KSJ SCIENCE EDITING HANDBOOK

MIT

THE KAVLI FOUNDATION

hhmi Howard Hughes Medical Institute

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Welcome to the KSJ Science Editing Handbook, a project of the Knight Science Journalism Fellowship at MIT, supported by the Kavli Foundation and the Howard Hughes Medical Institute's Department of Science Education.

Reporting on science can be confusing, even intimidating. Experts often use jargon and statistics to explain their work. People who posture as experts may use the same approach to dazzle and obfuscate. Both may leave reporters and editors uncertain how to critically evaluate and challenge assertions. Yet it's important that journalists not only explain science clearly but cover it as a beat, as they do politics, business, or sports. They must ask tough questions, analyze information, and demand that extraordinary claims be supported by extraordinary evidence. Key to holding that standard is the skeptical and sharp-eyed editor who knows what questions to ask, and who pushes reporters to dig deeper, confirm the facts, and get the real story.

Much easier said than done.

Most editors are generalists, working with teams to coordinate coverage across a wide and varied landscape. But, in this role, they're also the primary filters of science information for most Americans, who, according to a 2017 Pew study, report getting most of their science news from general-interest publications.

This handbook aims to draw lessons from those who specialize in science writing and editing — to provide their insights, knowledge, tips, and resources to all editors. The goal is to help ensure that science journalism meets the highest standards of quality no matter what the publication or the audience.

The handbook is designed to empower editors to ask the right questions, enable them to spot faulty reporting or flawed science, and to provide information on best practices in reporting on science and the many subjects, now more critical than ever, that it touches, whether the environment or a pandemic.

The book provides practical tips for editors. But it also seeks to recognize the unique challenges and decisions they face. Many of the lessons are illustrated by example — when science journalism shone as well as when it was left wanting.

The chapters are written by some of the most widely celebrated science editors and reporters working today. Each chapter ends with reference materials and other resources to help editors make the best decisions.

We hope that you find this handbook helpful. We also hope that it can help you find and tell science stories that both engage the public and strengthen its trust in science journalism.

We welcome your feedback, at **info@ksjhandbook.org**.

Deborah Blum, KSJ Director

Joshua Hatch, Handbook Co-Editor

Nicholas Jackson, Handbook Co-Editor

02

How Science Works

By Apoorva Mandavilli

Introduction

Science moves slowly — and good science even more so. If there is one overarching message in this chapter, it's that the best scientists are careful and methodical, moving from hypothesis to confirmation step by deliberate step. Journalism, especially daily journalism, tends to operate with a different metabolism, emphasizing significant advances that meet a subjective "newsworthiness" threshold.

That can make reporting on science challenging — first to discern where in the research process a particular study falls and then to engage audiences and clearly explain why that single step matters.

When reporters and editors don't fully appreciate this deliberate and incremental nature of science, it can result in overhyped headlines, reports of "cures" or "breakthroughs" based on studies involving just a few people, mice, or even cells, or in stories that seem to contradict one another, as is often the case with diet and nutritional studies.

"I think science journalism is and should be moving away from covering medical research when it is at the mouse-model stage," says Laura Helmuth, editor in chief of *Scientific American*. "There have been too many cures for cancer, Alzheimer's, genetic disorders, and other problems that look miraculous in mouse studies and fail completely in humans. It's cruel and misleading to raise people's hopes during this stage of research."

Scientific results reported without context can also erode readers' trust in both science and journalism.

In this chapter, we'll talk about the context in which science happens — how science is funded; how it is conducted in academia versus in companies; what standards results have to meet before they can and should be publicized; and how they are communicated to the public.

Results from mouse studies frequently fail to hold up in human studies.

We'll also delve into the publication process which, especially for biology and medicine, can be a bewildering morass of preprints, embargoes, niche journals, corrections, and retractions.

The Ivory Tower

For any journalist who covers science, knowing how to read research papers is an essential skill. In a later section, we'll highlight some tips for reading and decoding papers.

But first, a peek inside the labyrinthine world of academia and why "the paper" is so important to science.

Simply put, a research paper describes a set of experiments, their results, and an interpretation of the findings. But how, when, where and why scientists choose to publish papers is more complicated.

Academic institutions use strict and, in many ways, antiquated metrics to evaluate their faculty. They base decisions about tenure and promotion on such accomplishments as how many publications a scientist has and in which high-profile journals. University public-relations offices may also promote findings to raise their institutions' profiles. Many track mentions of their scientists in the media.

Based on the idea that "you are what you measure," this system intended to evaluate success has had several unintended consequences.

The emphasis on quantity of papers has contributed to what scientists derisively call a "minimum publishable unit," or the least bit of new data that can be fashioned into a paper. The goal is sometimes noble, such as giving junior scientists a shot at the spotlight by being the first author on the paper. (The first authors on a paper are typically the ones who did the work and the writing; the last authors are generally the heads of the lab, the so-called principal investigators.)

The more first-author papers that graduate students or postdoctoral fellows have under their belts, the better their prospects of future employment. Other authors benefit as well, leading some papers to expand to ridiculous lengths, listing dozens of authors. Some teams have even been known to list a big-name scientist (who maybe answered one question from the team) simply to raise the paper's profile and credibility.

In short, politics can determine who's on a paper and why. There is usually a specific author for each paper designated as the one journalists should contact. But even so,

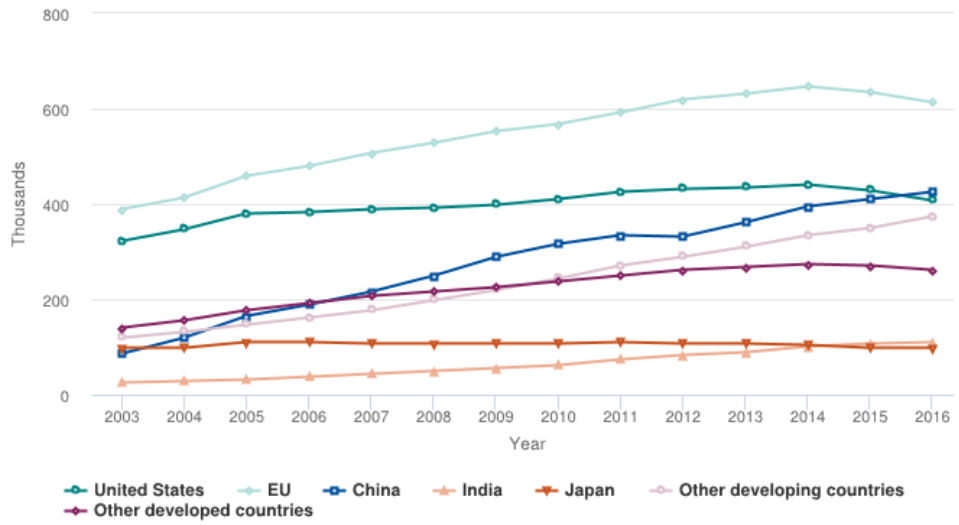
it's important to plainly ask such questions as: Who did the work? What does this research add to the existing body of knowledge about this topic? Why is this important?

If this author is a graduate student — which is often the case as grad students, early in their careers, try to build up their list of published papers — you might ask the student to do the interview along with the adviser. That's because graduate students may not always have the experience to provide broad context or be familiar with the back story of a project.

The glut of papers being produced every year — **more than 400,000 in the United States alone**[1] — also means that journals have an extensive backlog.

Figure O-8

S&E articles, by selected region, country, or economy: 2003–16



EU = European Union

Notes: Article counts refer to publications from a selection of journals, books, and conference proceedings in S&E from Scopus. Articles are classified by their year of publication and are assigned to a region, country, or economy on the basis of the institutional address(es) listed in the article. Articles are credited on a fractional-count basis. The sum of regions, countries, or economies may not add to the world total because of rounding. Some publications have incomplete address information for coauthored publications in the Scopus database. The unassigned category count is the sum of fractional counts for publications that cannot be assigned to a region, country, or economy.

Sources: National Science Foundation; National Center for Science and Engineering Statistics; SRI International; Science-Metrix; Elsevier, *Scopus abstract and citation database*, accessed July 2017. Information on the *International Monetary Fund economic classification of countries* was accessed December 2016.

Also, it's not uncommon for a paper to take a long time, perhaps 18 months, from first submission to final publication. That has the unfortunate effect of slowing science down by keeping findings under wraps while a manuscript snakes its way slowly up the line.

How Science Is Funded

Sometimes science is presented as a "pure" endeavor, free of bias and pressures that other professionals may feel. But of course, that's nonsense.

Science is conducted by scientists, and scientists are people, subject to all the same temptations and troubles as anyone else. A significant portion of the world's science is conducted at universities, which often function like corporations. They keep an eye on the bottom line and have expectations for employees' performance. Any grants that university scientists win typically help fund their home institutions, so universities tend to like people who win big grants.

So, as with any other kind of reporting, it's important in science journalism to follow the money: Who funded the work? And why?

When reading a study, "it's always best practice to look at the acknowledgements section and see who funded the research," says Roxanne Khamsi, an editor and writer for publications including *Nature* and *Wired*.

The federal government, through its various agencies, **funds a significant portion of basic research**[2] (defined as "activity aimed at acquiring new knowledge or understanding without specific immediate commercial application or use") in the United States. The National Institutes of Health (NIH) and other agencies under the U.S. Department of Health and Human Services (HHS) fund most biomedical research. The National Science Foundation (NSF) provides grants for research and education in basic biology, mathematics, and engineering. Other funding sources are industry, universities, and philanthropic organizations.

Research and Development Funding by Sector

	Basic R&D	Applied R&D	Experimental R&D	Total R&D
Business	$24,829	$62,133	$313,139	$400,101
Federal government	10,388	18,165	23,995	52,553
Nonfederal government	104	514	22	641
Higher education	44,302	20,009	6,941	71,251
Other nonprofit organizations	11,830	7,984	3,526	23,340
Total	**$91,453**	**$108,805**	**$347,622**	**$547,886**

2017 figures, in millions of dollars. Source: The National Science Foundation

For many researchers, these government grants are the primary source of funds for their own salaries and for their teams. How much money is available varies with administrations and their budget priorities, but the NIH has traditionally fared well with rising budgets through Democratic and Republican administrations alike. Nevertheless, the growing number of scientists vying for grants far outstrips available money.

These days, the NIH funds about one in 10 grant applications, so the competition is fierce. Researchers who lose out on multiple grants can find themselves having to shutter their labs.

This means scientists often feel pressured to make their work sound more exciting than it really is. A researcher working on an obscure **cellular mechanism in fruit flies**[3] may feel compelled to claim that it can lead to a treatment for cancer. Or be tempted to make progress on a previous grant or research paper sound more significant than it is, in order to justify getting a new grant.

It's incumbent upon journalists to be aware of these pressures and expectations on scientists, and to examine whether the data from a paper really support any lofty claims.

Other sources of funding include nonprofit foundations, like the Bill & Melinda Gates Foundation; advocacy groups, such as those that seek to cure a specific disease; and for-profit companies. In order to win funding, scientists sometimes try to angle their work to fit the organization's goals.

It is crucial for you to vet not just the work, but also the funding organization. The membership of a nonprofit's an advisory board can reveal a lot, as can the "About us" section of its website. Innocuous language like "understanding the role of the environment" in autism can be a front for **anti-vaccine advocacy**[4] by groups such as SafeMinds, for example. With the exception of a few private nonprofits, most such groups tend to be small, with niche interests in funding. It's wise to vet these nonprofits on GuideStar or **other organizations**[5] that list **front groups**[6].

The big money outside of government funding goes to research with direct clinical applications, often from biotechnology or pharmaceutical companies with deep pockets. It's not difficult to see the bias in studies funded by these for-profit entities once you know what to look for.

For example, when pharmaceutical companies run a clinical trial for a new drug, 75 percent of those trials test against a placebo (a substance with no therapeutic effect). That might seem reasonable, **but often it's not**[7]. The companies should test the candidate drug's performance against the best available treatment for that condition, to see if the new drug is an improvement over existing methods.

Many cancer drugs, for example, offer only a marginal benefit in survival when compared with the standard treatments.

Several studies have also shown that studies **funded by pharmaceutical companies**[8] draw **positive conclusions**[9] much more often than those funded by nonprofit or academic organizations. Often, that is because **unfavorable studies are never published**[10]. Other times, companies **may influence scientists**[11] to interpret a study's results favorably, both subtly through financial entanglements, and overtly through the omission of unfavorable data.

For those reasons, many journals now require scientists to disclose their conflicts of interest. That's a section of the academic paper Khamsi pays close attention to. "There are conflicts of interest listed on many studies at the end of the paper, so I always read those," she says.

Virginia Hughes, an editor at *The New York Times*, suggests going one step further. It's always a good idea to ask scientists about their funding sources during the interview, she says. "If a scientist gets squirmy when asked that question, there might be something juicy there!"

The Publication Process

Why does it take so long to get a paper published?

The simple answer is that it takes time to vet a paper's claims, which high-quality journals have traditionally done. In addition, the publication process can vary widely depending on the field and the quality of the journal.

At this point, we should differentiate between legitimate journals, which we describe below, and so-called "predatory journals," which have earned this description by preying on researchers' need to publish. Those journals, often with fake editorial boards, charge fees ranging from hundreds to thousands of dollars to publish papers, but don't provide peer review or any other editorial services. As a result, the research in them has not been vetted and should not be considered reliable. If you're unfamiliar with a journal, it's a good idea to check it against **lists of predatory journals**[12] or with experts who might know of its reputation.

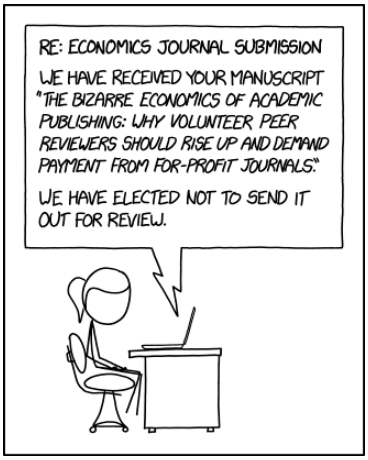
The fees at legitimate journals can also vary. Some publish papers at no charge to the authors, while others charge thousands of dollars for each paper. Editors generally send every manuscript of interest out for peer review, typically to two to four experts who can assess the quality of various aspects of the work.

For example, a paper that links a certain genomic signature to smoking-related lung cancer might need to be reviewed by a geneticist, a lung-cancer expert, and an expert in the statistical method used to analyze the genetic data. They analyze the paper to see if the experiments are sound, the results clear, and the conclusions logical and justified. They can recommend rejecting the paper, accepting it for publication, or, in a common scenario, suggesting that it be accepted in principle, pending further experiments or analyses.

The research team revises the manuscript according to the feedback and resubmits with new data. And on it goes, until the peer reviewers and the editor are satisfied. At that stage, the better journals send the paper out for copy editing to clean up the manuscript for publication. The paper is finally scheduled for a print issue — although most journals post papers online as soon as they are ready.

The volunteer peer reviewers sometimes write commentaries that accompany the paper, and make themselves available to journalists for interviews. Because they know the work well, that is a boon to journalists.

That's the best of peer review. But the system can go awry.



From xkcd.com

Reviewers can be careful as can be, but they, too, are human and limited by their own expertise and biases. They have to take on faith that the researchers did do the experiments they said they did, and that the data or images haven't been misleadingly manipulated. Reviewers cannot always catch intentional fraud, such as a **cancer-research paper published in *Nature Cell Biology*[13]** in which images and data were manipulated.

Most reputable journals use a single-blind system for reviews, meaning the reviewers can see who the authors are, but the authors don't know who is reviewing their work. Still, scientists try to game the system. They request reviewers who are their buddies, or they ask to exclude reviewers who they know will pan the work, saying they are competitors and might scoop their results.

In one egregious example, the *Journal of Vibration and Control* **discovered**[14] that a researcher from Taiwan had created a "peer-review ring," with nearly 130 aliases and email addresses for fake reviewers who would deliver positive reviews. In at least one case, the journal said, the researcher had reviewed his own work under an alias.

Having professional editors at the journals who choose reviewers — and know the field enough to see through any ruses — can circumvent some of these problems. Many of the highest-ranked journals have professional editors, often people who left research after just a few years.

The more prestigious a journal, the better it looks on a researcher's CV, and the more media attention it might receive. So, scientists are incentivized —

unfairly to them and to their field, critics say — to publish in just a handful of big-name journals, such as *Science*, *Nature*, *Cell*, and *The New England Journal of Medicine*. There are thousands of journals, and many within each niche discipline, but about a dozen dominate the landscape.

Scientists who are convinced that their study has uncovered the next big thing — and really, which scientist doesn't think that? — will submit first to these top-tier journals and then, if the manuscript is rejected, try for the next tier of journals, and so on.

This courtship can take months upon months. It can clog up the pipeline at the big-name journals by flooding them with manuscripts that stand little chance of being published. But historically, it has also given these journals, and their editors, enormous clout in the scientific world.

As a result, some journals have been able to charge hefty fees for published papers. To amplify attention to the journal itself, they often set policies limiting when and how scientists can talk about their results before publication. On the other hand, the journals employ professional editors — as opposed to scientists volunteering their time — who handle the manuscripts, polish them, and put out press releases that guarantee media attention.

So here's what that means for you in the newsroom. These journals control access to research papers, both by forbidding scientists to describe their unpublished work and by setting embargoes for papers in press. Most journals have embargoes of about a week before papers, and any news coverage of them, become public.

In theory, that's meant to ensure equal access to the work for all journalists and to make it easier for them to cover the papers. It should give them time to talk with multiple sources and write a more complete story than they could on deadline. "But in practice, journalists' embrace of the embargo system has essentially turned over control of what they cover and when they cover it to scientific journals, which have their own agendas," says Ivan Oransky, a veteran medical journalist and co-founder of Retraction Watch and Embargo Watch, nonprofit organizations that hold scientists and scientific publications accountable.

One way around the journal embargo is at scientific conferences, where researchers sometimes present preliminary work to their peers. A few conferences, such as Keystone and Gordon conferences in the life sciences, impose strict limits on journalists' attendance, either barring them or asking them not to write about any presented work without the presenter's explicit permission. These conferences are great for picking up on trends, however, because scientists often present unpublished work.

Other conferences are more press-friendly and encourage scientists to hold press conferences and offer interviews. For example, the American Geophysical Union, the Society for Neuroscience, and the American Association for the Advancement of Science encourage journalists to attend their annual conferences free of charge and report on the proceedings. It's worth asking conference organizers about their media policies before preparing to cover it.

Journals' policies allow researchers to provide this kind of communication to their peers, and even to clarify facts to journalists. But the journals hold such sway over the scientific community that many researchers, especially those still trying to make their mark, are too scared to speak to journalists. On the other hand, it's also a good idea to be wary of scientists who are eager to publicize their work before it has been reviewed by others. "Science by press release" is often a sign that the work may not pass muster. One need only recall the 1989 press conference by the chemists Stanley Pons and Martin Fleischmann in which they claimed they had achieved "cold fusion." They hadn't.

Much of this usual practice has been changing in the past couple of years — and even more so during the coronavirus pandemic — because of the advent of "preprints."

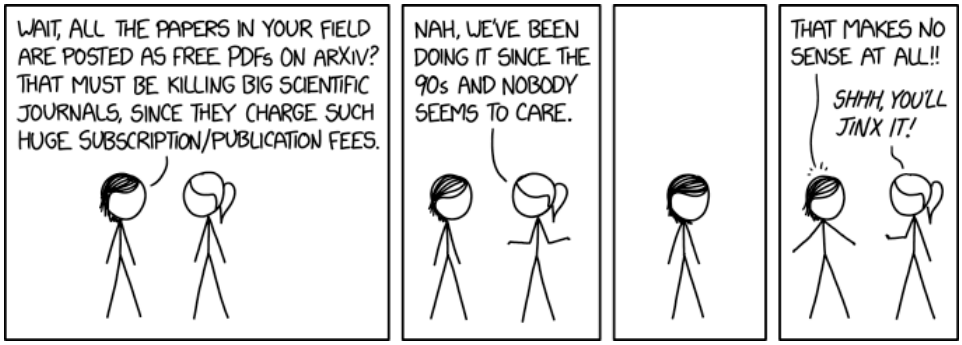
Preprints

Physicists and mathematicians have for nearly 30 years posted their work on an online archive called arXiv, inviting their peers to comment and even revise their work. The idea is to post work at the same time as, or even before, submitting it to a peer-reviewed journal for publication. Because publishing can be slow, this allows the work to be disseminated more quickly to the community of scientists, keeping science moving. It also allows scientists to get early feedback on their work.

The most popular preprint server for biology, bioRxiv, was launched in 2013, but it took years to grow popular. Life scientists found it difficult to embrace such openness, saying they were worried about their work being scooped by competitors. Eventually, bioinformaticians and geneticists, influenced by their mathematical backgrounds, adopted it. By July 2017, the server had begun receiving more than 1,000 submissions per month.

Buoyed by its popularity, its founders launched medRXiv, intended for preprints on medical research. Because the implications of medical research can be powerful, the curators of this repository vet papers even more thoroughly than is done on bioRxiv. But both archives have staff and volunteer experts check preprints for

basic standards: plagiarism, content that might pose a health risk, or research that could be unethical in some way.



From xkcd.com

In the early months of the coronavirus pandemic, both of these servers suddenly became the place to submit emerging information. Researchers all over the world, beginning with doctors in Wuhan, China, began submitting early studies of the virus and the disease it causes. By mid-May 2020, there were nearly 3,500 coronavirus preprints on the two servers.

How the Pandemic Changed Publishing

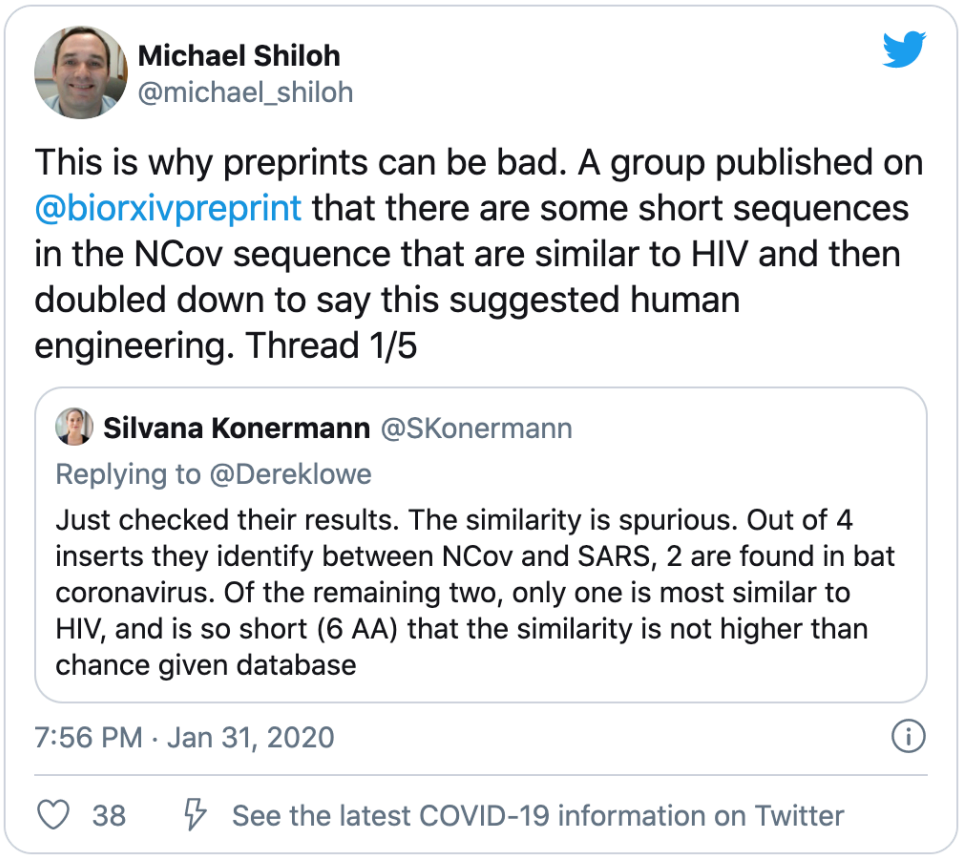
Before the 2020 coronavirus pandemic, many reputable publications shied away from writing about preprints, wary of work that had not passed a thorough peer review. But during the pandemic, those barriers vanished. There was simply no time to wait for peer review, so scientists and journalists took to discussing and writing about preprints.

This was helpful in some ways. The first studies in Wuhan of risk factors associated with Covid-19's severity came out in preprints, followed swiftly by their appearance in peer-reviewed journals. They helped public health officials in other countries prepare and warn residents with certain underlying conditions to be extra cautious.

But some preprints have created confusion and panic and seeded conspiracy theories.

For example, in January, a preprint on bioRxiv claimed to have found an "uncanny similarity" between the new coronavirus and HIV that was "unlikely to be fortuitous." In essence, the preprint suggested that the new coronavirus had been created in a lab, fueling an existing conspiracy theory about its origins.

The paper was **swiftly**[15] **taken apart on Twitter**[16], and before any reputable publication could cover it, bioRxiv pulled it.



The preprint server's staff began screening coronavirus preprints more stringently and **added a warning to the website**[17], reminding readers as well as the news media that the manuscripts are preliminary.

Editors should be cautious when assigning preprints and, at the very minimum, vet a preprint with one or two experts before deciding to cover it.

Aiming to match the speed of research, journals have also tried to rise to the occasion, rushing papers through peer review, rapidly posting reviewed papers online and, at least in the initial months of the pandemic, offering them to journalists sans embargo. One analysis of 14 journals found that the average time for a manuscript to complete peer review and appear online had dropped from 117 to 60 days. This, too, has raised eyebrows from scientists who note that thorough peer review takes time, and speed is sometimes the enemy of accuracy.

