at Stanford who has applied statistics to study the medical literature and has found that a large fraction of the literature is unreliable in ways that could have been predicted via statistical analysis at the time when the paper was submitted for publication.
- Peter Lawrence: A molecular biologist at University of Cambridge who has written commentaries about the problems with ways in which scientific productivity is measured and how these distort the scientific process.
- Paula Stephan: An economist who studies the economics of science.
- Brian Martinson: A demographer who has performed surveys of scientists and written some important perspectives on research integrity and the scientific workforce.