"What we saw during the pandemic is an acceleration of trends that had been taking place over the past two decades," says Ivan Oransky, co-founder of Retraction Watch. "My hope is that we learn lessons about how speed can be both really good and really bad."

Replication and Retraction

It's not clear that the old way, in which both the appearance of results and any corrections took months, if not years, is any better than this new environment of rapid preprint "publication" and equally quick analysis.

BioRxiv pulled the coronavirus-HIV preprint in the matter of a day, and although the conspiracy theory of the virus's being crated in a lab has not been squelched, the specific preprint and its findings have quickly disappeared.

With traditional publishing, controversial results might make a big splash, especially if they are heralded by embargoes and press releases. But any necessary corrections or retractions tend to go unnoticed, allowing the harm to persist.

Two examples that illustrate this problem:

A 2012 paper in an obscure journal called *Diabetes, Metabolic Syndrome, and Obesity: Targets and Therapy* shot to fame when Dr. Mehmet Oz promoted it on his *Dr. Oz* television show. He said the paper showed that an inexpensive extract of green coffee beans could cause people to shed pounds quickly and easily and without exercising. The journal's obscurity, its tall claims, and its sample size of 16 people were all giant red flags, as any journalist should have known. But the pill became hugely popular. Eventually the study was retracted, and the government forced the manufacturers to pay out $9 million to defrauded consumers.

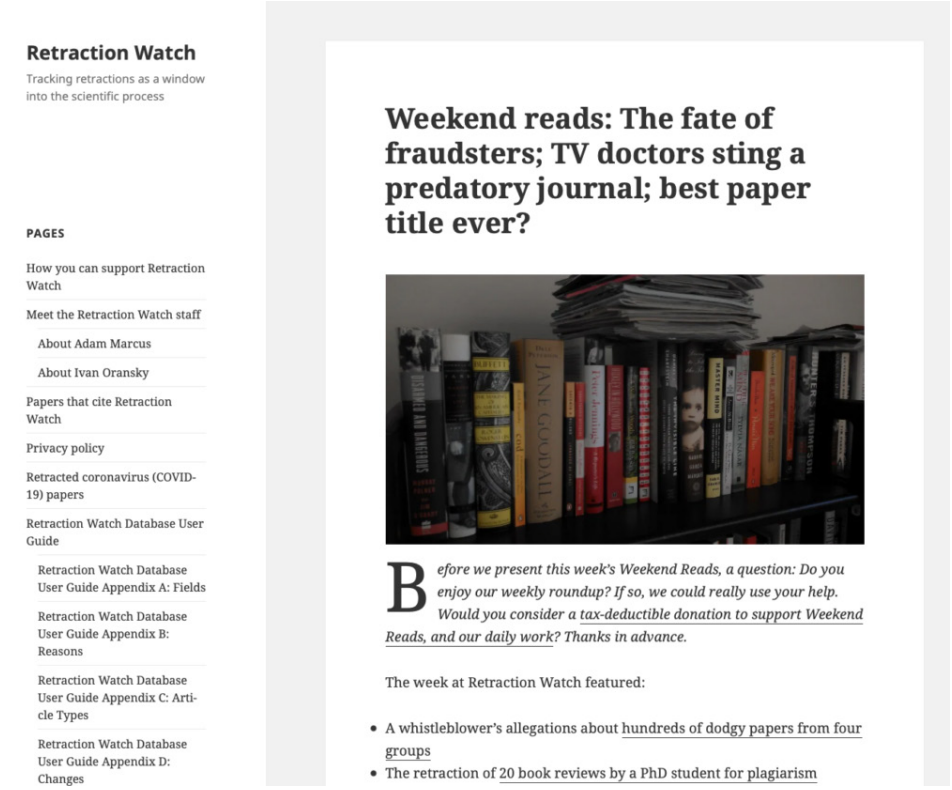
Perhaps the most destructive such retraction is a 1998 paper by a British doctor named Andrew Wakefield, who claimed to have seen a link between the measles, mumps, and rubella (MMR) vaccine and autism in a study of 12 children. Experts

were immediately skeptical, but because the paper was published in *The Lancet*, a prestigious, peer-reviewed journal, and announced at a time when some parents were panicked about the rising rate of autism, it was widely covered and found a foothold.

Although no one could verify Wakefield's claims, it wasn't until a 2004 exposé by the science journalist Brian Deer that Wakefield's fraudulent research and financial conflicts became clear. (He intended to sell testing kits and participate in litigation-driven testing.) By then the damage was long done. Wakefield has been discredited, and *The Lancet* retracted the paper in 2010, following a British government inquiry. But to this day, Wakefield is the patron saint of the anti-vaccination movement.

> ***"Retractions should get at least as much attention as the original paper did.***
>
> *Ivan Oransky, editor in chief, Spectrum*

The larger point is, editors should make sure "retractions should get at least as much attention as the original paper did," says Oransky. "That goes beyond just publishing it or even just putting out a press release about it. It's important to look at the context and how much attention a particular finding has received and make the publicity around the retraction commensurate with that."



Retraction Watch

Tracking retractions as a window into the scientific process

PAGES

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Weekend reads: The fate of fraudsters; TV doctors sting a predatory journal; best paper title ever?

Before we present this week's Weekend Reads, a question: Do you enjoy our weekly roundup? If so, we could really use your help. Would you consider a tax-deductible donation to support Weekend Reads, and our daily work? Thanks in advance.

The week at Retraction Watch featured:

- A whistleblower's allegations about hundreds of dodgy papers from four groups
- The retraction of 20 book reviews by a PhD student for plagiarism

ReactionWatch.org

It's easy enough for a journalist to check whether a certain paper has been retracted or even if an author has had other papers retracted. PubMed, the repository for papers in the life sciences, clearly flags retracted papers, as do most publishers. **RetractionWatch.org**[18], which Oransky co-founded, also tracks corrections and retractions.

Discussion hubs for papers, such as PubPeer, are also good places to vet a particular paper or an author. Many of these sites allow anonymous comments, so they tend to be gossipy, but they can be a good source of scuttlebutt about certain labs or publications — fodder for deeper inquiry.

How to Read a Paper

You know that journalistic concept of an inverted pyramid, where the most important information comes first? Scientific papers are the opposite. They begin with a long and rambling preamble that lays out the context of the work and the real-world implications (where you might see that far-fetched call-out for a cancer cure, perhaps), go through the methods, and only toward the end get to the results and discussion.

So you can go straight to the last section, often even the last few paragraphs of the discussion, to see what the paper is about. This is where editors make authors spell out how the work fits into the broader context of the field, and what the caveats are — that the sample size was small, for example, or that some crucial data were missing for some of the participants.

> ***"Scientists are experts at burying the lede, all the way at the end.***

"All studies have them, and good researchers will not be reluctant to admit them or be defensive when you ask about them," says the freelance writer Emily Anthes.

The abstract is like a microcosm of the paper, and here again, it's often the last sentence that holds the nugget you're looking for. Scientists are experts at burying the lede, all the way at the end.

Before you think about how to describe the paper's findings, first decide whether it even merits coverage. When Virginia Hughes was the science editor at BuzzFeed-News, her team covered a study only if the discovery was "really and truly newsworthy," she says, as when a new species of ancestral humans was **discovered through South African fossils**[19] or scientists in China **genetically engineered twin baby girls**[20]. The team rarely covered medical findings, she says, unless they were from a late-stage clinical trial, because of the potential harm from faulty research.

Ed Yong, of *The Atlantic*, says it's important to pay attention to what the study's findings mean in the real world: "There is a big difference between statistical

significance and actual significance. A study might be rigorous, but even so, does any of it actually matter?" Reporters should also consider what evidence would need to exist to make the results relevant in the real world.

How to Read a Press Release

Science by press release is anathema to most scientists — and to many science journalists, too.

Ed Yong, a staff writer at *The Atlantic*, gives pretty good advice: "Delete them. Ninety-five percent of the time they'll make your stories worse."

Press releases that are unaccompanied by journal publications rarely offer any data and, by definition, offer a biased view of the findings' value.

"Always remember that a press release represents only the company's version of events, and it's our job as journalists to make sure we have the whole story," says Caroline Chen, a reporter at ProPublica.

She cites an example from her reporting on the Ebola outbreak in 2014: a small medical-device company issued a press release saying that a major hospital had received its device for use with Ebola patients. The announcement sent the company's stock soaring. Upon further investigation, however, Chen learned that the company had sent its devices to the hospital, but that the hospital had neither asked for them nor was planning to use them.

Press releases can cherry pick the data. For example, drugmakers may report numbers from only a subset of participants to make their results look better than they are. Some participants may have quit the trial because of a bad side effect; excluding them would not capture the whole picture of the drug's risks.

For a class she teaches, Chen has used the example of a 2019 press release touting vitamin D pills to lower the risk of heart attacks, stroke and cancer, even though the paper that the press release was promoting had found no such effect. Kaiser Health News and *The New York Times* reported the results accurately, but Reuters parroted the press release's stance.

Reporters should also make sure that the claims in the press release are supported by the study design, says the freelance writer Emily Anthes. "If a press release says that the study proves that, say, eating chocolate for breakfast 'causes' heart attacks, but the study just looks for correlations between food diaries and medical records, that's a problem."

Occasionally press releases can be useful. For example, the issuing of releases from the institutions of all of the authors can be a sign that the paper is likely to

be big news and widely covered. A variety of press releases on a particular topic can also flag an emerging trend.

Expert Tips and Best Practices

The following advice comes from the science journalists Emily Anthes, Caroline Chen, Laura Helmuth, Roxanne Khamsi, Ivan Oransky, and Ed Yong.

- Don't rely on press releases for story ideas; they are intended to promote, not to inform.
- If you do use press releases, never presume that everything in them is accurate or complete.
- Read the paper, not just the press release. You'll be amazed how often the two bear no resemblance to each other in content or claims.
- Be wary of claims that the findings represent a "revolution," "breakthrough," or "paradigm shift." Science rarely works like that.
- Read the paper multiple times because, with every pass, you're going to deepen your understanding and catch new things.
- Read the authors' description of funding sources and conflicts of interest. Ask them about their funding when you interview them.
- Google it! Have other studies been published on this topic? Have these scientists ever made bold or unwarranted claims to the press? Is this field controversial?
- Poke around in PubMed with keywords from the paper. The most recent similar study can help determine whether the new study is too incremental to cover.
- Know the difference between correlation and causation, and whether the study's design supports its findings.
- Narrate your findings back to your sources by saying, for example, "Here's how I'd summarize your study: …. Does this sound right to you?"
- Mine the references in the paper to find sources for comment or background reading.
- For medical studies, know that the best trials have a control group, and that neither the scientists nor the participants know who received the drug and who received the control.

- Take a statistics class. Cultivate statisticians as sources you can turn to in a pinch.
- Do your own peer review. Build relationships with scientists who will give you quick takes on whether a paper is worth covering and what it adds to the field.
- No question is too small or dumb.

Additional Reading and Resources

Websites

1. **How to (seriously) read a scientific paper**
2. **NIH's guide to clinical trials**
3. **Committee on Publication Ethics' guide to preprints**
4. **Problems with preprints: Covering rough-draft manuscripts responsibly**
5. **Retraction Watch**
6. **Beyond the press release rat race: Fresh ways to cover science news**

About the Author

Apoorva Mandavilli is a reporter for *The New York Times*, focusing on science and global health. She is the 2019 winner of the Victor Cohn Prize for Excellence in Medical Science Reporting. She is the founding editor in chief of Spectrum, an award-winning news site on autism science that reaches an audience of millions. She led the team there for 13 years. She joined *The Times* in May 2020, after two years as a regular contributor. Apoorva has won numerous awards for her writing. Her work has been published in *The Atlantic*, *Slate*, and *The New Yorker* online, and in the anthology *Best American Science and Nature Writing*. She co-founded Culture Dish, an organization dedicated to enhancing diversity in science journalism, and was the founding chair of the Diversity Committee for the National Association of Science Writers. Apoorva has a master-of-arts degree in journalism from New York University and a master-of-science degree in biochemistry from the University of Wisconsin at Madison. She is fluent in English, Hindi, Tamil, Telugu, and Kannada.

Endnotes

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17 https://twitter.com/JohnRInglis/status/1223598414493077505

18 http://retractionwatch.org/

19 https://www.buzzfeednews.com/article/danvergano/new-human-species

20 https://www.buzzfeednews.com/article/nidhisubbaraman/hiv-crispr-china-twins

03

Sources & Experts: Where to Find Them & How to Vet Them

By Melinda Wenner Moyer

Introduction

People say that success is all about who you know. In journalism — and science journalism in particular — success is all about who you talk to. Reporters' approach to a particular science story — their angle, perspective, even their decision to cover it or not — will be shaped by the sources they interview and the perspectives and expertise these sources provide. Is this potential new cancer cure laudable? That can be a hard question for even the most seasoned reporter to answer, but a knowledgeable source can address the question easily. Is this new theory about dark matter plausible? The right physicist could immediately put the idea into context.

Sources are also crucial for finding and building narratives. An otherwise bland science story can blossom when it weaves in the tale of a scientist's long and tumultuous path to discovery. The real-life implications of a drug's clinical trial become much clearer and important to readers if they get to meet a patient whose life could be transformed by the medicine. Science is conducted by people with complex lives and stories and backgrounds, and it affects people with equally complex lives and stories and backgrounds. The more that reporters can bring humanity to the science they cover, the more their readers will value it.

But finding the right experts and sources can be challenging. How can reporters find sources with just the right expertise? How should they vet their sources to make sure they're appropriately knowledgeable and don't have an axe to grind? How should writers ensure that stories include diverse voices, and what's the best way to present opposing viewpoints? These are hard questions, but some, at least, have straightforward answers.

How To Find Sources For Your Science Story

- Contact the first and/or last author on a research paper you're covering
- Reach out to authors cited in the reference section of relevant papers
- Search PubMed.gov, a free search engine of life science and biomedical journals maintained by the National Institutes of Health, or other science databases, such as Google Scholar, for relevant studies and contact their authors
- Ask sources whom else you should talk to (including scientists who might disagree)
- Reach out to public information officers at research institutions doing related work

Finding Sources

When reporters cover new studies or scientific findings, they should begin by reaching out to one or two of the study's authors — typically the first author, who has conducted much of the research, and/or the last author, who is usually the senior scientist overseeing the project (often this author is listed as the corresponding author, meaning the author who was in communication with the journal during the publication process). Toward the end of those interviews, journalists should ask scientists for recommendations on whom else to contact who was not involved in the study. Even for a short news story, it's crucial to interview at least one — and ideally two — "outside" researchers who can comment on the finding's validity and significance.

Usually, authors will recommend scientists they know will agree with their findings. To ensure more diverse perspectives, it is useful to ask authors for the names of scientists they respect but who might have different viewpoints.

"I'll specifically ask them who disagrees with them about anything they're doing or claiming," says Natalie Wolchover, a senior editor and writer at *Quanta* magazine who covers physics and astronomy. "That sets you on the path of finding the conflict that can be important for your narrative."

Another excellent place to hunt for sources is in the reference section of the study being covered. Usually, researchers mention and cite other related studies

> ***"To diversify, ask your sources,*** **can you recommend who else is new and upcoming in the field?** ***Often, the people that sources recommend first are the already successful, senior people.***
>
> *Apoorva Mandavilli, science reporter, The New York Times*

in their field, including findings that inspired their research (often described in the study's "Introduction" section, which can also provide helpful history and context). In these references, reporters will find the names of scientists who might be good to reach out to as well.

> ***"Scan news stories and magazine pieces to see who has given pithy, evocative, or memorable quotes in the past.***
>
> *Ferris Jabr, contributing editor, The New York Times Magazine*

Without a range of perspectives, extraordinary claims may not get put in proper context. In 2016, a number of publications, including the *Independent* in the United Kingdom and Futurism.com in the United States, covered a seemingly exciting new theory in particle physics suggesting that a new natural force, like gravity or electromagnetism, had been discovered. The "discovery" was first described and disseminated in an institutional press release. Reporters and editors who didn't bother seeking proper perspective then ran breathless headlines such as "**Scientists Might Have Discovered a Fifth Force of Nature, Changing Our Whole View of the Universe**[1]." Most of these articles quoted only the first author of the paper, but no outside researchers — an unfortunate decision that prevented the reporters from getting the rest of the story. As it turned out, this new theory was speculative and had no data to support it. And, as Wolchover uncovered and explained in a **piece**[2] she wrote for *Quanta*, the research leading to the theory had a rich backstory that included accusations by other researchers of bias and cherry-picking. Simply put, better sourcing would have led to better stories.

For longer features, source hunting can be a more labor-intensive process, in part because features need more sources. (In my opinion, for 3,000-plus-word sciences features, writers should talk to between eight and 15 sources.) Reporters might want to begin by hunting for recent studies on the topic in research databases such as **PubMed**[3] (for published biomedical papers), **ScienceDirect**[4], **PsycInfo**[5] (for psychology papers), **arXiv**[6] (for physics and math preprints), and **medRxiv**[7] (for biomedical preprints). Then they should reach out to scientist authors who have published on the subject within the past couple of years. (If they published on the topic a decade or more ago, they may not know the current state of the science.)

Another approach is for reporters to reach out to public information officers (PIOs) at research institutions (such as universities and hospitals), explain the scope of their article and ask if the PIOs can recommend experts to interview. This can be especially useful if a reporter knows that the institution is well regarded in the field they are covering.

It's crucial, though, for reporters home in on exactly what the relevant field or subject is; for some stories, reporters will need to find scientists with very specific expertise. In 2019, I traveled to West Africa to report a **feature**[8] for *Scientific American* about a controversial theory in immunology suggesting that live vaccines (as opposed to inactivated vaccines) protect against more than just their target diseases (i.e. that the live measles vaccine might also reduce the

risk for diarrheal and blood infections). On one level, the subject of the story was immunology, and I could have interviewed general immunologists to get outside comments — but most would not have been familiar with this specific niche area of immunology. In order to find sources who were familiar enough with the idea to comment, I had to search PubMed using very targeted terms (such as "non-specific vaccine effects") to find relevant papers and sources. These sources could talk to me about the evidence base behind the theory as well as limitations in the research methodologies used to study the phenomenon, which most immunologists could not have done.

Journalists also need to keep in mind that researchers might present themselves as experts in a particular area even when they aren't. In January of 2020, at the beginning of the U.S. coronavirus outbreak, Harvard University-affiliated epidemiologist Eric Feigl-Ding **tweeted out**[9] a series of terrifying (and incorrect) statistics about the virus based on a non-peer-reviewed paper he had read. The tweets went viral, and Feigl-Ding was invited onto national television networks, including CNN, to discuss the coronavirus as an expert. But Feigl-Ding, while trained in epidemiology, has a Ph.D. in nutrition, not infectious disease — an important detail that journalists glossed over when contacting him as a source. As Harvard infectious disease epidemiologist Marc Lipsitch wrote of Feigl-Ding, "he has a temporary appointment in our department of nutrition, is not an expert on viruses or evolution, and is seeking publicity, not scientific dialogue." Had these journalists spent just two minutes vetting his background via his Harvard visiting faculty webpage, they would have discovered that he did not have the appropriate expertise.

Four Things To Consider When Considering Sources

- Does this source have expertise or training in the particular subject you're covering?
- Does this source collaborate with many other researchers in the field?
- Does the source's CV suggest that they are well-respected — have they won any research awards or held leadership positions in professional societies?
- Have other sources warned against them?

"A lot of people say, 'Oh, they have a Ph.D. or an M.D. and therefore they can speak about that subject,' and that doesn't fly with me," says Ivan Oransky, vice president of editorial at Medscape, Distinguished Writer in Residence at New York University's Arthur L. Carter Journalism Institute, and himself an MD. What matters, Oran-

sky says, is that sources have expertise in the specific area of science or medicine being discussed. "If, say, an oncologist has a really fantastic idea about a pandemic, then that's interesting, but they are only *a little bit closer* to being a reputable source on that than someone who doesn't have a medical degree," he says.

The Feigl-Ding debacle notwithstanding, social media can, sometimes, be a fruitful way to find experts. "I am pretty shameless about putting out calls for sources on Twitter," says Seattle-based science journalist Wudan Yan. But journalists have to be careful. People might recommend sources without appropriate expertise or present themselves as experts when they're really not. Also, given concerns over social media "bubbles" — that websites such as Facebook create mini echo chambers in which people only interact with like-minded others — journalists who use social media to find sources can inadvertently limit the types of sources (and perspectives) they find and include. If reporters use social media for sourcing, they should make sure to hunt for sources in other ways, too.

Still, if reporters are specific and careful in their calls for sources on social media, they can identify useful people they might not otherwise have found. Recently, I tweeted out that I was looking for researchers who study how schools shape the spread of infectious disease, and acquaintances suggested excellent researchers that I probably would not have identified by searching PubMed. But all of this does raise a question: Once you find someone to interview, how do you confirm that they really know what they're talking about?

Vetting Sources

It can be difficult to tell whether sources are truly knowledgeable in a particular area and, moreover, whether they might have an agenda or bias that shapes their opinions. One approach is for reporters to ask sources toward the end of every interview if there's anyone they should steer clear of in their field. Once, when I interviewed a female violence-prevention researcher about evidence-based approaches to preventing sexual violence, she told me that I might want to avoid a particular violence-prevention scientist who had recently been accused of sexual assault himself.

It's also a good idea to take a look at a source's resume or CV, which is often available via their institutional webpage (if not, ask if they can send you one). Reporters can check to see if the source has won any research awards or held leadership positions in professional societies (but also keep in mind how long the source has been working in the field; a postdoc or new assistant professor may not have earned a lot of professional accomplishments but still be a great source). Report-

ers can look, too, at the papers the scientist has published to see with whom they have collaborated. "It's always a red flag if they tend to publish papers with just their name and one other name," says *New York Times* science reporter Apoorva Mandavilli — in those cases, the sources may not be well regarded.

WEBSITE TO KNOW

Stop Predatory Journals

This crowd-sourced website maintains a list of journals that publish papers that haven't been properly peer-reviewed, that charge authors exorbitant submission fees, or that engage in other questionable practices.

VISIT SITE

Journalists should also research the journals in which a source has published, as well as journals the source may have edited. It can be tough to tell if a journal is high quality or not; some journals covering niche areas may not be well known (they may not have a high impact factor, a metric that reflects how frequently a journal's papers are cited by other papers and is typically listed as a journal metric on the journal's website), but that doesn't necessarily mean they're "bad." Journalists should, however, steer clear of sources who publish in predatory journals — these are journals driven by financial self-interest rather than quality and scholarship. Termed "predatory journals" because they prey on scientists' need to publish, these journals often deviate from best practices, including peer review, and publish misleading information. (For an up-to-date list of predatory journals, see **predatoryjournals.com**[10].)

Reporters can also search YouTube and watch sources' video interviews and conference presentations to get an idea of how they speak and whether they are engaging — a tip of particular value to audio and video journalists. "It's surprising how many sources you'll find are in YouTube videos, and sometimes you can pick up a vibe from them there," says science journalist Robin Lloyd, the former online news editor at *Scientific American*. Googling sources can also provide a snapshot of how many media interviews they have done and how frequently they've been quoted. While it can be good to interview someone with media experience, reporters should be careful not to quote the same people everyone else quotes, either.

> ***"Look into your sources' work and actually make sure that what they might say is relevant for your story.***
>
> *Wudan Yan, Seattle-based freelance science journalist*

Red Flags that Might Indicate Lack of Expertise or Conflict of Interest

- Source's opinion differs markedly from that of others in the field
- Source rarely collaborates with other researchers
- Source receives money from or has consulted for companies or advocacy organizations or has been on a speaker's bureau
- Source discloses potential conflicts of interest on research papers or conference abstracts
- Source is developing or sells products

One potential red flag is when a source's ideas vastly differ from those of other sources. "If what they're saying goes completely against the grain of what you're hearing from everybody else, sometimes that can mean that they are really onto something that just hasn't taken hold yet. Or it can mean they're just wrong," Mandavilli says. Asking other sources for their opinions about this person could help, but if the field is embroiled in controversy, and other scientists are trying to protect their own interests, it can be tough to decipher who's right. Do they dislike this researcher because he's doing bad science, or because his ideas challenge theirs? In such cases, a journalist might need to carefully review the scientist's work or confer with seasoned science journalists who have covered the subject before. "One of our responsibilities as science journalists is to distinguish between legitimate criticism, which is essential to science, and biased or unreasonable censure, which only hinders it," says Ferris Jabr, a science journalist and contributing editor at *The New York Times Magazine*.

It is also important for journalists to uncover potential conflicts of interest that shape a source's stance. That can be as easy as asking sources if they have ever received money from, or consulted for, companies or advocacy organizations or has ever been on a speakers' bureau. Reporters can also hunt for conflict-of-interest disclosures in a source's papers or conference abstracts. ProPublica's Dollars for Docs database is useful, allowing journalists to search for physicians who have received payments from pharmaceutical and medical device companies.

WEBSITE TO KNOW

ProPublica's Dollars for Docs

This online database tracks financial ties between physicians and medical companies. Reporters can enter in the name of doctors to see if they have received money from drug or device companies, indicating potential conflicts of interest.

VISIT SITE

Public records databases should be used as well. Not only will these databases provide information about past criminal behavior, they can also uncover businesses that sources might be involved in that create conflicts of interest. Journalists also need to be aware that non-profit organizations can present themselves as independent or grassroots but be backed by companies or industries — so-called "AstroTurfing" organizations. It can be challenging to identify who or what funds an organization, but journalists can try searching for information about the organization on GuideStar or looking at the organization's 990 tax returns.

Ensuring Gender & Racial Diversity

One key problem with science — and many other disciplines — is that many of the most successful and vocal experts are white men. There are, of course, many reasons for this gender and racial imbalance. Among other things, men can have an easier time rising to the top because they're less burdened by cultural expectations surrounding child-rearing. White scientists, too, do not experience the kind of racial discrimination that scientists of color do, which can hold them back in their careers in various ways.

WEBSITE TO KNOW

500 Women Scientists

This website represents marginalized women in science and works to transform leadership, diversity, and public engagement in science. Journalists can use their "Request a Woman Scientist" service to find female scientists working in particular disciplines or locales.

VISIT SITE

Though it takes work, journalists should strive for gender and racial balance in their stories if the fields they are covering are somewhat diverse. Often, reporters don't realize just how skewed their source representation is. When Adrienne LaFrance, executive editor of *The Atlantic*, evaluated source diversity in the articles she had written in 2015, she **discovered**[11] that just 22 percent of her sources had been women. Soon after, in 2016, science reporter Ed Yong, also with *The Atlantic*, ran an **analysis**[12] of the pieces he'd published so far that year, and found that only 24 percent of his quoted sources were women, and that 35 percent of his stories featured no female voices at all.

People — including scientists — notice when these imbalances make their way into your journalism. A few years ago, the digital magazine Spectrum — whose editorial team at the time was comprised entirely of women — ran a piece on the genetics of autism research that quoted only men. A female researcher contacted Mandavilli, who was then Spectrum's editor-in-chief, afterwards to express her disappointment. "She said, 'Imagine how I felt when I read this piece and you didn't quote a single female geneticist.' And it was like a dagger through my heart," Mandavilli recalls. "While we work so hard at this, we still messed up. It just takes a lot of vigilance."

> ***"When reading papers, I will specifically look down the author list for any feminine names.***
>
> *Natalie Wolchover, senior editor and writer, Quanta*

Indeed, the more reporters and editors think about and aim for source diversity, the more they can achieve it. "When I notice that my sources — especially those I will be quoting — are too homogenous, I make a concerted effort to include more diverse voices by redoubling my search efforts and asking experts to recommend additional colleagues I might consult," Jabr says. Sometimes, he specifically asks sources to recommend "colleagues that are doing great work but haven't received as much attention from the media."

It can help when writers (and editors) hold themselves accountable too. When Yong began tracking source diversity in a spreadsheet, he found that his female source percentages went up quickly, and eventually hovered around 50 percent. Spectrum, too, now maintains a source spreadsheet, which includes many young, female and racially and ethnically diverse scientists. "That's made a big difference," Mandavilli says.

Avoiding False Balance

Stories and anecdotes from "real people" — that is, sources who aren't necessarily experts but whose experiences can be valuable to include in a piece — can make scientific trends and discoveries much more relatable to readers. But when reporters aren't careful, they can fall into the trap of framing opposing beliefs and perspectives as equally valid when, from a scientific or medical standpoint, they

are not. This problem is called "false balance" or "false equivalency," and it can be exceptionally dangerous.

False balance often arises in stories about controversies that persist among the general public even though the science on the issue is clear-cut — such as climate change and vaccine safety. When journalists cover the ongoing societal debate over human-caused climate change, and they quote scientists on "both sides of the issue," presenting them as equal in merit and in number, they fail to communicate to readers that there is, in fact, a clear scientific consensus on the issue. Likewise, when journalists cover vaccine safety and they quote parents who are concerned about vaccines alongside experts who study vaccine safety, they frame these opposing opinions as equally valid, when the science clearly shows that vaccines are safe.

In February of 2015, the *Toronto Star* published an investigation into the HPV vaccine Gardasil under the headline "A Wonder Drug's Dark Side." The piece was based largely on anecdotes from young women who believed they had developed serious health complications because of the vaccine. Some women the newspaper profiled said they'd develop egg-sized lumps on the soles of their feet after being vaccinated and that the vaccine caused them to require feeding tubes and wheelchairs. What was missing from the piece, however, was the expertise of scientists and physician researchers who have studied Gardasil's safety profile, as well as a description of this science and why it shows that Gardasil is safe. The *Star* eventually **retracted**[13] the article, but not before damage was done to the public's trust in Gardasil and vaccine safety in general.

To avoid false balance, it's important for reporters who cover controversies to get a sense of where the scientific consensus lies. "They should only report scientifically outlier positions if solid evidence supports it, not just because someone is shouting it from their own tiny molehill," wrote freelance science writer Tara Haelle in a 2016 **explainer**[14] about false balance for the Association of Health Care Journalists. As an editor, check to see if your writers are equating ideas that may have different levels of merit. Be wary of patient anecdotes, especially if those anecdotes are being framed as medical evidence. Likewise, editors might want to Google the names of sources quoted on two sides of a contentious issue to see if they seem equally worthy of merit and respect.

Sources make stories — and they can break them too. It's crucial for science reporters to ensure that the people they interview have appropriate expertise, are devoid of major conflicts of interest, and reflect different races and gender identities. Sometimes, the difference between a good science piece and a bad science piece is one additional question asked at the end of an interview or five extra minutes of online research. If you're not sure that the voices in a piece truly reflect the scientific consensus, do some more digging until you are.

> ***"I constantly have to remind myself to remain reasonably skeptical about everything."***
>
> *Robin Lloyd, science journalist, former news editor at Scientific American*

> ***"Over time, try to develop a reverse Rolodex — people you should never quote, or who should be quoted with caution."***
>
> *Ivan Oransky, MD, vice president of editorial, Medscape and founder, Retractionwatch.org*

Additional Reading & Resources

Books

- *A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers, 2nd Edition.* Edited by Deborah Blum, Mary Knudson, Robin Marantz Henig. 2005.
- *The Craft of Science Writing: Selections From the Open Notebook.* Edited by Siri Carpenter. 2020.

Websites

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About the Author

Melinda Wenner Moyer is a science journalist and adjunct professor at New York University's Arthur L. Carter Journalism Institute. She is a contributing editor at *Scientific American* and a columnist at Slate and regularly writes for the *New York Times*. She was the recipient of the 2019 Bricker Award for Science Writing in Medicine, and her work has been featured in the *Best American Science and Nature Writing 2020*. Her writing has also received first place awards in the American Society of Journalists and Authors' Annual Writing Awards and the Awards for Excellence in Health Care Reporting. She lives in New York's Hudson Valley with her husband and two children.

Endnotes

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04 Making Sense of Science Stats

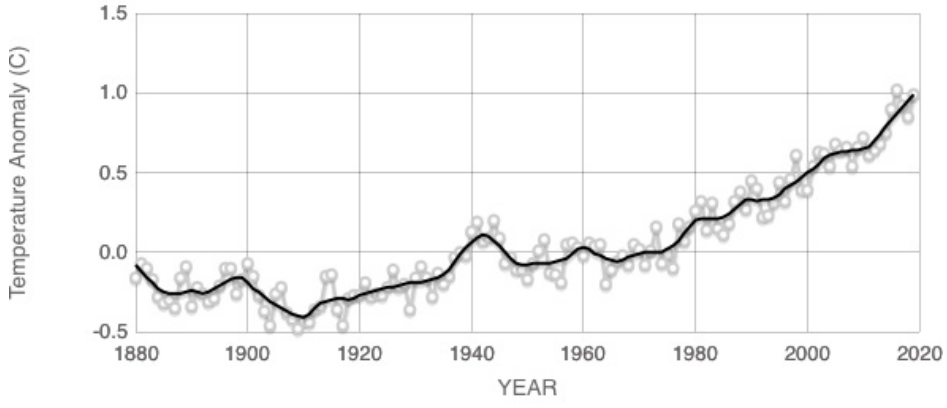
Introduction

By Elisabetta Tola

For many people, numbers convey a sense of specificity, precision, and objectivity. But numbers are merely one description of facts — one interpretation of phenomena. They are a means to compare things, to see patterns, and to evaluate risks. They are not "truth."

Consider the following: climate change deniers point to the average global temperature recorded in 1998 — 58.3° Fahrenheit — and compare it with that of more recent years, pointing out a decrease in average temperatures for more than a decade that followed. After all, in 2012, the average temperature was lower, at 58.2° Fahrenheit. This, they claim, is proof that global warming isn't real.

The numbers are true, but the conclusions are deeply flawed. The year 1998 was unusually hot because of a surprisingly strong El Niño. But when the data are considered as a trend, the reality of climate change is incontrovertible.



Source: climate.nasa.gov

1998 was indeed hotter than some of the years that followed, but recent years have gone even higher.

This cherry-picking of convenient figures is just one example of how scientific data can be misinterpreted. Other ways include:

- when figures are provided without context
- when references to margins of error, methodologies, sample sizes, or compositions are missing
- when correlation and causation are conflated
- when conclusions are drawn from insufficient data

How can you avoid falling into these traps? It is important that as an editor, you approach them with the same sort of skepticism and care that you take with words. What do statistics say and not say? What figures are truly relevant to the story you are telling? Which ones mean something to your readers?

The key, of course, is to understand what a given number or statistic means. Take the statistical concept of "risk." There are about 95 fatal car accidents a day in the United States. To put it another way, for all practical purposes there is a 100-percent chance of dozens of fatal car crashes in the United States today. But what risk is there to you when you get behind the wheel? How nervous should you be? Not very. Your individual risk of dying in a car crash is less than 1 in 4,000 in any given year.

It is incumbent upon you, the editor, to ensure that numbers and statistics are properly framed and contextualized to honestly represent reality, and that your readers properly understand them.

Questioning the Data and Accounting for Uncertainty

Numbers are assertions. When you encounter numbers and figures from science papers, institutions, or official reports, you must interrogate them as you would any other assertion. Do not use them as they are, even if you are in a hurry. Be sure to understand them, where they came from, and how they were derived. Have other sources scrutinized the data? What do those sources say? You can't assume that a figure, just because it is in a scientific paper, is the *Truth.*

The New York Times science writer Carl Zimmer **provides**[1] an example of this from the coronavirus pandemic. In April 2020, a team of researchers released a preprint paper in which they asserted that the fatality rate of Covid-19 was far lower than some experts had estimated. Newsworthy, right?

However, upon scrutiny by other statisticians, it became clear that the "newsworthy figures" were essentially the product of a statistical error. Then, the following month, a prominent study on hydroxychloroquine was published in *The Lancet*. The study claimed that hydroxychloroquine was ineffective and possibly dangerous as a treatment for Covid-19, earning the report rapid international media attention and pushing the World Health Organization to put clinical trials of the drug on hold. A hundred scientists responded by issuing an open letter raising concerns about the quality of the study's data. When *The Guardian* tried to obtain specific information on the data used by the study's authors and pointed out several inconsistencies that appeared in the results, the lead author was unable to vouch for the data's accuracy and asked *The Lancet* for a retraction. "This is a shocking example of research misconduct in the middle of a global health emergency," *The Lancet*'s editor **told *The Guardian***[2]. (A full recounting of this story is available on a **FiveThirtyEight.com podcast**[3].)

No matter that further research ultimately established the ineffectiveness of hydroxychloroquine in treating Covid-19; the screw-up cast doubt on the scientific process and damaged the public's trust.

Contrary to popular belief, science is far from being a source of certainty. The scientific method is based on doubt and the trial-and-error approach. Data and facts are always defined at a certain limited level of confidence. And even when lots of evidence points in one direction, there should always be space for constructive skepticism. What science contributes to our informed thinking is not numbers, data, and facts written in stone. On the contrary, its contribution is the ability to continuously investigate the world with an open mind.

One of the most important lessons to learn about the use of data in a story is to embrace uncertainty. "What many people overlook," says Heather Krauss, founder of **Datassist**[4], a company that supports journalists and nonprofits in working with data, "is that to tell a data story accurately, you must provide context. And that includes uncertainty."

Measuring Confidence

Scientists use several tools[5] to measure and account for uncertainty: p-values, confidence levels, confidence intervals, and margins of error.

The **p-value** is a concept that even experts can find difficult to express in plain language. In fact, in 2015, Christie Aschwanden, FiveThirtyEight's lead writer for science asked dozens of scientists to explain it as plainly as possible. The **result**[6] is both humorous and enlightening; while there is a clear technical definition, explaining it in layman's terms is a significant challenge. Nevertheless, it's worth trying, as the p-value is such a commonly accepted measure of significance.

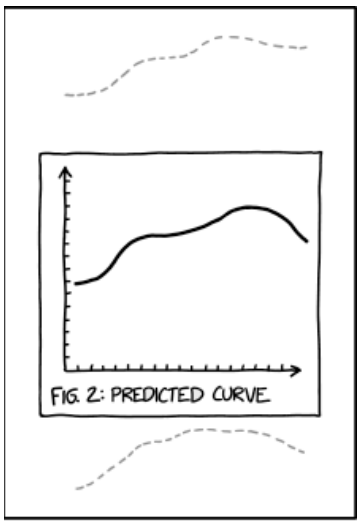
Here is our attempt: You can think of the p-value as a number that allows us to know how confident and reliable — how significant, in statistical terms — a scientific result is. To be more specific: if your hypothesis is not true, how likely is it that you would get a result that is consistent with your hypothesis? The less likely that is, the better — in terms of demonstrating that your result is statistically meaningful.

As an example, let's look at drug testing to find a treatment for Covid-19. Researchers start with an initial hypothesis (in this case, that the drug being tested is effective), but to test it, they need to be able to reject what's known as the *null hypothesis.* In this case, the *null hypothesis* is that there is no difference between taking the drug or not.

Through a randomly controlled trial of two groups of patients, the researchers compare the outcomes of patients who took the drug with those who didn't. From these data, the p-value is calculated.

If the p-value is high, it means there's a high probability that you could get a result showing the drug is effective, even if it isn't. Conversely, if the p-value is low, then there's a low probability you'd get a good result for the drug if it wasn't effective. The p-value is always a figure between 0 and 1, and, conventionally, scientists deem that if the p-value is under 0.05, the results are valid; otherwise they are not.

However, **some argue**[7] that p-values are improperly relied upon as a be-all, end-all measure of certainty — after all, the p-value is just one data point that can be used to ascertain confidence. Most important, **as a Stanford study emphasizes**[8], a p-value does not tell you whether something is true.



SCIENCE TIP: IF YOUR MODEL IS BAD ENOUGH, THE CONFIDENCE INTERVALS WILL FALL OUTSIDE THE PRINTABLE AREA.

From xkcd.com

In addition to the p-value, science papers often provide other indicators of uncertainty: **margins of error** and **confidence intervals**. Results are typically written +/- a margin of error within a defined confidence level (typically, 95% or 99%). Also used in political polling, margins of error and confidence intervals are a way of conveying how confident a researcher is that a range of values is accurate.

For instance, a **2016 research paper from the U.S. Centers for Disease Control and Prevention**[9] on neonatal health estimates that, from 2010 to 2017, 83.8% of infants born in the U.S. were ever breastfed. The figure came with a margin of error of +/-1.2, with a 95% confidence interval. The researchers were saying that if the study were reproduced 100 times, at least 95 of the studies would report a figure between 82.6% and 85%.

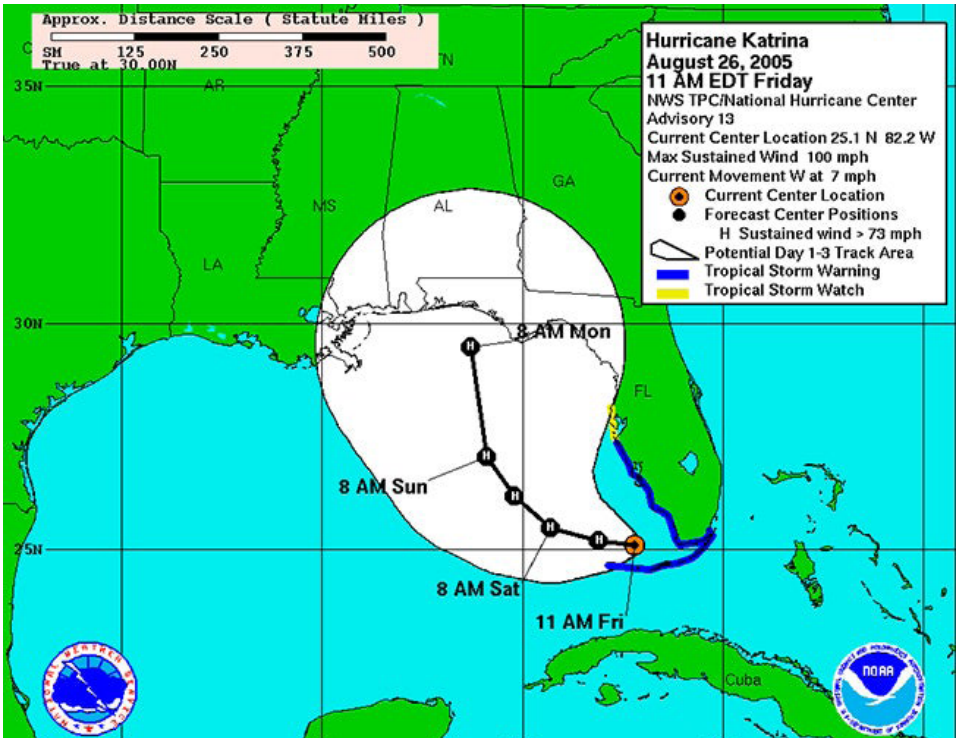
What's critical to understand — and is the subject of the next section — is that margins of error and confidence intervals are largely based on the size of the group being studied. This is important to keep in mind, since there are many cases when there is a scarcity of data — domestic violence, hate crimes, and racial injustice, for example — or when we deal with infrequent occurrences, such as rare genetic diseases. At those times, statistical models can fall short. That's

when it becomes even more important to add relevant context and perspective, filling the gaps with the help of experts.

Uncertainty also comes into play in other ways. In 2019, the journalist and visual designer Alberto Cairo looked at how uncertainty is communicated in the field of hurricane forecasting. In collaboration with the National Hurricane Center, he investigated how most people interpret hurricane-forecast maps that indicate landfall probability. The result: they don't interpret them very well.

Traditionally, forecasters use a "hurricane cone" map to indicate where a hurricane might land. But **as Cairo discovered**[10], people don't really understand the maps and may fail to take appropriate action because of that misunderstanding. The reason, Cairo learned, is that readers misunderstand the maps in a variety of ways, including how uncertainty is represented.

The cone is a range of possible paths with the "central line" indicating the likely center of the storm in the future. In reality, only 60-70% of the time does the center of the hurricane end up within the projected cone. Moreover, the extent of the storm's reach and devastating impact is far greater than either the cone or the central line indicates. The average person's ignorance of how to interpret personal risk from a hurricane cone map carries the potential for fatal outcomes. Hurricane landfall forecasting is an excellent example of why one must always ask, when writing about or graphically showing what is likely or probable: Are we accurately conveying uncertainty?



Several days before Hurricane Katrina made landfall, this forecast showed the prediction cone. While New Orleans is in the cone, few viewers of this graphic would have thought it was in the predicted area of possible landfall. Source: NOAA

Cairo suggests using alternative maps, like an impact "heat map," that better demonstrate the true risk. In other cases, writers may need to better describe how significant the uncertainty is and what that actually looks like. A good example of this concept can be found in **a *Scientific American* post regarding statistical significance**[11] vis-à-vis the Higgs boson, an elementary particle in physics. While dedicated to the very idea of uncertainty, the post is able to express in layman's terms some complicated math:

> *As a concrete example, there is just under a one percent chance of flipping an ordinary coin 100 times and getting at least 66 heads. But if a thousand people flip identical coins 100 times each, it becomes likely that a few people will get at least 66 heads each; one of those events on its own should not be interpreted as evidence that the coins were somehow rigged.*

Relying solely on numbers to do the work for you will fail you and your readers. The key is to explain the underlying concepts.

Sample Size

One of the drivers of statistical confidence is the size of the study group, also known as the sample size. Rarely do we have perfect data on a complete population. The U.S. census is an attempt to do just that — count every single person in the United States every 10 years.

In terms of data, you can think of it this way: imagine there are 100 people on an island, and you would like to determine their average height. If you measure all 100 people, you would have no margin of error and a 100% confidence level. Your calculation would be exactly right.

But, such situations are rare. More common are sample groups that stand in for an entire population. In our island example, we could sample the heights of 20 people chosen at random in order to estimate the average height of the population. We would probably be close to, but not quite match, the true average height. The larger the sample size, the better the estimate. The smaller the sample, the greater the margin of error and the lower the confidence interval.

Scientific experiments are usually done through *random sampling.* In statistical terms, a random sample is designed to be representative of the entire population under observation. You may be familiar with this concept in election polls. A similar approach is used in drug testing or in describing biological characteristics from a subgroup of individuals.

Observations vs. Experiments

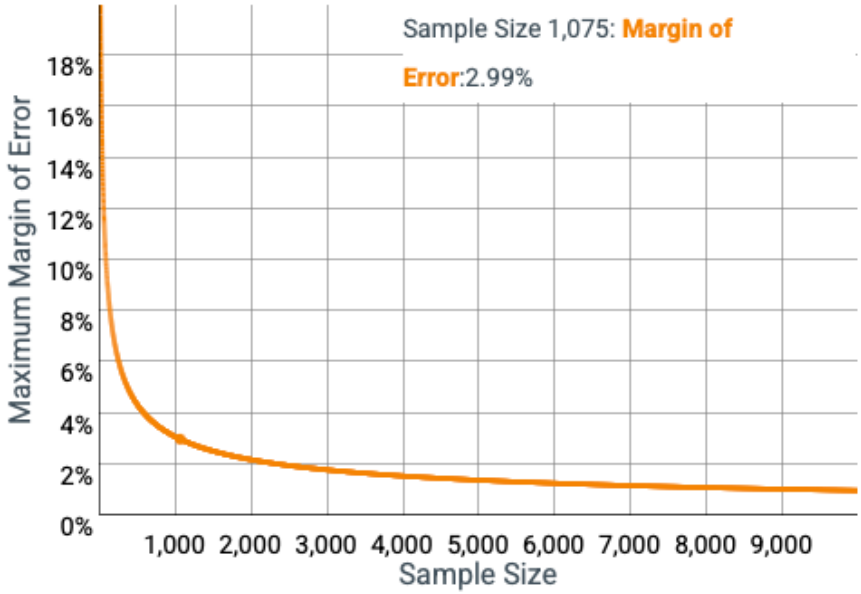
Observational studies are studies in which the variables and the data are not controlled and are not collected directly by the scientists performing the test. Typically, these studies apply statistical models to data compiled by other public or private entities. Their value is that they can provide insight into the real world instead of in a controlled environment.

Experimental studies provide data that are collected directly by the scientists who analyze them. They can be randomized or not, with or without a control group. For instance, the typical clinical trial is usually a randomized controlled one. Experimental studies make it easier for researchers to control variables and reduce statistical uncertainty, known as "noise."

Conversely, nonrandom samples, such as groups of volunteers, say nothing about the population as a whole. Therefore, studies that consist of such samples should be viewed with skepticism.

However, sometimes even well-designed samples might turn out to be skewed. It happens when there are either a high number of nonrespondents or a subgroup that inaccurately reports data. For example, a group of people who **report on their food intake**[12] might truly be a random sample, but their self-reporting could be flawed to the point of making the data irrelevant.

The number of people in the sample matters, too. Small samples are more easily skewed by outliers and more likely to be affected by random errors.



See how margin of error declines with sample size in this interactive graphic.

Moreover, as John Allen Paulos writes in ***A Mathematician Reads the Newspaper,***[13] "what's critical about a random sample is its absolute size, not its percentage of the population." It might seem counterintuitive, but a random sample of 500 people taken from the entire U.S. population is generally far more predictive — has a smaller margin of error, in other words — than a random sample of 50 taken from a population of 2,500. Different variables, including population size, determine a sample's reliability. For example, as a rule of thumb, the Italian National Institute of Statistics uses samples of 1,500 to 2,000 people to make periodic surveys of populations, regardless of the overall population.

However, there is an important caveat to sample size: as the British physician and science writer Ben Goldacre **points out**[14] in *The Guardian*, small (but still meaningful) effects are difficult to measure in small sample populations.

Evaluating Risk

Many science stories — especially health stories — attempt to quantify risk. Often, it is done as a ratio or percentage, as in the American Heart Association's estimated risk of an adult in the United States contracting a cardiovascular disease in his or her lifetime: 48 percent. Huge, right?

First, one must understand what cardiovascular disease is. It includes not just coronary heart disease, heart failure and stroke, but also high blood pressure. Remove that last category, and the risk drops to 9 percent.

From xkcd.com

Absolute Risk

That 9-percent figure is an estimate of the *absolute risk*, or the percentage of people in the entire U.S. population who are likely to contract the disease. It pays no attention to individual risk factors like genetics, smoking, or regular exercise, unless the population itself is limited by those factors. (In other words, if the entire population being studied is made up of smokers, then the absolute risk is for people engaging in that behavior.)

Of course, the reality is that everyone has a different risk, depending on various factors. Some are independent of an individual's behavior. Age, family history, and gender are out of a person's control. Other factors more likely to be under a person's control include nutrition, exercise, smoking, and drinking. There are also conditional probabilities to consider: one's risk of a heart attack might be higher if one previously suffered a heart attack.

Relative Risk

That's where *relative risk* and *odds ratio* come in. Both figures are ratios, but they are two different measures applying to different type of studies. Researchers calculate relative risk when doing a prospective study; i.e., a "cohort study," in which people are observed and data are collected following them in real time. An odds ratios is calculated in a retrospective study, also called a "case-control study," in which researchers compare two selected samples of people — for example, a group of people with HIV and a group without it.

Relative risk (sometimes abbreviated to "RR" and also called *risk ratio*) is calculated by dividing the risk of the population exposed to a certain factor (smoking; unhealthy diet; sedentary lifestyle) by the risk of the unexposed population. For each cohort, researchers will measure the incidence of the disease by calculating the ratio of affected people to the total number of people in that cohort. Finally they divide the incidence in the exposed population (for instance, smokers) with that of the unexposed population (nonsmokers).

As an example, let's do some math using data from **an article**[15] in the British Medical Journals' *Heart*. According to the data, the lung-cancer mortality rate for smokers is 209 per 100,000 people; for nonsmokers, it is 14 per 100,000. Divide 209 by 14 and you get 15 (14.93, to be precise), which is the increase in the relative risk of dying from lung cancer if you smoke.

That "15" can be expressed in a variety of ways: 15 times, by a factor of 15, or a 15-fold increase. All mean the same thing. Alternatively, it can also be converted to a percentage increase. To do that, employ the "NOO" formula, which is outlined later in this chapter. Doing so would show you that smoking increases your risk of dying from lung cancer by 1,400%. However, such percentages are difficult for most people to understand, so we recommend sticking with the "15 times" phrasing, for clarity.

A relative risk below "1" means there is an inverse relationship between the factor and the outcome. For example, if the smoking group had *fewer* lung-cancer deaths, you would have a relative risk below 1, suggesting that smoking is a prophylactic against dying of lung cancer. You would expect to see figures below 1 for tests of effective drugs.

When reporting on relative risk, it is important to always mention the original absolute risk. If the original incidence of a disease is very low, reporting only on a large relative risk will lead to an overstatement of the effects of that risk factor. For example, if a study reports that in a group of 100,000 people just one person dies of lung cancer, while in the comparison group, two people out of 100,000 die, that is a doubling of relative risk, but the absolute risk is still quite small.

On the other hand, when the disease has a very high incidence, even a small difference in relative risk translates into high numbers of people who might be affected.

Odds Ratio

Sometimes a study will report an odds ratio instead of relative risk. This is common in a "case-control study," in which researchers identify people with a disease or condition of interest and compare that group with another group that resembles the first but without the disease or condition. In such a study, the controls are not in place to determine relative risk. Instead, researchers can describe only probability or odds.

For example, imagine that researchers are looking at two groups of former lifeguards. One group contracted skin cancer, while the other group did not. By looking at the lifeguards' use of the sunscreen zinc oxide, the researchers are able to calculate their odds of contracting skin cancer if they did or did not use zinc oxide. But, the researchers would not be able to calculate a generalized reduction in risk that using zinc oxide would provide to a random population.

To further explore this odds-ratio example, let's pretend that the "case study" group of lifeguards who contracted skin cancer is made up of 100 people, of which 10 used zinc oxide. The "control" group consists of 400 lifeguards, of whom 300 used zinc oxide. To calculate the odds ratio that will tell you if the application of zinc oxide is protective against skin cancer, you would first look at the number of lifeguards who used zinc oxide versus those who didn't in the case-study group of lifeguards who contracted cancer. Then divide the result by the ratio between those who used zinc oxide and those who didn't in the control group.

The math, then, is your zinc-oxide users (10) divided by your non-zinc-oxide users in the case study's cancer group (90) which is 0.11 (or 1 in 9). Next, divide the zinc-oxide users by the non-zinc-oxide users in the cancer-free group (300/100), to get 3. Finally, divide the first figure (0.11) by the second figure (3) to get 0.037, which is your odds ratio. You could say, "Lifeguards who use zinc oxide have 0.037 times the odds of getting skin cancer as lifeguards who do not use zinc oxide," but that's difficult to understand. Instead, divide the ratio into 1 and turn the sentence around to say more simply, "Lifeguards who do not use zinc oxide have 27 times the odds of getting skin cancer as lifeguards who do use zinc oxide."

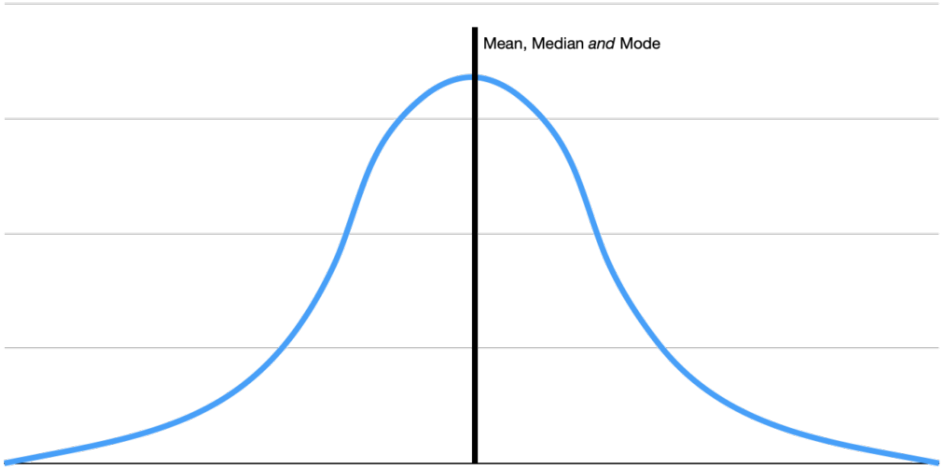
This is different from a risk assessment, since we don't know the overall risk of getting skin cancer, nor were there controls for other factors. All we know is that, based on our made-up case study, the odds of getting skin cancer are 27 times higher for lifeguards who do not apply zinc oxide.

To summarize, when we calculate risk, we are looking at the number of cases within a population. But when calculating odds, we are comparing the cases with non-cases.

Mean, Median, and Mode

Often, when trying to convey the meaning of the data, we use representative descriptive characteristics like **mean**, **median**, and **mode**. Any of the three is sometimes referred to as the average, though most of the time "average" is associated with "mean."

Imagine you have an airplane full of passengers and you measure the height of each individual. If you were to plot that information on a graph, you would probably see a few dots on the low end, a few dots on the high end, and a bunch of dots clustered together in the middle. That is your standard bell curve, also called a "normal distribution." In this case, the mean, median, and mode tend to be similar, if not coincident, at the midpoint of the graph.

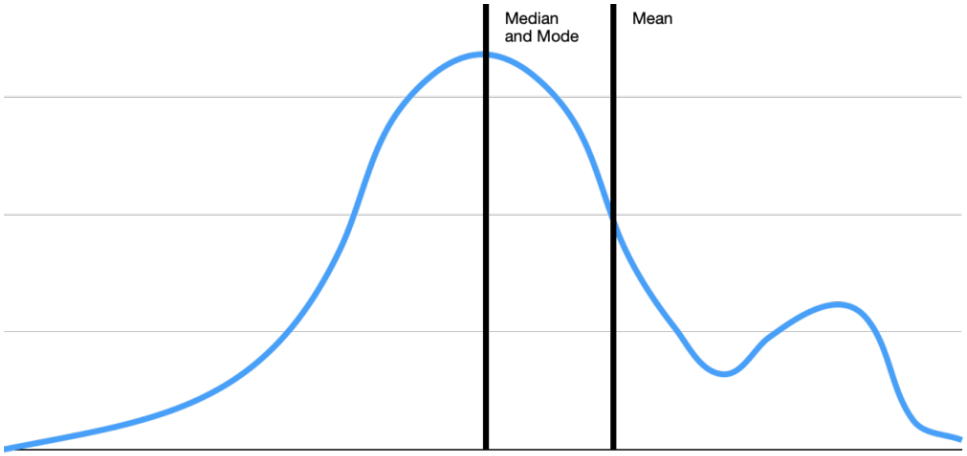


Typical graph of a "normal" distribution, also known as a "bell curve."

Biological features, like height and weight, usually behave like that. To calculate the mean, you simply sum up all of the values in your data set and divide it by the number of entities. If the sample is big enough, the values are likely to distribute in that symmetrical shape around the mean.

Associated with mean is "standard deviation." This term refers to how far the data points are, on average, from the mean. In other words, is the bell skinny (the data are clustered close together)? Or fat (the data are spread apart)? Small standard deviations suggest more-uniform data.

However, in a small sample, even biological features might be distributed in a non-normal way. For instance, what if a professional basketball team happened to be on board our imaginary flight? The presence of such tall outliers would affect the distribution of the values. Now our bell curve has a bump on the right, and the mean shifts to the right.



The "normal" distribution changes when a bunch of outliers appear in the dataset.

In such cases, it can be better to use the **median**, which is the middle number of all our values, if we arrange them from smallest to largest.

You often see "median" used to talk about income, especially in populations with high inequality. The presence of a few multibillionaires would shift the mean well above the level of income ever experienced by most citizens. So the median does a better job of indicating the midpoint on a distribution: half of the people make more than the median, half make less.

Another way to describe data is through the mode, which provides the value that is most common or most frequently occurring. As an example, let's disembark from our imaginary plane and instead head to the highways.

In 2018, according to the National Highway Traffic Safety Administration, here was the distribution of fatal accidents by time of day:

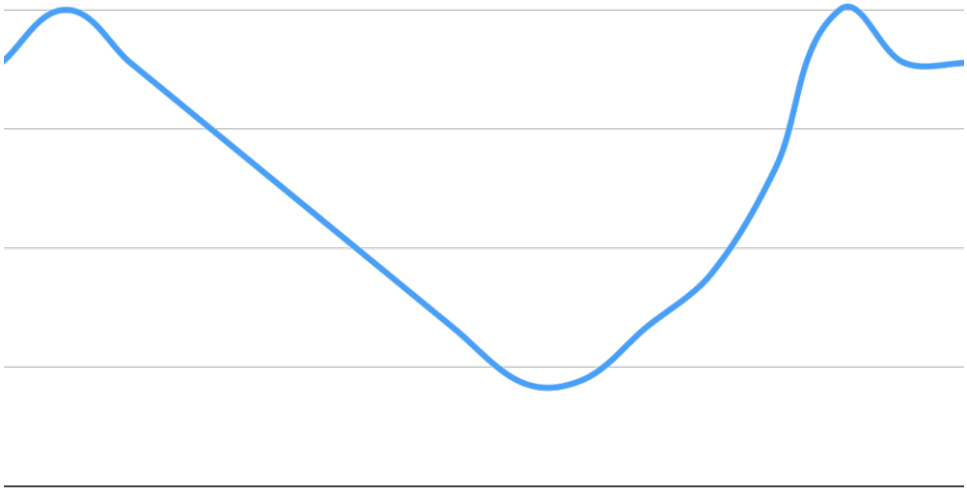
Midnight-3:59 am	4,574
4:00-7:59 am	4,388
8:00-11:59 am	4,154
Noon-3:59 pm	5,943
4:00-7:59 pm	7,329
8:00-11:59 pm	7,022

Fatal traffic accidents in the U.S. in 2018, by time of day; Source: National Highway Traffic Safety Administration

If we had the exact time for each accident, you could calculate a mean time of the accidents — it would be sometime in the early afternoon. Likewise, you could also determine a median time, which would also be in the early afternoon. However, neither would really tell you much in terms of the times of day that public-safety officials should aim at in order to reduce fatal accidents. The most common times — or the **mode** — for fatal accidents, is in the evening.

Therefore, from a public-safety point of view, officials should focus on improving safety in the evening — maybe through enforcement, lighting, signage, or road markings — in order to have the biggest impact on fatal accidents.

Some data sets don't have single modes. There might be two points that feature the most frequent data. That is known as bimodal distribution. (More than two modes would be called "multimodal distribution.")



In a bimodal or multimodal distribution, the high point is repeated. This graph shows the rate of auto accidents by driver age, with the youngest and oldest drivers having more accidents than other groups.

An example of this is with the most common ages of drivers involved in fatal accidents. New, young drivers and old drivers far outstrip drivers between the ages of 24 and 65 in terms of accidents. Therefore, policies aimed at reducing fatal accidents might focus on addressing those two age groups.

Correlations, Causations, and Data Over Time

It's not uncommon to see stories saying something like, "Antidepressant prescriptions have risen in the past 20 years," or "The number of people who do not have access to clean water has shrunk in the past 10 years." However, comparing data

over time demands careful consideration. The meaning of given numbers might well vary on the basis of the moment they are measured. Money is a classic example: financial comparisons must consider inflation; otherwise it's impossible to draw any meaningful conclusions.

To calculate the impact of inflation, use the **U.S. Bureau of Labor Statistics' Consumer Price Index inflation calculator**[16].

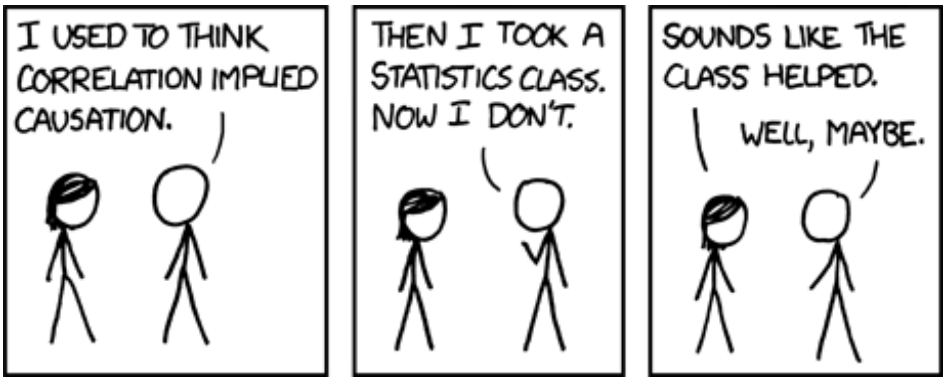
The issue, of course, extends far beyond the financial realm. Plenty of other factors can determine data quality when looked at over time. Another example: Diagnostic capabilities have improved over the years for a wide variety of health conditions. Reporting on the increase or decrease in the prevalence of a disease compared with a time when data weren't available or were measured with different standards makes little sense.

When we do see figures change over time, the natural question to ask is, "Why?"

In answering that question, scientists often use an array of statistical tests called regression analyses to see if they can establish a link between two variables. The most common way to express such a correlation is to use the index *r*, which goes from -1 to +1. There are negative correlations, in which one variable grows while the other one decreases, and positive ones, in which both variables move in the same direction.

For example, there is a negative correlation between rising temperatures and the use of heating oil. Likewise, there is a positive correlation between rising temperatures and the use of electricity (for air conditioning). Weak correlation values are closer to zero; strong correlations are closer to the extremes of -1 or +1.

However, just because two things are correlated doesn't mean they have anything to do with each other. Tyler Vigen presents a number of what he calls **spurious correlations**[17] on his website and book of the same name. He shows real data that create absurdly false correlations, such as the close correlation of the divorce rate in Maine and per capital consumption of margarine.



From xkcd.com

Vigen's charts demonstrate two common mistakes with correlations. The first is the tendency to draw conclusions about individuals from a set of data describing a population — something known as an ecological fallacy, which the statistician Heather Krause explains in a **YouTube video**[18].

As an example, it's generally true that there is a correlation between income level and life expectancy in the general population. However, it is not true that every rich person will live longer than every poor person, or that a very old and healthy person must also be wealthy.

The second common mistake is misinterpreting a correlation for causation. There might be many explanations behind the reason that variables are related. For example, there is causation in terms of rising temperatures and the decreased use of heating oil. But there is *not* causation between the decreased use of heating oil and the increased use of swimming pools. In the latter case, a third variable — rising temperatures — explains the apparent relationship.

To establish a causal relationship, scientists wade into statistics and perform complex tests on their data. To confirm a causal effect and rule out all other possible explanations, they must craft experimental studies using randomized designs and control groups. This is particularly important in fields such as environmental epidemiology, in which researchers want to understand whether a particular pollutant might be the cause of a disease. It is complicated to find a unique relationship between the presence of one substance and its impact on the population's health. We live in a complex environment, and many factors are at play: lifestyle, nutritional status, previous conditions, and genetic predisposition, among others.

Helping Readers Understand the Numbers

Stand-alone figures can be impactful, but they often lack necessary context. What does it mean, for example, that about **650,000 people in the United States die each year from heart disease**[19]? It's a big number, and that's a lot of people. In fact, it's the leading cause of death in the U.S., representing about a quarter of all deaths. But, should that be alarming to us? To provide context, it's helpful to provide a comparison.

Perhaps we should look at the United Kingdom, which has a similar diet and standard of living to those in the U.S. In the U.K., about **170,000 people die each year from cardiovascular disease**[20]. The U.S. looks pretty bad by that comparison. But the percentage of all deaths in the U.K. that are attributable to heart disease, about 27 percent, is a shade higher than that in the U.S.

Of course, this is a function of the differences in overall population size. The U.S. has about 330 million people, and the United Kingdom is just shy of 68 million. So, in terms of the percentage of the overall population, about 2 people out of every thousand die of cardiovascular disease in the U.S., compared with 2.5 in the United Kingdom. Turns out, the U.S. is actually a little better in that respect when the countries' populations are taken into account.

As an editor, the "So what?" question is a critical one when looking at data. What does this stat mean? What is it saying? Is it significant, surprising, enlightening? Don't fall into the trap of thinking that numbers in and of themselves are meaningful. They still must be explained, described, and contextualized.

Percentages, Rates, and Ratios

A percentage is just a specific ratio — a comparison to 100. But that doesn't mean it's the only one to use. Sometimes other denominators can be useful, like 10 or, as in the example of the death rates above, 1,000. Or, even 1, as in per capita comparisons.

For instance, if you wish to calculate and compare New York's and Texas's energy consumption, you could look at the total consumption in each state. Both New York and Texas are big and populous. But how many people use that energy is what matters a lot. The best way to compare is to divide each population's overall energy consumption, to get a figure *per capita*. That would give you a comparable result and one that readers find easier to relate to.

As it happens, Texas is among the biggest users of energy, at **470.2 BTUs per person**[21], while New York has the lowest per capita rate at **188.6 BTUs per person**[22] — less than half the rate of Texas.

Just be sure your comparison is a number that makes intuitive sense. Saying the cardiovascular death rate in the U.S. is 0.0028 per capita may be true, but good luck finding anyone who understands what that means.

One common mistake comes when people try to compare percentages. If you compare the expansion of Brazilian agricultural land from 1965 to 2015, you would see that it grew from 20% to 28%. One way to describe that difference is as an 8 *percentage-point* increase. Note, however, that this not the same as a "percentage change." If you wanted to express the change that way, you would have to follow the "NOO" rule (**n**ew minus **o**ld, with the result divided by **o**ld). In that case, you would calculate 28 – 20 = 8. Then calculate 8 ÷ 20 = 0.4. That produces the *percentage* increase: 0.4 * 100 = 40%.

Translating Big and Small Numbers

Analogies and metaphors are two more tools for making numbers relatable. For instance, our DNA is a text composed of four acids, which we represent as the letters A, C, G, and T. In all, a DNA strand is a chain of 6.5 billion base pairs of those acids. So, written out, that would be 6.5 billion A, C, G, and T characters. That's a pretty big number, which is tough for most people to grasp. To provide context, one could compare a DNA strand to *War and Peace*. The novel contains roughly 2.5 million characters, meaning that each of our cells contains a text that is as long as 2,600 copies of Tolstoy's magnum opus.

Something to Think About

Million, billion, and trillion sound like they aren't that different from one another. But, they are. *Significantly*. For example:

A **million** seconds is equivalent to about 12 days.

A **billion** seconds is about 32 years.

A **trillion** seconds would last nearly 31,710 years.

Small numbers, too, can be difficult to comprehend. Take the numbers used when talking about climate change, such as the amount of carbon dioxide in the atmosphere (400 parts per million) or the goal of holding temperature change to 2 degrees Celsius. In both cases, historical context can bring meaning that the small that figures themselves cannot. This passage from a ***Time* magazine article**[23] does that well:

> *We live enshrouded by an atmospheric greenhouse of gases and water vapor that has maintained life-supporting conditions for hundreds of millions of years; CO2 is part of that mix. But over the past three million years our greenhouse system has been highly unstable. The record of CO2 trapped in polar ice reveals that over the last 800,000 years, during dramatic swings between ice ages and warm periods, CO2 has oscillated between 180 and 280 ppm. In the last rapid warm-up from the most recent glacial period, CO2 jumped to 260 ppm, and then oscillated around 275 ppm. Since then, for about 9,000 years, our climate has been relatively stable. Agriculture, civilizations and states emerged, and **global population**[24] grew from several million at the end of the last Ice Age to 1.2 billion in 1850.*

Framing Figures

Repeat after me: *Numbers do not tell stories on their own*. Your choice of wording and the figures you choose to highlight serve to put a particular perspective on the data. This is known as the *framing effect* — thoroughly described by that Nobel laureate Daniel Kahneman in his book *Thinking, Fast and Slow* — and it has a substantial impact on readers and listeners; our decision-making depends enormously on the way facts are presented. For example, saying a type of surgery has 70% chance of success sounds very different than saying three people out of 10 will very likely die during said surgery. Slight changes in wording and framing can lead people to interpret the information very differently.

Not only are data not inherently objective, but they can be downright subjective in certain circumstances, such as when crucial statistics or context is omitted. It is essential to describe the source of the data and what conflicts of interest might be lurking behind the spreadsheets. Who paid for the research? How were the data collected? What data were excluded? The power of figures to sway public opinion is well known. Just look at the tobacco companies that provided research to downplay the risks — and tout the perceived benefits — of tobacco on human health. We now know that those studies were flawed, but they filled the news and the commercials for years. And of course, they set the template for other companies and industries to follow.

Where do the data and studies landing on your table come from?

- **Preprints** are papers with data and results that have not yet been scrutinized through the peer-review process; they are published on "preprint servers" rather than in journals. They pose a special challenge when used as a source of public information. So why do they exist? One reason is that they provide an avenue for other scientists and researchers to provide early feedback that can be used to improve a study or paper.

- **Primary studies** are the data and results from original sets of experiments, born out of a hypothesis and generated through a well-defined methodology.

- **Meta-analysis and systematic reviews** are papers that collect, analyze, review, and discuss other scientific articles[25] on a given subject, rather than reflect new research. Such papers are useful to provide an overview of research and knowledge in a specific field.

- **Surveillance and monitoring systems** are data collections undertaken by public research organizations on a rolling basis to keep track of

developments in a given area. These could include epidemiological surveillance, CO_2 emissions trackers, or seismic- or volcanic-activity monitoring networks. Often these data are made publicly accessible through open platforms.

- **Periodic reports** are annual, monthly, or other periodic bulletins and reports published by international organizations. They often reference and synthesize other research papers, studies, and reports.

Tips When Writing About Numbers

It should be to our profession's embarrassment that many journalists take pride in not understanding anything about numbers or math. Yet, as Sarah Cohen points out in the must-have reference book ***Numbers in the Newsroom***[26], "The fear of numbers marks a reporter as one who can only do part of the job." Here are a few tips on how to make numbers and math work for you as a journalist:

- **Know your universe**. Sarah Cohen and Jennifer La Fleur, two award-winning data journalists, say the most important step is to know some of your beat's basic figures. For example, if you're editing stories about climate change, you should know your region's average temperatures, the current concentration of carbon dioxide in the atmosphere (416 parts per million), and the warmest year on record (2019, as of this writing midway through 2020), among other basic statistics. Those editing Covid-19 coverage should have internalized such basic information as the fatality rate (estimated at 1%) and how that compares with other diseases, like influenza (0.1%), SARS (11%) and MERS (35%), as well as transmission rates (or R0), which for the current coronavirus is estimated at 2 to 2.5. Of course, the R0 depends greatly on environmental factors, such as whether or not people are wearing masks and practicing social distancing. The point is, knowing the basic stats and facts will allow you to catch errors and put a finer point on stories.

- **Use large and small numbers with care.** People are terrible at understanding very big and very small numbers. It's challenging to put a "billion" into context, or to understand how tiny a virus is (less than 100 nanometers). So it's better to relate numbers to something in people's experiences. Saying 800 million people do not get enough to eat each day is easier to understand when phrased as "more than twice the population of the United States goes to bed hungry every day." Likewise, find creative ways to visualize the very small. For example, in describing the size of bacteria, you could say, "about 150,000 bacteria can fit on the tip of one hair."

- **Beware of false precision**. Imagine a scientist saying a dinosaur skeleton is 100 million years old. Five years later, would you say that skeleton is 100,000,005 years old? Of course not. The "hundred million" figure, like many measures in nature, is an estimate with some inherent uncertainty, not a precise figure. Using "exact" figures with decimals to the hundredths place is rarely the best way to present numbers. It is often much better to use a good approximation within the appropriate order of magnitude. Rather than "23.7%," go with "slightly less than one out of four.' Likewise, 44% becomes "more than 4 in 10."

- **Don't overuse numbers in a paragraph**. Ideally, you should write concise sentences and short paragraphs, describing the sense of data without necessarily displaying the numbers, unless they are needed. Sarah Cohen suggests reducing the number of digits in your copy to improve the use of those you do use. As a rule of thumb, she says it's worth reducing the number of digits in a paragraph to eight. As an example, saying, "More than 200,000 people in the U.S. died from coronavirus in 2020" already has 10 digits. It's a rule of thumb, though, and not a law. Just be judicious and use digits only when necessary to explain the ideas.

Additional Reading and Resources

Books

- Darrell Huff, *How to Lie With Statistics* (1957), Penguin Books. The best and most immediate entry into the world of numbers in the news.

- John Allen Paulos, *A Mathematician Reads the Newspaper* (1995), Anchor Books. Informative, full of examples, and easy to read.

- Hans Rosling, *Factfulness* (2018), Flatiron Books.

- Alberto Cairo, *How Charts Lie* (2019), W.W. Norton and Company. A useful focus on how charts should be drawn and used in the news.

- Sarah Cohen. *Numbers in the Newsroom* (2014) Investigative Reporters & Editors. Math made easy for journalists, with examples of how to calculate the most essential formulas needed to understand statistics.

Websites

- **GapMinder** – Teaches how to foster a fact-based worldview, exploring data and facts that are widely available on health, wealth, demographics, and environment, and how to combine data in compelling narratives.
- **FiveThirtyEight's Science Section** – Good examples of the use of scientific data in an approachable and accurate way.
- **Science Feedback** – A nonprofit effort that brings scientists with relevant expertise from different institutions and disciplines (currently limited to climate and health issues) to review and comment on news articles containing science information and data, calling out inaccuracies and faulty reasoning.

About the Author

Elisabetta Tola is a scientist and data journalist who holds a Ph.D. in microbiology. She was a Tow-Knight fellow in 2019 at the Craig Newmark Graduate School of Journalism at the City University of New York. As founder of **Facta** and chief executive of the science communications agency **formicablu**, Tola applies the scientific methodology to journalism. Tola is the author of the international data and multimedia investigations **Seedversity.org**, **SEEDcontrol.eu**, and **Hearing Voices**. She is a radio presenter at **RAI Radio3scienza** and has freelanced for publications including ESMH, IIBOLive, AGI, and WiredIT. She is also a media trainer and lecturer on data-science journalism and the author of a **handbook for journalists on environmental science** for the European Forest Institute.

Endnotes

1 https://www.nytimes.com/article/how-to-read-a-science-study-coronavirus.html

2 https://www.theguardian.com/world/2020/jun/04/covid-19-lancet-retracts-paper-that-halted-hydroxychloroquine-trials

3 https://fivethirtyeight.com/features/what-happened-with-that-bogus-hydroxycholoroquine-study/

4 https://idatassist.com/

5 https://www.researchgate.net/publication/45891209_P_Values_Confidence_Intervals_or_Confidence_Levels_for_Hypotheses

6 https://fivethirtyeight.com/features/not-even-scientists-can-easily-explain-p-values/

7 http://www.nature.com/nmeth/journal/v12/n3/abs/nmeth.3288.html

8 https://med.stanford.edu/news/all-news/2016/03/misleading-p-values-showing-up-more-often-in-journals.html

9 https://www.cdc.gov/breastfeeding/data/nis_data/results.html

10 https://www.nytimes.com/interactive/2019/08/29/opinion/hurricane-dorian-forecast-map.html

11 https://blogs.scientificamerican.com/observations/five-sigmawhats-that/

12 http://www.uniteforsight.org/global-health-university/nutrition-study

13 https://www.ams.org/notices/199603/comm-kolata.pdf

14 https://www.theguardian.com/commentisfree/2011/aug/12/bad-science-exaggerated-study-results

15 https://heart.bmj.com/content/85/5/491

16 https://www.bls.gov/data/inflation_calculator.htm

17 https://tylervigen.com/spurious-correlations

18 https://www.youtube.com/watch?time_continue=332&v=RmYIpnzbQtM&feature=emb_logo

19 https://www.cdc.gov/nchs/data/nvsr/nvsr68/nvsr68_06-508.pdf

20 https://www.bhf.org.uk/-/media/files/research/heart-statistics/bhf-cvd-statistics-uk-factsheet.pdf?la=en

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23 https://time.com/5680432/climate-change-history-carbon/

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26 https://www.ire.org/product/numbers-in-the-newsroom-using-math-and-statistics-in-news-second-edition-e-version

05 Editing for Story

By Rachel Feltman

Introduction

The challenges of editing a journalistic article on a scientific subject are no different from those of editing any other sort of content. Your job is to polish a writer's prose and poke and prod at the reporting without sacrificing the integrity of either. You are acting as the article's first reader and greatest advocate — spotting narrative roads in need of swift rerouting, and holes in need of filling — to ensure that its intended message reaches as many readers as effectively as possible. Depending on the publication you work for, you may be tasked with tweaking your writer's style to fit the tone of the intended platform. Your goal is always to elevate the piece, whether that requires a few touch-ups or a major face-lift.

But much more nebulous (and daunting) than a simple line edit is the challenge of making a journalistic article into an engaging and entertaining story. This can become a Herculean effort for stories rooted in health and science. There may have been a time when many straight-down-the-middle pieces of news could get away with being, well, straight-down-the-middle from a narrative standpoint. When readers had to subscribe to a newspaper in order to stay informed, they had no choice but to tolerate the dry treatment of a serious topic — and what topic is more serious than science? The old-school journalistic norm held that these pieces of news should be technical and precise; if readers' eyes glazed over and jumped immediately to something more engaging the next column over, editors were none the wiser.

I don't need to explain to you how much this has changed. With 20 percent of Americans copping to getting their news on social media — and many of the rest relying on digital news sites — every story must be arresting in its own right.

Editing a piece to make it as riveting as possible is no different when the subject is scientific, but it may present potential pitfalls if you're used to other subjects. It's easier to inadvertently sacrifice facts for a thrilling plot line when the facts themselves are foreign to you. On the other hand, science stories have long been

seen as outside the interest of the general reader. An editor must be cautious not to muddle the truth in pursuit of making a piece more engaging, but that doesn't mean all science stories should be dry and academic.

This chapter will help you to recognize moments when the urge to make a scientific story more compelling can lead you or the writer astray — and to understand how to present even the most technical findings as thrilling pieces of content.

Telling the Right Story

Writing about science as a great story begins not with line edits, but at the beginning of the assigning process. The first question to ask yourself is whether this science news is worth covering. The next is how your reporter should cover it. Having the right conversations with a writer in the earliest stages of reporting can help ensure that you receive copy with the potential to become a great story.

First, consider — and ask your writer to justify — the need for this particular article.

Here are some less-than-ideal reasons to assign a story:

- **It's trending online.** It is, of course, tempting — and sometimes necessary — to chase the algorithm-assisted traffic bumps that can result from grabbing onto a story that's trending on Google or Apple News. While that is a fine way to find stories to *consider* covering, news-curation platforms have a bad track record when it comes to serving up good and important science news. While some social news feeds have quality-control editors or spotters on the lookout for stories to include, the question of what rises to the top is largely dictated by algorithms — computer script designed to pluck out articles that are likely to be clicked on, and then to continue promoting those links and ones like them to feed off of click success. Google and Facebook have not entered the same endlessly negative feedback loop as, say, YouTube, which has become a **hotbed of radicalized misinformation**[1] in the effort to attract eyeballs. But in addition to often relying on racist, sexist, or otherwise **problematic human viewpoints**[2] in deciding what news is worth sharing, these sorts of semi-automated feeds are often just not very smart. I have, on more than one occasion, seen Google News share an unscrupulous headline about alien life on Mars as one of its top science stories.

  It's easy to spot a tabloid article about how **there might be little rodents on Mars**[3] as an obvious falsehood, but not everything that a news-feed curator or algorithm mistakenly elevates will be so obviously false. Misleading

headlines are a much more common problem, as are fairly unimportant studies and stories that rose to the top simply because something about them *sounds* exciting. For example, most studies on nutrition are misleading, or represent only an incremental change in medical advice. Actually **understanding how food affects health**[4] is difficult to track and even harder to translate into widely applicable advice. But because most people drink coffee and care about how long they'll live, a study claiming to show that coffee adds to or subtracts from projected lifespan is always going to trend high.

As an editor, you should never assume that something is worth elevating just because it's trending. Dig deeper before you assign it. Ask why it's caught the attention of so many people, and see what various experts are saying about the news. Ask your writer if the story can be moved forward.

- **It's embargoed.** Getting access to embargoed journal articles — either through a service like **EurekAlert**[5] or directly from a publication like *Nature* — is a good way to stay abreast of current and forthcoming science news. Many scientific studies are released "under embargo," which means that journalists and editors have a chance to look at their findings (and perhaps their data) before the news goes public. However, scientific institutions can and do use the embargo system to their own benefit. Because an embargo gives journalistic publications more time to report before the news can end up trending on Google or Facebook, these studies are often viewed as more serious and more worthy of our attention. But plenty of good and important pieces of science news are sent out to journalists at the same time the findings go public, and most embargoed studies are far from groundbreaking. The existence of an embargo is not, in and of itself, a cue that science news is particularly important.

- **The press release says it's a big deal.** If the White House sent out a press release trumpeting how amazing a particular presidential initiative was going to be for the country, you wouldn't just seek to confirm the stated facts. As a skeptical editor, you would question the way the administration was framing its actions, and ask yourself what it might serve to gain from spreading that narrative. It's obvious, in this scenario, that the press officer is pushing a particular agenda — perhaps not a malicious or even misleading agenda, but that's for your reporter to suss out. Science press releases are the same: They are crafted by entities, like universities and drug companies, that stand to gain from widespread praise of the work described therein. In many cases, a press release will overstate the importance of a scientific finding or even misrepresent the facts. A thrilling press release often turns out to be science fiction; you should never lean on the narrative presented by a press officer in your quest to assign and craft a compelling story.

Here are some good *reasons* to assign a story:

- **Scientists (other than the ones who did the study) seem excited.** Just as you must assume that the people writing press releases have an agenda, you must also recognize that scientists have a bias when it comes to studies they're involved in. No amount of excitement from a study report's author, however genuine, should be taken as evidence that the story is particularly novel or important. But that doesn't mean excitement within the scientific community should be discounted. This is where it becomes helpful to cultivate a wide array of scientific sources to keep in touch with and follow on social media: Watching for a generally enthusiastic reaction about new research can clue you in to findings that are actually a big deal.

- **It concerns issues that will seriously impact peoples' lives (even if those people aren't your readers).** One of the most important jobs a science editor has is elevating research and news that readers might not realize will affect the world around them. Sometimes these topics are obvious — climate change is altering the fabric of the earth, even though many individuals in wealthy countries don't see clear effects of it every day. Other topics are easier to ignore: A study on how palm-oil production is affecting wildlife diversity in Borneo may not seem immediately interesting to your readers, even if you understand that it's a serious issue. But their shopping habits are likely to contribute to the problem — poorly sourced palm oil is in countless products sold across America. For a story like this, the reporter and editor must explain not just what the problem is and whom it will hurt, but also why the reader — presumably not in immediate danger — should care. These stories are under-covered but quite valuable.

- **It explains something being discussed in the news, or uses a current event as an opportunity to explain a scientific concept.** When "The Dress" and "Yanny vs. Laurel" went viral, these digital illusions sparked online debates and countless memes. Science had a place in the conversation: Both of these seemingly silly internet arguments could be explained by talking about the **quirks and limits of human perception**[6]. If everyone is talking about the same thing, editors should ask themselves what science stories could ride the resulting traffic wave. This can be overdone — you don't need to explain "the science of" every single superhero movie, given the fact that most of them contain little actual "science" — but it's certainly worth soliciting pitches that take a sideways look at big news events. You can also use current events to get readers interested in bizarre but informative science questions, like **how much sweat comes out of a single Super Bowl**[7].

- **Lots of publications are getting something very wrong.** Sometimes a debunk — in which your reporter explains what other publications or

> the general public are getting wrong about a widely -shared story — can provide a valuable service. If the story is trending on news algorithms or social-media platforms, debunks also have a shot at surfing a big wave of traffic. **Consider this article**[8] on dolphin perception, which I wrote after looking into a story being shared on many science and tech websites. Googling the source of the press release and reaching out for comment made it clear that the widely shared narrative was untrue.

One note of caution: It's important not to "debunk" articles that are not getting significant attention or convincing lots of people of something untrue. Doing so can serve to elevate dangerous mistruths to an even larger audience. For instance, *Popular Science* may not have chosen to report on **sellers of bleach as a medical treatment**[9] if the promoters had done business only in small, private Facebook groups. But when the practice was empowered by a statement made by the president of the United States, the claims had a large enough audience to justify debunking.

Once you are confident that this topic is worthwhile, the next step is figuring out what kind of approach and treatment a story warrants. Not every story will shine in the same outlet, or with the same editorial treatment.

Is It a Story?

"I happen to think that if it's important science and there's a news hook, there's always a way to make the story compelling," says Maddie Stone, a freelance science writer and founding editor of Earther, a website of nature news.

She goes on:

> *I think it comes down to figuring out, first and foremost, who the audience is. If it's a story about a new medical device that is a big deal for individuals with a rare condition but won't affect anyone else, that's probably better suited for a medical news outlet than the NYT science section. If the science is important and impacts everyone but the technical details are very dry, then it's about getting the "why does this matter to me" front-and-center.*

There are several questions you should ask in order to determine whether a pitch is a compelling story.

Does this article feature life-or-death information?

Some pieces of science news — especially in the age of global pandemics like Covid-19 — are simply crucial for the health and wellness of the general population. While the era of digital news means that all stories must be presented in an interesting and engaging way, getting potentially lifesaving information to your

readers quickly and efficiently is more important than weaving a stunning tale for them to enjoy.

Popular Science has used several story rubrics designed to push out essential information on Covid-19, including weekly roundups of new and important news, and posts with running updates on death tolls and medical advice. It publishes these articles, which are reported for accuracy but written without much concern for narrative or "story," in addition to more compelling and gripping pieces on similar topics. Sometimes a short and efficient piece of science news should stay exactly that.

The reverse-pyramid structure is your best friend in these circumstances, particularly when readers may have a hard time understanding why this reporting is so vital. A snappy headline followed by a simple, declarative lede will make sure that readers understand what they're about to read. You should make sure to quickly present a nut graf that gets at the crux of the importance of the scientific finding. From there, you can add whatever additional information and context the reader might need.

Consider these two (made-up) examples:

> ***She was sure it was just allergies—and then she lost her sense of taste***
>
> *Dolly Jones has always prided herself on possessing a sophisticated palate. The 53-year-old restaurateur and Brooklyn native cheerfully recalls traveling "from Thailand to Tennessee" to gather inspiration for her Michelin-starred Williamsburg Dolly's House, which features fanciful fusion dishes such as congee-style shrimp and grits and bulgogi pulled pork sandwiches. But her reveries on past culinary adventures now carry a tinge of regret: For the past two weeks, Jones has been unable to taste even the most powerful of flavors.*
>
> *"I've tried everything from sprinkling cayenne in my chicken soup to chewing on sprigs of mint," she says. "It's like my taste buds have gone to sleep."*
>
> *"I keep trying to remind myself that being able to taste shouldn't be my biggest concern," she adds with a sigh. "But it's hard to worry about having coronavirus when I see my life's work flashing before my eyes."*

Dolly's story is, no doubt, a compelling narrative to follow in exploring the science behind a new and intriguing Covid-19 symptom, and you might very well decide that this feature is worth assigning. But when experts noted that loss of taste is a new sign of Covid-19, readers didn't need flouncy ledes about foodies. They needed to know to be on the lookout for this unexpected sign of infection.

Here's a simpler and more effective way to present that information:

> ***Scientists identify a surprising early warning sign for Covid-19***
>
> *Researchers are now saying that Covid-19 patients can exhibit a more striking symptom than dry cough or fever: They can also lose their ability to smell or taste.*
>
> *While more research is needed to understand the exact mechanism of this bizarre symptom, experts warn that new and sudden changes in one's ability to recognize odors and flavors could indicate infection with the virus that causes Covid-19. People who experience this phenomenon should self-isolate from family and friends to avoid spreading the contagion, even if they otherwise feel fine.*

From there, this structure can unfold to provide context on where this symptom might have come from, and what readers should do if they suspect they have the disease. Both of these article structures are valid, even though one clearly presents a more compelling story than the other. And in this particular case, the latter — and less engaging — example is probably the one your publication should put out first.

Your science story may not even need to exist as a story; once a week, *Popular Science* editors solicit questions on Covid-19 from our Twitter followers and answer them live. Some of these answers could have been written out as full stories, and some of them eventually are. But to best serve readers, the magazine chooses to give them the answers they're looking for in a free, instantaneous fashion.

Is humor appropriate?

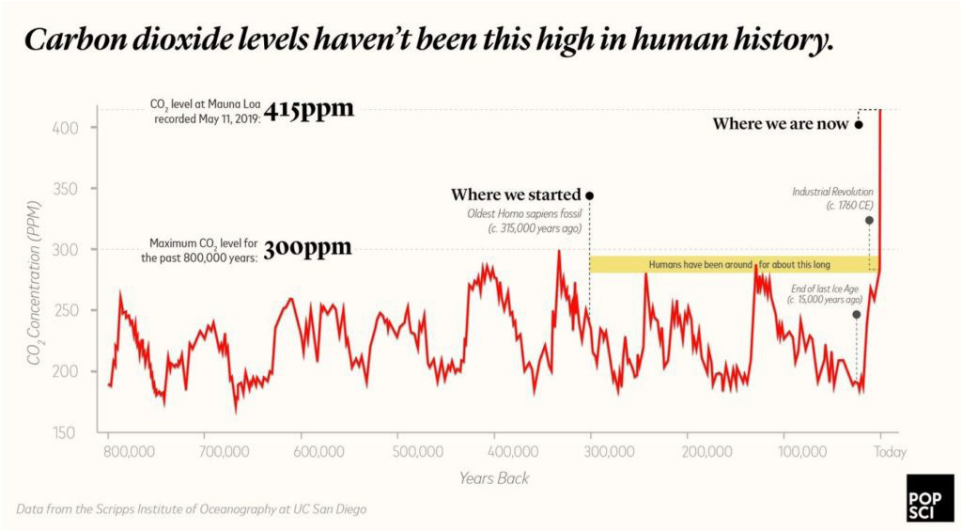
Not every story is about a pandemic, and not every science story needs to be serious. One should never try to force one's way into humor, but as an editor, you can and should give your reporters the freedom to have fun with science news. Are there puns to be made? Cheeky innuendos?

I have, on numerous occasions (like **here**[10] and **here**[11]) written or assigned stories on scientific findings about the planet Uranus that lean heavily on puns and double entendres. I would never write a story about a deadly pandemic that relied on butt jokes, but snickering at a distant planet's expense is about as harmless as fun can get. And guess what: Those stories have gotten a *lot* of people to care about new scientific findings.

Similar nuggets of fun can be found all over the world of health and science. Allowing your writer to take on a silly tone can be the key to getting readers excited about obscure or esoteric science. There is nothing inherently dirty or low-brow about creating accessible, relatable, and enjoyable content.

Is there too much information for a single, streamlined piece of written content?

Like any other story, a piece of science news can evolve to take many forms — audio, video, PowerPoint, and so on. Consider whether the facts and figures your writer would have to cram into the text could be presented in a better way. Would infographics or even simple charts be helpful to the reader? These might end up replacing large blocks of what would otherwise be inscrutable text.



Graphic from PopularScience

Consider the simple but compelling graphic above, which expresses complex data on climate change much more quickly than text can — and was shared widely on social media. You might also create an informational package with different types of rubrics and formats. An opening essay followed by timelines, charts, and short blurbs could be far more effective than a narrative feature.

If you feel it would be impossible to get all of the necessary facts and figures and context into a streamlined story, you might be right — but that's not an excuse for leaving them out entirely. Sidebars, section headers, and infographics are your friends.

Building Narrative Into the Reporting Process

One challenge we editors and writers face in making science stories universally interesting: scientists themselves. While folks in the sciences are, generally

speaking, a fascinating bunch, most of them aren't trained in storytelling, and some are downright awful at translating their own research into a good yarn. This can be compounded by the fact that even the most thrilling science often occurs in a surprisingly dull setting, which can leave a general-assignment reporter feeling at a loss for how to build scenes, develop characters, and weave together narrative threads.

That heightens the need to find details to bring a story to life, says Susan Murcko, features editor at *Popular Science*. "Traditionally desirable building blocks like scene and character can be challenging. The reporting timeline might mean that the writer has to meet the scientist in an office or lab, as opposed to more interesting settings out in the world — assuming the person's work even takes them out and about. It's really important to try to glean any shred of telling detail or personality in otherwise nondescript or literally sterile settings."

As a result, you should encourage writers to seek out the most engaging possible settings for their stories — fieldwork sites, for example, or residential communities being directly affected by the scientific issues they're reporting on. But if most of their interviews will take place in a lab, advise the reporters of the potential difficulties *before* reporting begins. Helping them brainstorm what questions to ask and details to look out for can help ensure that you receive a first draft with at least the beginnings of a compelling story — and can limit the amount of follow-up you will need them to do.

"It's really important to try to glean any shred of telling detail or personality in otherwise nondescript or literally sterile settings.

Susan Murcko, features editor at Popular Science

Conversely, don't rely too much on an unusually articulate or glamorous researcher. Science journalism is still journalism, and if scientists' take on their latest work is full of heroes and villains and twists and turns, you still have to track down corroboration for their statements, seek the opinion of outside experts on the data, and challenge any exaggerations or oversimplifications they've crafted in the name of getting their work more attention.

If it seems as if the story is just writing itself after a single phone call with the main author of the study, that version of events is almost certainly too good to be true. Some stories about science will not cast the findings — or the researchers behind them — in a positive light. You should always ensure that your reporters have sniffed around enough to detect corruption and misconduct.

One trope that science writing sometimes leans on, but shouldn't, says Maddie Stone, of Earther, is the idea "that science is inherently 'good' and the people doing science are the 'good guys.'" She goes on:

> *Most people go into science journalism because they love science, not because they're trying to expose corruption or injustices. But those science stories matter, too. Too often, stories of sexual harassment or discrimination in academia, or science becoming another tool of colonialism, are sidelined because the scientists and institutions at the center*

of them are respected leaders in a field, and the research they are doing is deemed more important or interesting by the media.

Here are a few interview questions I've found crucial in learning to coax the good stuff out of scientific sources without letting them get away with telling tall tales:

- Is there anyone who might not get credit for this who deserves recognition?
- What previous work was integral to the new study?
- Do you have any conflicts to disclose?
- Why do you care about this subject?
- Did any of your findings surprise you?
- What are some of the study's limitations?
- Do you expect these findings to be controversial in your field?
- What are the broader implications?
- What do people usually get wrong about this subject?
- Looking back on the study, what were some of the most memorable moments for you and your colleagues?
- What are you working on next?

Meanwhile, asking questions that might *seem* less crucial can yield surprising opportunities for crafting a unique story.

"Sometimes an interesting piece of a science story — something the writer finds out by asking what was most interesting or difficult about the process, or what the researchers tackled in a particularly unique way — can be used to reveal something wider, creating a story about the broader enterprise of science," says Gideon Lichfield, editor in chief of *MIT Technology Review*. "Maybe that line of inquiry reveals how funding works, or how rivalries in science and academia work, or how misunderstandings between scientists and the general public work. All these issues might be encapsulated in a relatively small story, if you ask questions that go beyond the scope of what a study's findings were."

Asking why a scientist cares about a subject of study is especially crucial if you hope to craft a narrative. All science stories should answer the question of why

the readers should care (otherwise, they're liable to feel that their time has been wasted), but it's quite likely that the scientist's personal reason for caring is different, and more surprising.

For example, consider a scientist who studies naked mole rats. These wrinkly, uncharismatic creatures will seem repulsive to many readers, but there's a good reason why they should care about this research: the ugly critters have unusually low rates of cancer for a mammalian species — and understanding why might help us gain some of the same benefit for humans. To tell a more compelling story, you could report some anecdote from the researcher's childhood; maybe an eccentric uncle kept naked mole rats as pets and mentioned their medical potential.

> ***"Sometimes an interesting piece of a science story … can be used to reveal something wider, creating a story about the broader enterprise of science.***
>
> *Gideon Lichfield, editor in chief, MIT Technology Review*

Finding Structure Without Losing Touch With Science

Many of us, having grown up being told about geniuses like Stephen Hawking and Albert Einstein, develop a sense that science is a series of breakthroughs made by maverick scientists. But those are the exceptions. Most of the time, science is a slow, gradual process that involves the collaborative efforts of dozens — sometimes thousands — of people with different backgrounds and skill sets.

When scientists first detected gravitational waves, the general public was enthralled. But people heard mostly from a handful of already esteemed scientists, which meant that many enthusiastic readers didn't realize that more than a thousand researchers, in various disciplines, had been crucial to the discovery.

When just three men received the Nobel Prize in Physics for the endeavor, *Popular Science* sought to **highlight the discrepancy**[12] in a print article that featured every single name listed on the study, and noting the work of a few of the scientists who hadn't yet been mentioned in press coverage.

But the solution isn't always as obvious as "give credit to the other 1,000 or so people involved." Sometimes, breaking down the false narrative of the lone genius means looking for characters who aren't scientists at all.

"It clearly serves the story well when you can make it about one character, their journey, their odyssey to solve the problem," says Gideon Lichfield, of *MIT Technology Review*. "But the reality is that science doesn't work that way a lot of the time."

Lichfield suggests solving that problem by finding a main character other than the scientist doing the research. Consider a story about **patients trying to get**

From xkcd.com

their problem cured[13] when nobody in the medical world is paying attention. Such a story can still be heavy on the science, but focusing on the people affected by the science instead of the people doing the science itself — that's a great way to avoid making it seem as if science is being done by lone geniuses.

Another misunderstanding about science comes down to the basic concept of "discovery." Individual scientific studies do not close the book on the subject they investigate. It takes years of repeated experiments and tweaked questions to come up with definitive answers — if there are any. Stories are meant to have beginnings, middles, and endings; in science reporting, an editor has to realize that conclusions are almost never neat and tidy.

> *"A common mistake for editors would be to take any given finding as gospel.*
>
> *Azeen Ghorayshi, science editor, Buzzfeed*

Azeen Ghorayshi, science editor of Buzzfeed, agrees. "There's this fake idea that scientists are infallible, that discoveries are made in a vacuum, and that the accumulation of knowledge is linear — when really all of it is so much more messy than that." The pandemic put this on display more clearly than ever, she notes. With Covid-19, "the production of knowledge is in overdrive, and information is being shared so rapidly that we're seeing all the mistakes and foibles and dramas play out in real time. At the end of it, we've definitely learned a lot about this virus. But a common mistake for editors would be to take any given finding as gospel."

That lack of clarity or certainty is a common challenge. Maddie Stone, of Earther, provides an example of this from her climate-change beat. "In climate journalism, editors and journalists alike have a strong tendency to impose the 'X is a problem, and climate change will make it way worse' narrative on just about any story," she says. But in a lot of cases, while scientists think that something might be exacerbated by climate change — a certain type of extreme weather, for example — because of data limitations or the newness of the field, we can't be sure.

Stone says editors should resist imposing simple narratives and instead embrace complexity. "Building uncertainty into our narratives, and telling important stories that subvert expected narratives, is not only intellectually honest — it gives readers a more complete understanding of how the scientific process works."

> *"The process of trying to find out why we don't know something often makes a great narrative for building a feature.*
>
> *Gideon Lichfield, editor in chief, MIT Technology Review*

"There is a genre of tech and science stories which is all about, 'These people came up with this thing, isn't it cool? Maybe it could be used to solve problem X, but it's too early to tell,'" says Lichfield. At the same time that it glorifies discovery, it also decontextualizes it, leaving readers none the wiser.

"The Covid-19 crisis has really clarified that for me," Lichfield continues. "What we found people were really looking to read were explainers. But at some point, it became less about explaining how things worked and more about explaining why we don't know how a thing works. It's very honest, and a way to describe how science is difficult. The process of trying to find out why we don't know something often makes a great narrative for building a feature."

As is the case with any other piece of journalism, finding a narrative starts with asking what story you're trying to tell. To summarize the sentiments above, a number of narrative tropes are *unlikely* to yield a scientifically accurate article that's useful to your readers:

- The story of the great scientist who solved a big problem.
- The story of a breakthrough discovery.

But scientific stories are rich with other potential angles. Taking a unique tactic can yield fascinating characters and narratives that don't inherently misrepresent the scientific process. For example:

- Focusing on people who are affected by a scientist's work, rather than on the scientists themselves.
- Finding ways in which a scientist or a method differs from the norm, and exploring what problems the scientist was working to avoid with this innovation.
- Exposing science's shortcomings — corruption, difficulty finding funding, misguided approaches to solving problems.
- Exploring how lesser-known members of the team — junior scientists, women, people of color, researchers with unusual backgrounds — contribute to the process.
- Asking why scientists turned out to be so wrong about something, or why a scientific problem is still too complex to solve.

Once you internalize these potential pitfalls and red flags, editing a science story into a compelling narrative should be no more difficult than doing so for another subject.

Additional Reading and Resources

Advice for Editing and Writing

- ***Storycraft: The Complete Guide to Writing Narrative Nonfiction*(Chicago Guides to Writing, Editing, and Publishing)**, by Jack Hart
- **Nieman Storyboard** — Articles from *Storycraft,* by Jack Hart
- ***Telling True Stories: A Nonfiction Writers' Guide From the Nieman Foundation at Harvard University***, by Mark Kramer
- ***You Can't Make This Stuff Up: The Complete Guide to Writing Creative Nonfiction — From Memoir to Literary Journalism and Everything in Between***, by Lee Gutkind
- **The Open Notebook**: A great resource for anyone learning to write about science.

Science Writing That Tells a Great Story

- "**Into the Gulf Stream: A powerful current just miles from SC is changing. It could devastate the East Coast"** (*The Post and Courier*)
- "**Long-Haulers Are Redefining COVID-19**" (*The Atlantic*)
- "**Hostile Waters: Orcas thrive in a land to the north. Why are Puget Sound's dying?**" (*The Seattle Times*)
- "**The Pandemic Experts Are Not Okay**" (*The Atlantic*)
- "**The answer to lactose intolerance might be in Mongolia**" (*Popular Science*)
- "**Florida scientists are working to solve greening. They were too late for Cee Bee's**" (*Tampa Bay Times*)
- "**This land is (still) their land. Meet the Nebraskan farmers fighting Keystone XL**" (*Popular Science*)

And One Example That Forgoes Story

- "**The most important science policy issue in every state**" (*Popular Science*)

About the Author

Rachel Feltman is executive editor of *Popular Science* and head of its Uranus-pun-loving science team, as well as the founding producer and host of "The Weirdest Thing I Learned This Week," *PopSci*'s podcast. Before starting at *PopSci*, in 2016, she ran an irreverent blog for *The Washington Post* called "Speaking of Science." Rachel holds a degree in environmental science from Bard College at Simon's Rock and a master's in science, health, and environmental reporting from New York University. She has a book about the history of sex in the works with Bold Type.

Endnotes

1 https://www.theverge.com/2018/10/29/18037436/google-news-feed-homepage-algorithm-facebook-twitter-radicalization

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11 https://www.popsci.com/uranus-hydrogen-sulfide-cloud/

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13 https://www.nytimes.com/2020/07/07/health/rare-diseases.html

06

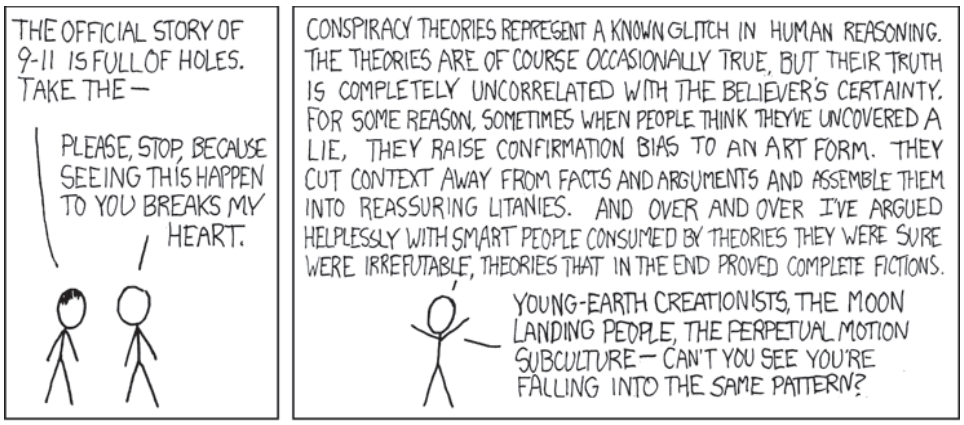
Editing Controversial Science

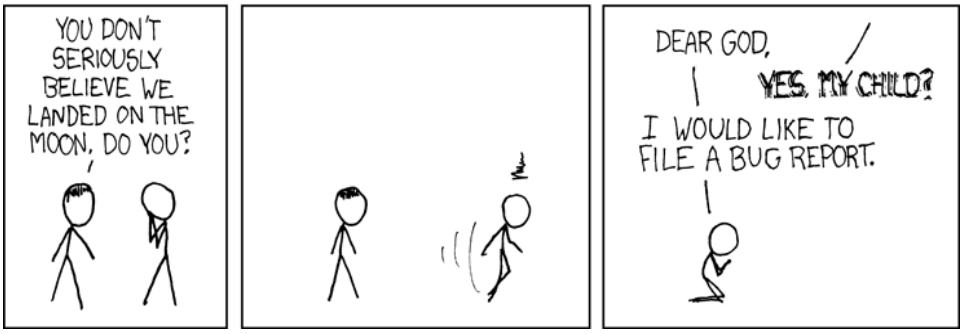
By Laura Helmuth

Introduction

Journalism is having a reckoning[1]. People inside and outside the business are re-examining the tension between truth and objectivity[2], questioning whose voices we amplify and don't, warning about the dangers of publishing both sides of a controversy when both sides aren't supported by evidence, and learning when to call racism racism and a lie a lie. The reckoning accelerated with criticism of coverage of the 2016 presidential campaign and of the Trump administration, and it has become more urgent with the coronavirus pandemic and the Black Lives Matter movement for social justice.

Science journalists have been grappling with these questions for a long time, and other areas of journalism could learn from our experiences. **Good science stories don't air both sides of a debate when only one is correct:** We don't include creationists in a story about evolution, climate-science skeptics in a story about climate change, or antivaccine activists in a story about vaccines. And when we cover creationism, science denial, or antivaccine activists, we make it clear that those views are contrary to the evidence. We call a conspiracy theory a conspiracy theory.





From xkcd.com

We evaluate the relevance of someone's expertise, and we don't trust people **solely on the basis of their credentials**[3]. An expert in one field might be very confident in a mistaken notion about another field, as we've seen with some amateur epidemiologists who have made bold predictions about the coronavirus pandemic. We generally know better than to quote a **Nobel laureate saying something bombastic**[4] about a topic outside his or her area of expertise. When a publication does make an error in judgment, such as when *The New York Times* quoted James Watson (co-discoverer of the structure of DNA) saying that another scientist "is going to cure cancer in two years" — that was in 1998 — the rest of us try to learn from it.

That said, controversy is a powerful elixir. It can draw the attention of people who don't usually follow science but who like a good brawl. Controversies often involve passionate characters who offer up arresting quotes. Presenting a science story as a controversy can help get attention within a publication as well — it's a framing that top editors and the guardians of the front page or home page understand. But like nuclear power, you should use controversy for good, not evil, and be careful of spills.

This chapter will cover how to tell the difference between a false controversy, a policy controversy, and a science controversy. It will examine issues of fairness, false hope, and how to protect yourself and your publication and writers from lawsuits. And it will have practical advice about how to *constructively* use controversy to get attention in a crowded news environment.

False Controversies

After the U.S. Supreme Court ruled in 1987 that public schools can't teach creationism as science, creationists got creative. They renamed their belief system "intelligent design" and used the language of science to make it look like a

legitimate field of study. The religiously conservative Discovery Institute created a **"wedge document"**[5] that laid out a plan to make intelligent design an alternative to evolution that **should be taught in science class**[6]. Their slogan appealed to people's sense of fairness and good pedagogy: "Teach the controversy."

Eventually the effort was shut down by the 2005 ***Kitzmiller v. Dover Area School District***[7] ruling, in which a federal judge (appointed by President George W. Bush) ruled that intelligent design was a religious belief, not a science.

But before that ruling, the intelligent-design movement manipulated journalism's "show both sides" sense of fairness to amplify pseudoscience and fringe scientists who distorted the fossil record and made baseless claims. Journalists were trapped — the issue was playing out before school boards across the country, and they needed to cover it. But by mistakenly adhering to the "objective" language of standard news reporting, some journalists false-balanced evidence from physics, chemistry, paleontology, geology, and biology with disproven claims that the bacterial flagellum is so complicated that it must have been designed.

Some of the most insightful criticism of the case came from outside journalism. The **Church of the Flying Spaghetti Monster**[8] endorsed Kansas' plan to teach alternatives to evolution, suggesting that teachers include their theory of pastafarianism. And a series of **"Teach the Controversy" T-shirts**[9] showed other theories that should be included in science class, such as alchemy, the idea that aliens built the pyramids, and that the earth is flat (which was funnier at the time than it is now that **flat earthism is thriving**[10]).

Science bloggers were rightly outraged that creationism was being sold as science, and they wrote clearly about the errors and misinformation that were being presented as a serious controversy by traditional journalism. It was quite a learning experience, and the whole ordeal showed the power of humor, clear language, and righteous indignation to communicate about science.

As Naomi Oreskes and Erik Conway have shown in their book, ***Merchants of Doubt***[11], many supposed controversies about science have been manufactured by people who stand to lose profit or prestige. Campaigns to obscure evidence about tobacco, DDT, and climate change cynically adopt the language and values of science and journalism. They turn the iterative, self-correcting nature of science into a reason not to trust any conclusions, and they weaponize journalists' principles of fairness and questioning authority.

Science editors should be on the watch for such campaigns, and then be prepared to cover them appropriately and effectively. Rather than present the controversy as a question of "Which side is right?," editors should make it clear that one side is casting doubt on the overwhelming evidence because it threatens that side's organization or industry. You can use the controversy to get attention

> ***"Don't assume the reader has been keeping up with the news or knows the background on the topic.***
>
> *Angela Fritz, general assignment editor, The Washington Post*

for the science, show how it's being distorted, stand up for the truth, and help audiences understand why it all matters.

Journalism students are taught to present the evidence and let the readers come to their own conclusions. But journalists, and especially science journalists, are increasingly realizing that's not enough. The evidence doesn't always speak for itself, especially for complicated or frightening subjects.

For example, the antivaccine movement is a conspiracy theory based on debunked and fraudulent claims. Stories about the movement should **say so prominently**[12] and make clear that **antivax misinformation endanger people**[13]. In reporting on leaders of the movement, journalists can, for example, relevantly refer to **Robert F. Kennedy Jr.**[14] as a **prominent antivaccine conspiracy theorist**[15] rather than an environmental lawyer.

At the same time, Apoorva Mandavilli, a reporter at *The New York Times* and a **former editor in chief of Spectrum**[16], a website on autism research, advises journalists not to forget that "there is always a human element to people's strongly held beliefs. Exploring a controversial theory's roots can lead to interesting and powerful stories, or help to build narrative tension within a story."

Tips for handling false controversies

- Clearly label falsehoods as such.
- Don't cover a claim unless it's already getting attention.
- Clearly describe the dangers of the false claim.
- Refer to proponents by their association to the false claim.
- Stand up for the truth.

An editor's biggest job is to decide what's worth covering, and that can be a tricky decision when it comes to false controversies. Famous people often share misinformation or disinformation, whether it's about vaccines or coronavirus or a flat earth. If the statements aren't getting a lot of attention already, don't cover them, since debunking can draw attention to a false claim that otherwise would have faded away. (Editors don't get enough credit in general for stopping bad stories.) When the false information can't be ignored — if it is being used to guide policy decisions — it is crucial to note clearly that the claim is false and to cover the falsehood as prominently as the claim.

An editor's second-biggest job is to write headlines. Those are the most important words in the story, and too often the only words an audience will see. For stories about false controversies — especially if they could have an impact on people's health — the headline itself should say that a false claim is false. For example, when President Trump speculated that injecting bleach could protect people from the coronavirus, *The Washington Post*'s headline began: "**Trump Floats Another Bogus Coronavirus Cure**[17]."

It's also important to recognize that your audiences aren't necessarily paying as much attention to these issues as you are. As Angela Fritz, a ***Washington Post* editor on the general-assignment desk**[18] who previously edited on the health-and-science desk, puts it, "Be clear about what the controversy is. Don't assume the reader has been keeping up with the news or knows the background on the topic."

Also be aware that writing about controversies takes extra effort. You and your reporters can and should expect blowback. "You do need to be realistic about whether you have the time to deal with a controversial topic," says Torie Bosch, an editor at **Future Tense**[19]. "It may end up requiring more-intensive fact-checking, legal resources, top edits from the top editors at the publication."

Policy Controversies

Every policy story should also be a science story. What is the evidence for or against a proposed policy? Teaming up science journalists with reporters and editors who cover policy can make your publication's coverage richer, more accurate, and more relevant — especially if you can help distinguish among false controversies, science controversies, and policy controversies.

In many policy debates, there is clear scientific evidence for one side or the other. Sarah Zielinski is an editor at **Science News for Students**[20], a site "dedicated to providing age-appropriate science news to learners, parents, and educators." She warns editors that when they are assigning a story in a controversial area, they should do their research. "Know what you're getting yourself and your writer into. Identify potential pitfalls early on — and strategies for dealing with them." And then be sure to "ground your story in science. It's harder for readers to complain when you've got data to back up your points."

For example, gun ownership is a charged subject. And while the National Rifle Association can claim that people should buy guns for their own protection, the evidence is overwhelming that gun owners are more likely than people who don't own guns to die of gun accidents, accidentally kill a family member, or intention-

ally kill themselves with their weapon. The science is clear, and science editors can help use it to inform urgent policy coverage about gun laws.

The evidence that fluoridated water is safe and prevents cavities is abundant and has been replicated in municipalities around the world. When a city votes on whether to fluoridate its water supply, the coverage should prominently feature the fact that there is no scientific controversy — one side has science to back up its advice to fluoridate, and the other has misinformation that endangers public health.

Debates about abortion policy are full of false claims about health and science, and editors should make sure their coverage presents the evidence and not just the advocacy. Women who have abortions are highly unlikely to regret their choice, for example, and the procedure does not increase their risk of mental illness or breast cancer. Reporters naturally pick up on the terminology and framing they hear from the people they interview. As an editor, you can flag loaded terms and ask for more specific, neutral, or scientifically accurate language. For instance, an "unborn baby" is an embryo or a fetus. A "heartbeat" in a fetus at six weeks of gestation isn't like a baby's heartbeat; it is medically known as **fetal pole cardiac activity**[21]. Avoid the term "pro-life," because it implies that the other side doesn't like life. Instead, specify the policy positions: A politician or organization supports abortion rights or opposes abortion rights.

> *"Ground your story in science. It's harder for readers to complain when you've got data to back up your points.*
>
> *Sarah Zielinski, editor, Science News for Students*

Genetic engineering, too, is loaded with loaded words, like "Frankenfoods" or the claim that scientists are playing with nature. There is **no evidence that eating genetically modified foods is dangerous**[22]. There is scientific debate about how various GMOs can be used to help or harm the environment. Coverage of policy debates about how and whether to label genetically modified products should flag false health claims, show who benefits from them, and explain what is and isn't known.

Science journalism is some of the best protection people have against health scams. In the United States, the Food and Drug Administration and medical-licensing organizations have been ineffective against those who use the language of clinical trials and experimental medicine to **promise miracle cures**[23]. More than a thousand "stem cell" clinics claim to cure arthritis, macular degeneration, **lung disease**[24], neurological disorders, and other conditions by taking people's fat cells, spinning them to isolate supposed stem cells, and then re-injecting them.

How to Use Science Journalism to Elevate Other Coverage

1. Ask what evidence there is to support for a claim.

2. Beware of loaded terms; use accurate and neutral language.

3. Separate policy debates from debates over facts.

4. Add explanations for how your journalism was conducted.

The policy controversies lie in how aggressively the FDA should **crack down on unproven treatments**[25], whether medical boards should penalize members for false claims, and whether desperate patients should have a "right" to try unproven remedies. Those are legitimate debates, but coverage should make clear that those providers have no evidence for their treatments and have **harmed people**[26].

When you're editing stories about controversial health claims, beware that people whose fortunes rely on misinformation, hope, and desperation tend to be litigious. When you're covering the **overblown marketing claims of nutritional supplements**[27] or safety problems with clinics promoting unproven treatments, for example, bring the lawyers in early and often. Focusing on science can protect you from libel claims. So can showing your work. Many articles taking on false or controversial claims now include a "how we did it" section up high that lists the number of sources, why some of them were anonymous, what documents were uncovered in the reporting, and which points were confirmed by the subject of the story.

Scientific Controversies

Editing stories about legitimate scientific controversies is *fun*. This is what a lot of people get into the business for: a robust debate about the nature of reality, new discoveries, and how we know what we know.

Some debates are around big questions: How did life evolve? Was the world dominated by RNA before we DNA-written creatures could emerge? Is our universe just one timeline in an endless multiverse? Was the earth once covered pole-to-pole in ice? Will the Yellowstone supervolcano ever erupt again?

Stories about those subjects tend to work best if they use some of the classic science-writing techniques described in other chapters here: Bring in the right experts, explain their evidence and their statistics, use multimedia to depict mind-boggling concepts, convey a sense of wonder and awe and exploration.

Other controversies mix science and ethics: Can and should we genetically engineer human embryos to eliminate disease genes? Can and should we use geoengineering to prevent the worst consequences of climate change? What is

the value of animal research, and how can it be more humane? And the big one, always: Who should decide?

These controversies require careful editing that brings in the best evidence for all sides, the most trustworthy ethics experts, the concerns of nonexperts, and more humility than some editors (speaking for myself here) might bring to other subjects.

Editors should also focus on the story's structure, says Tim Appenzeller, news editor at *Science*. "Avoid Ping-Pong. When sources differ, it can be easy to write the story as an extended back and forth — criticism, response, criticism, response. That can be dizzying and disorienting for the reader. Instead, after signaling to readers that there is controversy, it's often better to present one side's case in full, then get into the criticisms."

"Avoid Ping-Pong.… That can be dizzying and disorienting for the reader.

Tim Appenzeller, news editor, Science

Presenting these subjects as controversies invites readers to engage with the science. This framing can help audiences understand that there is a lot at stake, that there are smart and passionate people on different sides, and that readers should be part of the decision-making process.

You might also find that some sources might not be comfortable going on the record when it comes to scientific controversies. Evelyn Strauss, a freelance writer who was senior news editor of the former "Science of Aging Knowledge Environment" section of *Science,* suggests reminding sources of the public service they perform by speaking up.

"The key is to convey the truth that she is contributing positively to her field," and that "if she stays mum, she's contributing negatively," Strauss says. Remind sources that there are probably peers who agree and would appreciate the source's willingness to speak up and articulate this line of reasoning.

A dual profile can be an effective technique for humanizing a science debate and making it comprehensible. The proponents can represent the different sides of an issue and show why they matter so much to some people. As with any profile subject, be sure to vet these people, because profiling them can boost their careers and give them a lot of power. Screen out people who are jerks on Twitter; listen for whisper networks that someone is a bully or harasser; have your reporter talk with a lot of people in the field, including former students, to make sure the profile subjects are trusted and respected. Give consideration to the diversity of the people you profile. The person you're considering elevating as an important voice in a debate may be charming to deans but abusive to graduate students.

Considerations When Contemplating a Profile

- Is this person respected by peers?
- Does this person have influence in their discipline?
- Does this person abuse his or her position?
- What is the quality of this person's work?
- How does this person expand the diversity of voices you amplify?

Some science controversies are about enduring questions that will outlast any of our careers. Other controversies persist but really ought to go away. The ones of this kind that you'll encounter most often will probably come from nutrition science.

There's a perverse incentive to cover studies about the effects of various foods on health. People read the heck out of stories about red wine, chocolate, coffee, eggs, and other familiar foods, especially if the stories say our favorite foods are good for us. But **nutrition research is really hard**[28], and a lot of what's published in the literature turns out to be spurious correlations. The more we publish simplistic stories that merely reverse the advice in the previous simplistic stories, **the less likely readers are to believe them**[29].

Rather than publish stories based on single studies that support one side or the other, it can be effective to cover a heavily studied area of nutrition research with a variant of a controversy story. One approach is "It's not really a controversy." For example, some scientists argue that coffee is healthful, and others say it's dangerous, which sounds like a classic controversy. But they're both wrong, because if there were a big effect, it would be clear by now.

"Nutrition research is really hard, and a lot of what's published in the research literature turns out to be spurious correlations.

Another variant is the "controversy settled" approach. For example, largely on the basis of animal studies, some scientists say red wine can prolong life, a claim that has spread through pop culture. But other scientists have since gathered a lot more evidence that even small amounts of alcohol decrease lifespan (I'm so sorry). In this case, it's a controversy that got a lot of attention at first but has since been resolved.

Whenever you cover a science controversy, be aware of whom the controversial science could help or harm, and put the human consequences at the center of your editing decisions. This is important for technology stories, which often focus on how well a new device or algorithm works rather than on how it will be

used on real people. Artificial intelligence may seem objective, but it's based on human intelligence at every stage of development, with all the racism and sexism and other biases baked in.

And wherever possible, expose the politicization and false controversies about what should be evidence-based decisions. Broadening access to health care in the U.S. is a political debate, yes, but it means the **difference between life and death**[30]. Trumped-up controversies about **where the novel coronavirus originated**[31] have fueled racism and given cover to politicians who withdrew funding for international collaborations with China. And for the most important issue of our lifetimes, **climate change**[32], the science is not truly controversial, and neither is the need for fundamental change to slow down the catastrophe.

Practical Advice

Red Flags, Checklists, and Best Practices

For any science story, but especially for controversial subjects, beware of hype.

Watch out for red-flag words in press releases or an expert's self-appraisal of their research: *revolutionary*, *game-changing*, *breakthrough*. If a reporter turns in a story with such language, make sure it's in a quote from an independent outside source and not from the researcher who did the work. If it's the reporter's own words, make sure the research and the context and outside sources can justify the strong language.

Beware of the tempting trope of an outsider who claims to have a revolutionary new understanding or a fix for some disease or problem but is being thwarted by the establishment. Sometimes this is true: The theory of plate tectonics was rejected by most geologists at first, and Galileo was convicted of heresy for saying the Earth moves around the Sun. But as his biographer Mario Livio says, "**Galileo wasn't right because he was an outsider — he was right because he was right.**[33]" It takes a lot of evidence to overthrow the scientific consensus.

> *"Galileo wasn't right because he was an outsider — he was right because he was right.*
>
> *Mario Livio, Galileo biographer*

Beware of top editors trying to frame false controversies as debates. Many publications are run by people trained in political reporting, in which the formula is that every policy story should present the best case from each of two sides. You may have to explicitly address this expectation and say clearly: This isn't a debate story. This is an accountability story about misinformation.

Make sure the story format is appropriate. Do not publish an opinion piece

(which can't be debunked within the article) by a conspiracy theorist. Don't do a Q&A with someone who spreads false information, unless you're prepared to challenge every statement.

Photos and graphics have disproportionate power in stories about controversies, so be selective with them. Don't use photos of screaming babies cowering from needles if you're covering a measles epidemic; that's a trope of the antivaccine movement. For stories about the early days of the coronavirus pandemic, avoid photos of crowded markets that implicitly blame Chinese people, "othering" them because of where some shop for groceries. If you're covering the controversy over the usefulness of the Body Mass Index as a marker of health and you use images of overweight people, show them at normal activities rather than use cropped images that show their midsections but not their faces and perpetuate a blame-and-shame approach to weight management.

Encourage your reporters to be skeptical about surprising or miraculous findings. Scientists make mistakes, and **some scientists make things up**[34]. A lot of **exciting findings can't be replicated**[35], whether because of errors or statistical flukes. Just because a paper was published in *Science* or *Nature* doesn't mean it's true.

Make sure the research you're covering was properly vetted. Anybody can call a press conference, which is how **cold fusion was announced to the world**[36] in 1989. This was a classic outsider narrative: two physicists claimed they could create safe and cheap energy under simple lab conditions, and they got a lot of attention from credulous mainstream media before the claim was debunked.

Articles published on preprint servers before they've gone through peer review and been published in a scientific journal require an extra-extra level of scrutiny. Even if a study is peer-reviewed, have your reporters conduct their own peer review and run it by additional outside experts.

Check social media for responses. Twitter is an early warning sign that a publication was hyped, insufficiently peer-reviewed, or absurd. When *Science* published a controversial paper claiming that some microbes can replace phosphorous in their DNA with arsenic, experts **immediately debunked the claim**[37] on social media.

Does the story accurately and fairly represent all sides? If it's a genuine controversy, you want each side to present its best case. If it's a false controversy, you want to be accurate but make clear which side is supported by evidence and which one is endorsing debunked or discredited or conspiratorial ideas.

Consult the lawyers. Assume that any critical story will be met with legal threats. Lawyers can help you solidify it and protect your publication from lawsuits.

> ***"Readers should spend their attention understanding the science, the stakes, and the conflict rather than parsing elaborate language.***

Typically, you should bring the lawyers in after the story has been through the first round of edits but well before publication time.

Have you given everyone a chance to respond to criticism? If the story is breaking news about a media-savvy institution, like the federal government or a large company, you would typically give it until the end of the day to reply with a comment. If it's a longer-term project or involves less media-savvy groups, you might want to give 24 hours. If you don't get a response, say explicitly in the story that you sought comment to show you're doing your due diligence.

Use simple language when publishing stories about complicated controversies. Readers should spend their attention understanding the science, the stakes, and the conflict rather than parsing elaborate language.

It's not aliens. Whenever there's an unusual signal from a distant spot in the universe or an asteroid hurtling through our solar system, somebody raises the possibility that it's a sign of aliens. It's not, even if a **Harvard professor says it might be**[38].

It's not faster than the speed of light. If a team of physicists claim that they've detected particles traveling faster than the speed of light, **it's a calibration error**[39], not a fundamental upheaval of physics.

It's not a miracle cure for cancer, dementia, heart disease, or schizophrenia. Be especially clear that a new treatment isn't a miracle cure if the research is on mice. Lots of treatments that work in animal models of disease fail in humans, and most publications, in most cases, should not cover this stage of medical research. If there is an interesting controversy about a basic biological question, frame it as a search for understanding rather than an imminent cure, to avoid raising false hope.

And after a story appears, "be ready for sources to complain that the other side is wrong and you should not have quoted them," says Tim Appenzeller, news editor at *Science*. "Scientists sometimes have a hard time accepting that reasonable people can differ."

Additional Reading and Resources

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- Nathan Ballantyne and David Dunning, "**Which Experts Should You Listen to During a Pandemic?**" (*Scientific American*)

- Brian Deer, "**How the Case Against the MMR Vaccine Was Fixed**" (*The BMJ*)
- **Retraction Watch**, a source for examples of fraud or mistakes that make it into the scientific literature
- **SciLine**, a source for connections with experts, workshops, and fact sheets about controversial science subjects

About the Author

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07

Holding Science to Account

By Tom Zeller Jr.

Introduction

"Good science journalism stands apart from science," wrote Boyce Rensberger in 2014. The veteran science journalist and former director of the Knight Science Journalism Program at MIT — publisher of this handbook — was **lamenting**[1] news that the program would no longer produce the **KSJ Tracker**[2]. For nearly a decade, and through a weekly churn of blog posts critiquing science journalism the world over, the tracker served as both a watchdog and a conscience for the discipline — one that was sorely needed, Rensberger and others agreed. After all, one of the primary concerns among many journalists at the time was that science reporting was in crisis. Newsrooms across the country were shuttering their science desks as the industry contracted; ever-larger numbers of science writers were losing full-time jobs; and the rise of "science engagement" and "science communication" was blurring the lines between what might be called science boosterism and rigorous, journalistic coverage of science, warts and all (and there are warts).

In the end — and despite some worrisome inflections in the **memo announcing its planned phaseout**[3] — the function of the KSJ Tracker endured as a regular column in KSJ's successor publication, **Undark**[4], and then later as part of Undark's continuing mission: exploring science not just as a "gee-whiz" phenomenon, as we like to put it, but as a frequently wondrous, sometimes contentious, and occasionally troubling byproduct of human culture. Whether we do that successfully is for others to judge, but I distinctly recall the resonance of Rensberger's words for me as a longtime journalist who came to science-and-technology coverage from other beats, including politics and business, and later as we began conceiving of Undark.

Rensberger continued:

> *[Science journalism] serves the general public — the readers, viewers, and listeners — not the scientific community. ... It does not exist to 'communicate' to the public whatever the scientists and engineers want communicated. That's the job of a different breed of science writer – the public-relations person who stands with the scientists and serves their*

> *interests. Good science journalism is journalism first and must retain an arm's-length relationship to science. Its goal is not to increase public "engagement" with science.* **Its goal is to keep the public informed of what scientists are doing.**

Those are important words, though they can be easy to forget when our charge as editors is to cover "science" writ large. So much of the beat involves great feats of empiricism and human discovery that it would be easy — and gratifying — to feed readers a steady diet of "**wonky whale skulls**[5]" and "**scrotum frogs**[6]." Sure, those stories matter, too. But as with politics, business, urban affairs, sports, the arts, and every other human endeavor of interest, covering "what scientists are doing," as Rensberger put it, means being willing to uncover a world that is, yes, full of magic and light, but also infused with human frailty. Just like the White House and City Hall, after all, the world's universities, research institutes, commercial labs, and government science agencies can be bastions of both courage and cowardice, genius and bigotry, and deep currents of humility, self-interest, ambition, and greed. Research fraud, conflicts of interest, discrimination, and all manner of questionable research practices have long dogged the sciences — with **calls for reform growing**[7].

For some journalists covering science, those observations will speak to a familiar and motivating truth — one that might even border on the obvious. "One of the biggest deals to scientists themselves is money, and actually getting the grant funding to be able to do the work," said Azeen Ghorayshi, science editor at BuzzFeedNews. That's neither a good thing nor a bad thing, of course. Money is needed for good science — important science — to flourish. But if there is anything to be learned from the best political and business journalism, it's that money both enables and corrupts.

And yet many journalists forget to "follow the money" when it comes to science. The reasons for that, the British science journalist and author Angela Saini noted, can be self-evident. "Editors sometimes — especially on newspapers, or general-publication editors — see science as a kind of wacky extra, almost. They look for fun stories, new discoveries, that kind of thing," she said. "They don't see it as a journalistic beat in the same way as other topics always. And I think that's a mistake, because scientists and the scientific establishment have such huge power over our lives — not just in terms of what gets researched and what doesn't, and the findings of that research, but also in shaping how we think about ourselves."

> ***"Scientists and the scientific establishment have such huge power over our lives — not just in terms of what gets researched and what doesn't, and the findings of that research, but also in shaping how we think about ourselves.***
>
> *Angela Saini, British science journalist and author*

Any science editor seeking to orient a reporting team around a mission, Saini suggested, ought to be mindful of that power — and be willing to task writers with investigating it. "Sometimes people, especially if they come from a science background, get into this because they want to communicate the beauty and their passion for the subject and distill that down for audiences," she said. "But for me, in particular — I know this is not the case for everybody — but for me, this is also an area that needs to be interrogated."

New York Times investigative journalist and science reporter James Glanz described the science journalist's core mission more bluntly: "First on the list is raising hell," he said. "Raising hell is [number] one. You gotta raise hell. That's what I do for a living. I raise hell."

Not everyone in science journalism thinks that way, of course. Maybe you're a science editor who isn't interested in raising hell, or who finds such an oppositional posture off-putting, perhaps even inappropriate in the coverage of science. I'd like to use this chapter to convince you otherwise, and to provide some reasons why you might want to discover your inner hell-raiser. And for those of you already eager to mix things up and root out bad actors in science, I'll share some of my own thoughts, as well as those of a few journalists I admire — reporters and editors alike — on ways to move beyond "gee-whiz" coverage of science and report stories that keep the discipline and its practitioners in check.

"If we shine a clear light on the research enterprise, we do more than just tell an accurate story, although that's an essential part of this," said Deborah Blum, current director of the Knight Science Journalism Program. "We give science a chance to recognize and correct the flaws we illuminate — and we do our readers, our listeners, our viewers, the honor of treating them with respect."

One note: This doesn't mean that the wonder and mystery of science don't matter. They do. But just as a good political reporter ought to keep her antennae up for legislators on the make, and just as a good business editor knows how important it is to follow the money, a good science editor should be encouraging reporters to regard scientists openly and skeptically, though not cynically. Look beyond embargoes and press releases for the stories that researchers don't necessarily want publicized, and never forget that enthralling as science can be, scientists and the institutions that support them need tough watchdogs, too.

"I think that a lot of people — and it would be fair to include myself here — go into science reporting, medical reporting in my case, you know, really loving that subject," said Ivan Oransky, editor-in-chief at Spectrum as well as president of the Association of Health Care Journalists and founder of the science-accountability website Retraction Watch.

"Now, it's one thing to find a subject interesting," he added. "It's another thing to forget that the field is populated by human beings."

> ***"It's one thing to find a subject interesting. It's another thing to forget that the field is populated by human beings."***
>
> *Ivan Oransky, editor in chief, Spectrum*

Planting Flags, Luring Tips, Drawing Heat

Before becoming editor of the science-reporting team at Buzzfeed, Azeen Ghorayshi made a name for herself as a reporter on the desk covering sexual harassment in science. Trained as an undergraduate in molecular and cellular biology, and armed with a master's degree in science communication from Imperial College London, Ghorayshi said she arrived on the newly formed science desk in 2015. It was a time when the problem of rampant sexism in science departments was well-established.

"There had been lots of news stories talking about the leaky pipeline," she said, referring to the tendency of women to leave the sciences during their studies, "and sort of getting at the fact that there was this problem in science departments…. Why is it that so many women end up leaving as you go higher and higher up the chain? And there were many, sort of, microscandals that got at the sexism-in-science problem."

> ***"I think like one of the main tools we used was to just plant a flag.***
>
> *Azeen Ghorayshi, science editor, Buzzfeed*

The new science team at Buzzfeed, though, saw an opportunity to turn a powerful and important light on bad actors in science. They aggressively covered those "microscandals" — a 2014 **cover story**[8] in *Science* that was perceived by critics as casting transgender women in a negative light, for example (the editor in chief at the time, Marcia McNutt, now head of the National Academy of Sciences, **issued an apology**[9]), and the **sexist commentary**[10] of the Nobel laureate Tim Hunt at a 2015 conference in Seoul. (Hunt would eventually resign from his teaching post at University College London, and from the European Commission's Science Council as well.)

That coverage, Ghorayshi said, set the stage for a tip that would lead to an explosive — and exclusive — **report**[11] on a sexual-harassment investigation of the astronomer Geoff Marcy at the University of California at Berkeley. While other news outlets, including *The New York Times* and *Science*, had done their own reports on the scandal, which included charges of sexual harassment involving several women over nearly a decade, it was Ghorayshi, at Buzzfeed, who broke the news to the wider public. That scoop revealed Marcy to have been credibly accused of "inappropriate physical behavior with students, including unwanted massages, kisses, and groping — repeated instances of sexual harassment."

The result of a months-long investigation by the university was that Marcy — a pioneer in the study of exoplanets who cultivated frequent media appearances and was considered by some to be in line for a Nobel Prize — had been given merely an admonition with "clear expectations" for better behavior. Frustrated by the lack of a more robust response, the complainants went looking for a media outlet that might care to know the details of the closed-door investigation. They found one in Buzzfeed, and Ghorayshi said that was no accident.

"I think one of the main tools we used was to just plant a flag, and to signal to readers that this is a topic that we were interested in, and sort of doggedly cover that," she said. "And also tell people, we are here to hear your pitch, you know? So, I think in a way we sort of telegraphed that this topic was one that was really central to our desk."

The best accountability stories, Ghorayshi said, need to come from folks on the ground: postdocs in university labs, bench technicians in private research organizations, even administrative staff members inside the bureaucracy of a government science agency, who are witnessing things going wrong. You want those people to think of *you,* Ghorayshi said, when they have the itch to go public with what they know.

"When the people came along who had gone through a whole investigative process at U.C. Berkeley, and had put together a complaint detailing sexual-harassment allegations stretching back almost a decade, and then after … Berkeley proceeded to not do anything about it — once those people who had filed the complaint were frustrated enough, and they had sort of exhausted all the other options of going through the laid-out processes within their institution to address this, at that point they were like, 'We need to go to someone to get this news out,'" she said. "And we were there — in a whole newsroom also, I should say, that was reporting a lot on sexual assault and Title IX and issues, campus issues — we were there for them to come to."

Now that she's the editor running all of Buzzfeed's science coverage, Ghorayshi said, she's gratified to see her team continuing that sort of approach — and it's one she suggests that editors ought to encourage in young reporters: **Build up a drumbeat of coverage in a specific area so that whistle-blowers and tipsters know you're out there.** That strategy, she said, has been paying large dividends for BuzzFeedamid the coronavirus pandemic.

By way of example, Ghorayshi pointed to the work of one of her reporters, Stephanie M. Lee, whose coverage of **p-hacking**[12] and other research misconduct helped to lay the groundwork for a number of Covid-19 scoops, including several stories relating to the controversial research on coronavirus infection and death rates by the Stanford professor John Ioannidis. From covering **troubling sources of funds**[13] underwriting his research and **misguided advocacy campaigns**[14] early in the pandemic, Lee has positioned herself as a go-to reporter for information on questionable coronavirus science.

That's the sort of journalism that Jim Glanz, of *The New York Times*, also encourages. He recalled an early **story**[15] in the mid-1990s, when he was writing at *Science* magazine, that dealt with the science community's enthusiasm for the International Thermonuclear Experimental Reactor. "It was getting all kinds of, you know — I'm trying to not swear here — it was getting all kinds of coverage that

just sort of kissed up to this international collaboration, you know, 'infinite energy,' and 'You can use the material from the oceans,' or whatever. Well, what I found was that there was this young insurgent group of physicists who had discovered that it was going to be leaky. It couldn't hold the heat, because of turbulence on the edge of the reactor, and nobody would listen to them. And the senior people who bought into this giant international collaboration and were afraid to ruffle the feathers of the people who were providing the money… just would not listen."

"You have to approach it like that City Hall beat.

James Glanz, reporter, The New York Times

The resulting story carried the headline "Turbulence May Sink Titanic Reactor" — and Glanz said the turbulence he kicked up was memorable. "I have never had anybody scream at me as loud as those physicists did when that story broke. And it was right. They had to redesign the entire thing. They would not listen, you know? They weren't going with the best science. They were going with their institutional directives. And it would have been a $10-billion disaster. Instead they had to deal with an unhappy story and pick up the pieces and scream at me." (Remember, as George Orwell or William Randolph Hearst or Katherine Graham **once quipped**[16]: "News is what somebody does not want you to print. All the rest is advertising.")

And how did Glanz's blockbuster come about? It wasn't magic, he said, and it certainly wasn't because he was reviewing the reactor's technical plans. He simply listened — and came to the issue with what he called "a prepared mind." That means both reading up and, more important, talking with scientists informally, at the margins, rather than waiting for embargoed press releases and the slow drip of peer review to dictate coverage. It means being in a mental space, Glanz said, that is prepared to receive — and recognize — an actionable tip when it lands.

"How did I figure that story out? Wandering the halls of a conference," Glanz said. "I wasn't going for somebody's dog-and-pony-show talk. Somebody pulled me aside and said, 'Have you heard?' Now, obviously you have to check these things out. But it was my first lesson, or one of my first lessons: that science, as wonderful as it is — and I'm a former scientist, right? — as important as it is to the world, to our society, and as respectful as I am, as a person, of science, you have to approach it like that City Hall beat."

If you're an editor overseeing a team of reporters covering science and you're not encouraging your team to cover science like City Hall, and to cultivate sources and leads and tips outside the routinized, PR-controlled world of science conferences and science publishing — at least some of the time — then, Glanz suggested, "you're not doing anybody a favor."

The Takeaway

Encourage your reporters, among other things, to…

- **Make small talk with scientists and researchers.** Tips and inside information are often the fruits of casual, untargeted conversations.
- **Learn the power structure.** Who are the decision-makers within a scientific organization? How do influence and power move up, down, and laterally?
- **Don't overlook support staff.** Administrators, clerks, research assistants — all of them are privy to information that can lead to important stories, or stories that their bosses would rather not be told.
- **Look for the counternarrative.** The news that emanates from press releases is crafted to cast scientists and their institutions in the best possible light. But are there other stories lurking beneath?
- **Plant those flags.** Identify themes of coverage that you want to "own," and spend time publishing shorter, iterative stories on that front. In time, the tips will come.

Oh, and another useful observation from Glanz: "If someone is raising their voice with you, that sorta tells you something."

Questioning Scientists' Motives — and the Status Quo

Back in 2017, the British science writer Angela Saini and Jonathan Leake, the London *Sunday Times* science editor at the time, did not agree on whether a new **study**[17] out of Erasmus University, in Rotterdam, was worthy of coverage. The study purported to find that men's brain size, larger on average than that of women, results in a higher average IQ compared with women's. Such research was familiar to Saini. Her **2017 book**[18], *Inferior: How Science Got Women Wrong, and the New Research That's Rewriting the Story,* excavated the long history of male-dominated research making unsubstantiated claims about women's intelligence — often based on dubious and **scientifically fraught**[19] measures like IQ tests and tenuous correlations to brain size. So it was surprising to her, she said, when Leake reached out for comment as he prepared to cover the study.

But it wasn't just this long history that informed Saini's wariness. She looked into the Erasmus U. researchers and found some troubling associations. Among them: Two of the authors of the paper had previously published work alongside the **controversial British psychologist**[20] Richard Lynn. The Southern Poverty Law Center describes Lynn this way:

> *An unapologetic eugenicist, Lynn uses his authority as professor (emeritus) of psychology at the University of Ulster to argue for the genetic inferiority of non-white people. Lynn believes that IQ tests can be used to determine the worth of groups of people, especially racial groups and nations. The wealth and power of nations, according to Lynn, is due to their racial intelligence and 'homogeneity' (or 'purity'). He argues that the nations with the highest IQs must subjugate or eliminate the lower-IQ groups within their borders in order to preserve their dominance.*

Lynn is also editor in chief of ***Mankind Quarterly***[21], a "journal of anthropology" founded in 1961, and described in *The Atlantic* in 2010 as a "pseudoscientific" publication started, in part, by "a Nazi doctor who conducted experimental genetic research on cadavers he obtained from Auschwitz." (The current RationalWiki **entry**[22] for *Mankind Quarterly* is less circumspect, calling the journal simply a "far-right racialist pseudojournal." Are those characterizations fair? Lynn and others might not think so — but from Saini's perspective, they were enough to call into question the motives of researchers seeking purportedly scientific grounds for establishing the inferior intelligence, on average, of women — an idea that, she argues, has long ago been debunked.

Saini said she provided comments to Leake just the same, although she hoped that her suggestions regarding the scientists' motives would dissuade him from covering the research at all. They did not, and the piece was published in *The Sunday Times* on July 2, 2017. It was a breezy take, overseen by Leake as the science editor, and it touched on the politically charged nature — both historical and contemporaneous — of such lines of research. It ended with Saini's unequivocal quote: "For more than 100 years, male anatomists and neuroscientists have sought to find evidence of women's intellectual inferiority by comparing their brains to those of men. It's surprising that in the 21st century, those efforts haven't ended."

> ***"It also takes having real rigor in terms of what things you decide to skip.***
>
> *Azeen Ghorayshi, science editor, Buzzfeed*

It was disappointing, Saini told me recently, that *The Times*'s editors decided to cover the study. "It kind of disappointed me, because now you're just pandering. We have to exercise some judgment as well, as science journalists. I think that's part of the responsibility that we have to the public." *The Times* wasn't the only publication to cover the study, and Saini said she understood, at some level, why. It's a contentious topic likely to generate attention. And it's also likely, she conceded, that some editors simply might not know to question the legitimacy of the studies they cover. "If you're new to the area, it might have looked legitimate. It's one of the issues that we say … there's a big spectrum in terms of quality in scientific publishing, academic publishing. And it's not always easy to tell where a study lies on that spectrum."

Azeen Ghorayshi, science editor at BuzzFeed, said something similar in contemplating the role of science editors amid the current deluge of Covid-19 studies. “It also takes having real rigor in terms of what things you decide to skip,” she said. “There are a lot of single studies coming out in the course of this pandemic that have been, after the fact, called out as problematic. And they’ve gotten a lot of attention. So it’s a real balancing, I think, in terms of figuring out which things to decide to cover.”

As a science editor, Leake could have — and in my view, probably should have — known better than to give coverage to a study in such a highly charged and sensitive area without more rigorously investigating its pedigree. But, again, the siren call of an attention-grabbing headline can be difficult to resist. And for his part, Leake saw the issue of the Erasmus study differently. “The key aim of a science journalist is to try to work out whether research is both newsworthy and scientifically worthy,” he said in an email message. “The number of papers published is huge — but very few are of general public interest. For the few that are, the reasons vary — sometimes it’s just because the science is fascinating. Other times it’s because the science is not just interesting but also controversial, often meaning it has uncomfortable implications for the way we live or think about each other.”

Leake acknowledged that the research out of Erasmus U. was controversial, but he aergued that the academic authors came from respectable research centers, and that while *The Sunday Times* welcomed and sought out Saini’s countervailing views — including them at greater length than even those of the scientists themselves — her suggestion that the authors were politically motivated and linked to the alt-right were provided without proof. He also said the findings “raised interesting questions not just about the topic itself but also about the freedom of scientists to conduct such research — and the potential political impacts it can have. I hope we addressed all those points.”

Still, in a follow-up email, Leake, who has since left *The Times*, said Saini’s concerns about the research were intriguing. They suggest, as he put it, “that there is a group of academics holding positions in prestigious universities who are using those positions to conduct research to ‘prove’ a prejudice originating in their politics, rather than real science. We missed this at the time but, if provable, it could have been a much more important story or follow-up. Maybe it still could be.”

The Takeaway

Science editors ought to encourage their reporters to chase this story, and others like it. While there are surely legitimate, empirical efforts to understand and explore hot-button issues like race, gender, and other matters at the intersection of biology and culture, these areas are also often replete with dubious motives

and/or bad science. And even where the science isn't poorly executed, the mere fact that there are divisions among researchers and other stakeholders over what these lines of inquiry are really designed to prove, or whether they are worthy of investigation at all — particularly when society faces so many other pressing matters — is itself a fruitful area for your journalists to explore. Deciding what to cover, and what not to, is a responsibility that science editors ought to take seriously. It matters.

Standing Apart From Science

In the spring of 2016, not long after the launch of **Undark**[23], we commissioned a story from the veteran science reporter Charles Schmidt on the collapse of the National Children's Study, a 14-year, $1.3-billion taxpayer-funded effort, overseen by the National Institutes of Health, to understand childhood disease. The study was shuttered in 2014 under a cloud of professional ineptitude and mismanagement. Schmidt's was the most comprehensive accounting of that failure, and to date it remains, in my estimation, one of Undark's **finest pieces of journalism**[24]. But getting there was not without its struggles, and a particular episode that unfolded between the editing staff and the reporter — shared here with Schmidt's blessing — can, I think, help foster some useful thinking on the role of science journalists, when deference to scientific or academic sources is warranted — and when it is not — and how editors can best nurture the sort of journalism and scrutiny that readers expect and deserve.

The incident involved the word "jerk." It was used by Lynn Goldman, dean of the Milken Institute School of Public Health at George Washington University and a longtime adviser to the National Children's Study, to describe Steven Hirschfeld, a pediatrician who took over as acting director of the study in 2009, and whom many critics described as both inexperienced and dismissive of expert advice. The description was made in an on-the-record interview — though Schmidt did not include it in the draft of the piece he submitted. Rather, it surfaced via a transcript of the interview, which he had turned over to Undark's deputy editor, Jane Roberts, for fact-checking.

Hirschfeld, Goldman said, "was a jerk."

The short version of this anecdote: We thought the sentence above should be included in the story. It was made on the record, and it spoke much more candidly to the sentiments of the study's frustrated and, in truth, angry critics — far more clearly than the watered-down, hedging, and PR-approved constructions that many NIH scientific advisers and staff members had issued. But we were already

at the end of the story-production cycle, the piece was scheduled to run that evening, and Schmidt was not having it. He took offense to our second-guessing of his reporting, and he protested that while the quote was, indeed, entirely on the record, he considered Goldman a "friend" and felt she would be embarrassed, or even angered, by its inclusion. In the end — and after a frenzied evening of phone calls and recriminations, we agreed to remove the quotation marks and to soften Goldman's sentiment, which referred to Hirschfeld's stepping in to replace a problematic predecessor.

Hirschfeld, Goldman said, was no better — and in some ways worse.

That's how the story ran in May 2016 — and it was a powerful story. But the episode still bothered me, and it raised a number of questions. What is the role of science journalists, and whose interests do they serve? The readers? Their sources? Both? What is the role of the science editor in communicating standards, expectations, and mission? At what point should science editors push their reporters to self-examine, and when should they back off?

In a post-mortem email to our staff, Schmidt said that he had probably overreacted to the insertion, and that as the clock ticked toward publication that evening, he felt he had no time to properly consider the issue. But he also defended — somewhat less vigorously — his decision not to use the quote in the first place.

> *My concern was the quote was too strong, since Goldman had been so reluctant to go on record in the first place. If she had had no problem with going on record, then fine, but I didn't want to anger her. I called her a "friend" in the voice mail, but I was emotionally ramped up at the moment. Really she's an acquaintance, someone I've met at various meetings, and we are friendly with each other. She always returns calls and is an agreeable source. In hindsight, Tom, you are right, having her call Hirschfeld a jerk would have made for a stronger transition. I'm actually on the fence with it right now.*

At the risk of seeming indulgent, I include most of my lengthy response below, because I do think it highlights the role that editors can play in advising science reporters to consider their obligations and allegiances. Now, did I fumble in my handling of this incident? Probably. In hindsight, I should have simply delayed publication until we could have a more full and fruitful conversation about it. And surely some reporters will take umbrage at the idea that editors and fact-checkers might peruse notes and transcripts and second-guess their decisions on what to include. I get that.

On the other hand, this wasn't just about sticking with a punchy quote. Many journalists — editors and reporters alike — might feel that agreeing to soften the language in deference to a powerful source was the wrong move. Here's what I told Schmidt:

For my money, the goal of journalism is to uncover candor and truth wherever we can. Too often we have to settle for overly massaged, PR-tested and hopelessly neutered bullshit commentary from powerful people, whether in the corporate world, government, or academia. These do a disservice to readers because they aren't real, and they are usually designed to hide — or at least obscure — what is often a much more raw and vivid truth.

This is why I pushed you ... to insist that Goldman stand by her words publicly, rather than try to take the bite out of them after the fact. The truth of the matter is that she was very much inclined to bite when speaking candidly and on the record weeks before, and the anger and frustration embedded in the word "jerk" spoke volumes. It was a truly human moment, one that would have resonated with ordinary readers, ordinary taxpayers, everyone who has ever run into an asshole boss or a vindictive co-worker, and of course all the mothers and fathers with the kids who agreed to participate in this study, to open their lives and their bodies — and those of their children — for a higher cause, only to see bunglers in Washington fuck it all up. We do our journalism for them, and the word "jerk" would resonate with them because they have probably thought it themselves — and because they are human, too.

It's also worth noting that most of those ordinary readers don't have big titles and communications staff to help them hide their humanness simply because it's politically expedient. One of our goals as journalists ought to be to prevent the Lynn Goldmans and Francis Collinses of the world — just like the Obamas and the Trumps and the Clintons — from hiding the true view of things whenever we find the opportunity to do so.

For his part, Schmidt responded positively. "Part of the problem here was that I came up in the science trade press, where editors tend to give sources a lot more control over their input," he told me at the time. "When you would push me to push sources, my conditioned instincts were literally to think, 'Wow, can I do that?' It really came as a jolt — routine to you, I'm sure, since you're coming from the *NYT,* but not to me. Not to belabor, but … what you encouraged me to do in my writing for Undark — specifically holding sources to what they really said in the moment — is liberating for me as a journalist, even if it's taken some getting used to."

The Takeaway

On the science beat, you may be more likely than on other beats to come across reporters who, while talented and dedicated, haven't been fully exposed to some of the fundamentals of journalism — including the importance of maintaining distance from their subjects and their sources. Many science journalists, after all, get into the discipline precisely because they love science — and why not? It *is* fascinating. But it is incumbent upon you as their editor to remind your reporters that scientists are human, that their actions and interactions can, as with any discipline, be influenced by money, politics, and professional rivalries. It

is your team's job to document that accurately, because at the end of the day, the reporter's primary allegiance — and yours — is to the public, not to science.

This episode puts me in mind of something *The New York Times*'s James Glanz told me. He has a Ph.D. in astrophysics from Princeton University. He also spent many years as the newspaper's Baghdad bureau chief. He is back to writing about science now, but he says that's no different than covering city politics or business. "If you want to make a living doing this, and if you want to break stories that are really meaningful, you have to challenge authority," he said when I asked him for his perspective on science journalism, and how editors should encourage their reporters to approach it. "You have to be aggressive."

Playing the Watchdog and Plumbing for Documents

The story of Ohio State University's Dr. Carlo Croce is Shakespearean. He had long enjoyed a reputation as a lion of cancer research, but a less visible record of misconduct allegations and charges of data falsification burst into the open in the spring of 2017, when the science reporter James Glanz and the data reporter Agustin Armendariz dropped a nearly 5,000-word bombshell on the front page of *The New York Times* under the headline "**Years of Ethics Charges, but Star Cancer Researcher Gets a Pass**[25]."

Funded by more than $86 million in federal research grants, which in turn bestowed millions of dollars on Ohio State (and perhaps provided a disincentive for the university to vigorously investigate any charges against its celebrated cancer researcher), Croce was described as a "case study of the complex and often countervailing forces at work as science seeks to police itself." But the *Times* story itself was a case study in how the fundamentals of investigative reporting, and the editing structure supporting it, can and should be adroitly applied to science journalism.

In their reporting, Glanz and Armendariz conducted a sweep of any and all available public records related to Croce. Ohio, it turned out, "is paradise for open documents," Glanz told the editor Susan Lehman in a **deconstruction of the story**[26] published in *The Times* the following day. (Glanz declined to discuss the story with me directly, on the advice of *Times* counsel.) Of course, as any journalist knows, public-records laws are often only reluctantly followed by the governments and public institutions compelled to act on them. But in this case, the reporters got lucky in late 2016, with a bumper crop of emailed documents

related to Croce's work. "The documents arrived," Armendariz told Lehman, "and lights just started shooting out of the box."

The lights that emerged from those documents, as well as from deep dives into other publicly available databases — including at the University of California at San Francisco's Tobacco Control Archive, which contains decades of records — was a tale of a researcher with a knack for drawing money, and a university captured by what seemed to be a clear conflict of interest in being Croce's arbiter when charges of misconduct surfaced. (**Science editors take note:** There are lots of universities out there, and there are lots of Croces.)

The story had a long afterlife: Croce sued the *Times,* and the reporters, for libel. The case was dismissed, appealed, and thrown out again in 2019. (As it happens, Croce has **recently been sued**[27] for unpaid fees by the law firm that represented him.) More important, the story illustrates the role that science editors and their reporters can play in keeping the practice of science — which involves, after all, **billions of dollars**[28] in federal funding — on the straight and narrow. Sure, there are other watchdogs: for example, the Office of Research Integrity, in the Department of Health and Human Services, is nominally charged with investigating instances of research misconduct, mostly in areas of health and medicine. But in many cases, it falls to individual universities to investigate their own, and there are real questions as to how well and how vigorously these institutions do that, particularly with faculty members who draw big research grants, money from which is always peeled off for the institution's general use.

Ivan Oransky may well know this better than anyone. Having founded **Retraction Watch**[29] in 2010, he and his collaborator, Adam Marcus, have spent a decade tracking fraud and corruption in science. One thing he's learned is that, like the Catholic Church, the university system has a way of passing bad actors around. This was, in fact, the subject of an investigative piece **jointly produced by Retraction Watch and Undark in 2018**[30], and it all started with looking through science journals' retractions.

"Adam and I have built a whole thing … around finding problems in science that are hiding in plain sight, right? Retraction notices. I mean, there are 1,500 of these a year," Oransky said. "Are they all interesting? No. But there are far more of them than Adam and I — and even if you add the small but really growing and really smart group of reporters who are also thinking that way now — can handle. So, like, go to town. We **have a database**[31]. It's openly available."

Meanwhile, multiple editors and reporters I spoke with say the Freedom of Information Act is underused in science reporting. "I think at a high level," Oransky said, "FOIA is a really important tool for science reporting, just as it is for other kinds of reporting." Keep in mind that most public research universities are subject to FOIA by dint of being public.

The Takeaway

The importance of enterprise journalism is easy to forget in a discipline often doubly tasked with covering the detection of a black hole or a previously unknown organism in the deep ocean. Those stories matter, too — and they have clear economic value. After all, they are the bread and butter of science sections, drawing readers and eyeballs in ways that many other stories cannot. But science editors are uniquely positioned to task their reporters, at least some of the time, with peering into the corners of the scientific enterprise that individual researchers, universities, and regulators would prefer remain in the dark. As an editor, point your reporters to databases where they can dig for leads. Set goals for filing FOIAs — even as fishing expeditions; you never know what you might catch. And remind your teams to always be skeptical, inquisitive, enterprising, and tough. (Also, I agree with Glanz: Raise some hell.)

Cultivating these sorts of sensibilities in a team of reporters should be every science editor's goal, the British science writer Angela Saini told me — especially if their team is young, or they don't have a lot of experience covering other topics. She didn't have that problem. "I was lucky because before I went into fund [nonprofit-supported] journalism, I was working with the BBC. And one of my jobs was … to doorstep people. I don't know if you have a phrase for that in the U.S., but it's essentially where there's some provocative story and you have to turn up to a politician's house early in the morning, wait for them to leave, and then confront them. It's not a fun thing to do, and they usually make the youngest person do it.

"But you learned very quickly to not take 'no' for an answer."

Additional Reading and Resources

Countless resources can be of use in doing research on subjects or digging up potential stories. Here are just a few.

Finding Stories

- **MuckRock:** Nonprofit organization that helps journalists — and any other citizens — make requests through the federal Freedom of Information Act and analogous state-level sunshine laws

- **Retraction Watch:** Searchable database of retractions by scientific journals
- **Office of Research Integrity:** U.S. government agency that focuses on investigations of federally funded research misconduct, particularly in the areas of health and medicine
- **Knight FOI Litigation Fund**

Reporting Tools

- **Bellingcat's Online Investigative Toolkit:** Satellite and mapping services, tools for verifying photos and videos, websites to archive web pages, and much more.
- **ProPublica Dollars-for-Docs Database:** Tracks pharmaceutical companies' payments to doctors
- **ProPublica Nonprofit Explorer**
- **Chrono Download Manager:** Quickly download whole websites. Useful for government sites.
- **The Accountability Project:** Standardizes and indexes public data to give journalists, researchers, and others a simple way to search across otherwise siloed records. The collection includes 891.4 million public records so far.

Education

- **Free Google News Investigative Reporting Course**
- **AAAS Kavli Winners' investigative Tips**
- **BMJ Glossary of Scientific Misconduct**
- **International Committee of Medical Journal Editors**

About the Author

Tom Zeller Jr. is an American journalist who has spent more than two decades covering energy policy, poverty, science, technology, and the environment for a variety of national publications, including 12 years as a staff reporter and editor at *The New York Times*. He is the founding editor of **Undark**, an independent digital magazine devoted to coverage of science in the public interest. Under Zeller's leadership, Undark's journalism has been included in the "Best American Science and Nature Writing" book series and honored with numerous awards, including the George Polk Award for Environmental Reporting and the Al Neuharth Innovation in Investigative Journalism Award from the Online News Association.

Endnotes

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08 Covering Health Care

By Erin Brodwin

Introduction

Health care in the United States is a fraught business. For you, as an editor of health-care stories, your most valuable asset is your skeptical eye: Powerful institutions shape much of the narrative but often cause unseen harm to patients and consumers along the way. These institutions include health-insurance companies, hospitals, drug makers and — increasingly in recent years — technology behemoths, as well as their public-relations apparatus.

By comparison, patients and society do not possess the financial capital, time, or professional support to thoroughly vet the claims made by drug makers, hospitals, insurers, or tech giants, nor do they have public-relations professionals working on their behalf to present their needs to those institutions. The U.S. health-care system prioritizes later-stage, costly procedures and cutting-edge technological innovations over basic, quotidian care.

This results in worse outcomes for patients and society, and has significant implications for journalism: Although innovative surgeries and glamorous new medical devices often receive more attention, everyday interventions focused on increasing access to basic care are at least as important, if not more so. The incentive structures underlying the U.S. health-care system — more money for more "care," more and better care for the insured than for those without insurance — mean that underrepresented groups, particularly Black Americans and other people of color, experience disproportionately worse care — and receive less care overall — than white Americans do.

Your job as editor is to play the triple role of storyteller, watchdog, and investigator. The stories you edit should be fair and balanced — not because they present two opposing views, but rather because they weigh equally the potential benefits of every new treatment or intervention with its potential risks and harms to patients and to society.

Peer-reviewed medical research provides one key means of cutting through the

> ***"We want patients to receive the best care available. We also want consumers to pay less. And we don't want to bankrupt the government or private insurers. Something must give.***
>
> *– Sendhil Mullainathan, Roman Family University Professor of Computation and Behavioral Science, University of Chicago Booth School of Business*

noise generated by pharmaceutical companies, insurers, and the like. So I've devoted a large section of this chapter to reviewing best practices involving studies. Even clinical trials, however, are subject to bias and conflicts of interest. Keep in mind, for example, that most medical-research involves white males, even though the demographic groups that experience the worst health-care outcomes in America include Black men and women of color.

Meanwhile, health-care inequity is expected to worsen. In 2018, **the proportion of Americans without health insurance rose**[1] for the first time in a decade; that figure is predicted to grow even more on the heels of the coronavirus pandemic and its resulting job losses.

Because of these challenges, your job is now more important than ever. The stories you will edit will help draw attention to injustice, analyze new health technologies and discoveries, and debunk dangerous misinformation.

And the stakes are high. Just as a slip-up in the operating room can impair a patient for life, a misleading or erroneous health-care story can spur a vulnerable patient to seek out something dangerous without understanding its consequences. Similarly, stories that further stigmatize critical issues, including mental illness and disability, can keep someone in need from seeking care.

Here are some basic pointers to keep in mind as you make your way through this chapter.

Don't

- … use the word "cure."
- … treat a press release as a research study.
- … assume that because a study has been peer-reviewed, it is free from bias or other limitations.

Do

- … use words like "treat" and "address."
- … review the evidence, possibly with the help of experts.
- … encourage reporters to be mindful of potential gaps or limitations in research, especially with regard to race, gender, and potential conflicts of interest.

Now that you've had a chance to review the basics, let's dive in.

Cover Your Bases

Because true breakthroughs are rare in health care, one of your primary tasks is to ensure that the framing of stories — from headline to conclusion — about new interventions or treatments balances potential benefits with potential risk or harm. You should familiarize yourself with the regulatory process by which medical products and interventions enter the market. In most cases, new interventions, whether tests, drugs, or other treatments, are overseen and reviewed by the Food and Drug Administration. After a thorough review, the agency may grant some level of clearance, authorization, or approval to a given intervention. Each label implies a different level of scientific rigor, with "approval" being the highest and most difficult to earn. Do not call a new intervention "FDA-approved" in a story unless you are certain that that is the case.

FDA Terms Glossary

- **Approved:** This is what most people think of; it means that the safety and efficacy of a product have been demonstrated to and reviewed by the Food and Drug Administration. Only about 10 percent of medical products gain FDA approval.
- **Authorized:** Products that have been "FDA authorized" have been granted an "Emergency Use Authorization" to allow limited-time use in an emergency to diagnose, treat, or prevent serious or life-threatening conditions when there are no adequate, approved, and available alternatives.
- **Cleared:** A cleared product does not mean that the FDA has tested it. Rather, it means that the product is "substantially equivalent" to a product that has already been approved.
- **Registered:** Many products are "registered" or "listed" with the FDA, but this should not be mistaken for having gone through any kind of certification process. It refers only to the manufacturer's letting the FDA know that the product exists.

Because the public is unfamiliar with these terms, relying on them in your stories is unwise. You should be sure to define the terms so that readers understand exactly what they mean. The FDA provides **more information**[2] on what the FDA does and does not have authority over.

Above all else, put evidence and data above anecdotes, and do not be swayed by the experiences of one patient or family in a way that leads you to gloss over key limitations that could have an impact on treatment for others.

Let's look at an example of a problematic health-care story, in which an editorial team relied on one couple's experience with a new intervention in a way that was dangerously misleading. After we discuss this example, we'll look at an alternative example of a well-reported story on the same topic. Both examples focus on endometrial receptivity tests, which analyze the activity of genes in the lining of the womb to help identify the optimum window for embryo implantation.

For a **story**[3] published by ABC News in 2018 titled "How a breakthrough new fertility test is offering hope for families who have suffered miscarriages," the editorial team profiled a couple who for years had struggled to conceive. They succeeded in having a child after using a new analysis tool called an endometrial receptivity test. If you've been paying attention, you've probably already identified the story's first error: using the term "breakthrough" in a headline.

Though there are rare instances in which these kinds of terms are merited, this story was not one of them. Why? It lacks the evidence necessary to support such a claim. For starters, there's a classic correlation/causality problem at work here: We don't actually know that the test *caused* the successful pregnancy. All we know is that after taking the test, one woman succeeded in conceiving.

We also don't know anything about the test's success rate or the risks or possible harm associated with it, because the story fails to reference a single piece of peer-reviewed research. What's more, the story does not tell us anything about the cost of the treatment or the companies or institutions that stand to benefit financially from its use. Without that information, we can't determine how accessible or available this test will be, or whether the couple highlighted by this story was spurred to talk by a company with a vested financial interest in their success.

General Questions for Reporters

- How will the story affect someone in need of the treatment or topic being covered?
- Does the story treat an anecdote as data?
- Does the story balance potential benefits with potential risk and harm?
- Does the story adequately summarize the funding behind a new treatment or other intervention?

Conversely, here's a story that covers the same topic but nails all of the basics:

In the **story**[4], published by *The Guardian* in 2015, the author provides a balanced overview of a new treatment that checks off all of the "dos" and none of the "don'ts" discussed in this chapter. The headline, "IVF test improves chances of implantation by pinpointing fertility window" expresses hope but does not exaggerate. The text, rather than focus on one couple's success, describes the state of research into the treatment and includes perspectives from a wide range of scientists and clinicians — from those affiliated with a new study to others who might be interested in providing the treatment.

The piece does use the word "breakthrough" — but places it into appropriate context, in a way that avoids hype. Rather than place the word in the headline or even in the lede, the author offers a quote lower in the story from one of the researchers, shows clearly that it expresses an opinion, and appropriately identifies the researcher's role in the new study: *"Geeta Nargund, medical director of Create Fertility whose London clinic is participating, said: 'The weakest link in IVF is implantation failure. I believe this is a breakthrough.'"*

The story goes on to report on the treatment's limitations and the basic science of how it works, and to identify the institutions that funded the research.

As these two examples show, health-care stories should not play the role of press releases. They should not encourage readers to make purchases by presenting only partial data. Instead, they should provide a balanced overview of risks and potential harm by giving readers access to the available evidence.

Navigating Sources and PR

For every journalist, there are approximately six public-relations professionals, **according to a 2019 report**[5] from the U.S. Department of Labor. And that ratio is growing. Two decades ago, there were two PR people for every reporter. Hospital systems, start-ups, and other health-care companies have powerful public-relations machines. Editors and reporters must be able to navigate relationships with PR professionals that include fielding pitches, coordinating interviews, providing an opportunity to comment, and confirming basic facts and figures. Depending on the level of the reporters, it may become part of your job as an editor to help them navigate this relationship.

A first step in many such interactions involves agreeing to an embargo — a request or requirement that whatever information is shared will not be published until a certain date or until certain conditions are met.

Fact: An embargo requires an agreement between the source and the journalist. Just because an email contains "embargoed" information, it shouldn't be considered binding unless there is written or oral agreement from the reporter. If reporters say something is embargoed, be sure to ask them whether they agreed to it. If they didn't, you're not bound by it.

Embargoes can have value, especially when they give journalists time to research a story and develop well-rounded reporting. But increasingly embargoes may contribute to hype or harm.

Here's an example of an experience I encountered: A public-relations person representing a health-tech start-up and a private university with a respected public-health program emailed me an "embargoed" press release announcing that the start-up would release, within the next 24 hours, a new FDA-authorized Covid-19 test that people could take at home. Regulators at the Food and Drug Administration, however, have repeatedly said in public guidance that they have not yet authorized any at-home tests for Covid-19.

In general, reporters and editors should treat a product announcement the same way they would any other press release: locate evidence backing up the claims. In this case, that evidence is the FDA authorization.

So, what are the issues here?

First, I had not agreed to an embargo, so there was no obligation to hold a story.

Second, recall the earlier discussion about the difference between FDA-authorized and FDA-approved. Be sure to explain distinctions in terminology that readers may not be aware of.

Third, what support was there for these assertions? If such documentation is insufficient (meaning it either can't be verified or lacks key data) or unavailable, the FDA should be able to verify.

As an editor, if a pitch to write a story based on this release were to come across your desk, there are a few questions you should ask your reporters:

- Is there reason to believe the company will attain authorization by the time the artificial embargo lifts? Why or why not?
- Is the company contributing to unjust hype, and if so, is that worth calling attention to with a story?
- Is the company doing public harm by selling an unauthorized test?

If the answer to the first question is yes, you should consider holding the story until the test is officially authorized. If the answer to either of the second two questions is yes, consider writing a story without respecting the artificial embargo, calling the company out. As an editor, you can help your reporters make this decision, which should also take into account the value of maintaining a relationship with the company, university, and public-relations professional involved.

General Questions for Reporters

- Do you understand a given embargo and feel comfortable producing the story within its confines?
- Do you understand the limitations of a press release and have clear strategies for addressing these limitations?
- Has the public-relations professional offered to connect you directly with a source for follow up questions and fact-checking? If not, are you comfortable taking these to the PR person?
- If the story is critical or negative, does the reporter feel comfortable sharing certain elements of the story with the PR person or source before publication, for purposes of fact-checking and allowing a response to criticisms?

Pre-Publishing Review

Another tricky part of the editing-and-reporting process involves choosing what information to share with public-relations professionals and sources before publishing. This may include an overview of the main elements of a story as well as quotes, selected story segments, or individual statements represented as facts.

In health-care writing, quotes can be easily misinterpreted, misattributed, or placed without the proper context. To ensure that a given quote or element of a story is factually accurate, many reporters choose to share certain parts of a story with their sources before the story is published, a practice that has grown more frequent as media outlets eliminate fact-checkers in response to budget cuts.

Increasingly, PR professionals avoid directly connecting reporters with the sources they offer up for interviews, such as clinicians, researchers, analysts, and entrepreneurs. Instead, it is often the PR professional who sets up conference calls, fields emails and calls, and answers follow-up questions and fact-check requests.

This is obviously problematic, not just because it makes the process of fact-checking more difficult and may prevent reporters from asking tough questions, but also because it puts an intermediary between you and your source. Encourage reporters to ask PR professionals to directly connect them to their sources.

When a story is negative or critical, it is fairly standard practice to share the basic elements with sources and PR professionals before publication — both to avoid surprising them and to give them a chance to respond to the criticisms. If elements of a critical story are not shared before publication, sources and PR professionals may respond in a threatening or angry manner or avoid sharing important information with the reporter in the future.

Of course, that does not mean that reporters should send an entire story draft to a PR professional or source — doing so could result in vital elements of the story being unjustly removed. Instead, some reporters may want your help choosing which parts of a story to share with sources before publication. Other reporters may be accustomed to handling this process on their own, so be sure to allot a certain amount of time in the editing schedule for this fact-checking and follow-up.

After a story is published, PR professionals or sources may request that something be amended, changed, or removed. Beware: These requests should not always be honored, especially when they do not concern factual information. Sometimes PR people will ask for various components of a story — particularly those that are critical of the company or institution they represent — to be removed, for critical wording to be softened, or even for changes to a source's quotes. Work with your reporter to assess these requests and to focus on any errors rather than on personal preferences or other spurious requests.

Research, Peer Review, and the Clinical Trial

Medical research is to health-care reporting what yeast is to bread. Almost every story relies on medical research, and if the research is missing, the story falls flat.

The bulk of medical research is the product of peer review — the process of subjecting a given piece of research to review by experts in the same field. Not unlike the role that health-care editors play, peer reviewers serve to fact-check and critique medical studies, to vet their claims, and to identify any key limitations or conflicts of interest. The result is a study published in a medical or scientific journal.

The peer-review process is the best protection we have against faulty, self-serving, and promotional studies. But it is not flawless. Understanding the limitations

of peer review will enable you to make important choices about how a given study is framed and presented, as well as what kind of descriptive language reporters should use and what data they should include.

Key Terms

- **Absolute risk:** The probability of a given outcome.
- **Clinical trial:** Research studies performed in people to evaluate a medical or behavioral intervention.
- **Conflict of interest:** A situation in which a researcher's professional judgment may be clouded by conflicting personal or financial interests.
- **Disclosure:** A portion of a peer-reviewed study where researchers declare any potential conflicts of interest.
- **Efficacy:** How well a given treatment works to produce an intended outcome.
- **Effect size:** The magnitude of the difference between groups given a treatment.
- **Endpoints:** The primary outcomes a clinical trial is designed to evaluate.
- **Peer review:** The process of subjecting an author's research to the scrutiny of experts in the same field who were not directly involved in the research.
- **Peer-reviewed journal:** A journal that published research that has been peer-reviewed.
- **Preprint:** A research paper that is made available before being subject to peer review and is typically published later in a scientific or medical journal.
- **Relative risk:** The likelihood of an event's occurring in a group of people compared with another group of people who may have different behaviors, physical conditions, or environments.
- **Stigma:** Discrimination against a person or set of behaviors based on perceived characteristics, behaviors, or assumptions about those characteristics or behaviors.
- **Outside expert:** A skilled researcher, clinician, or other expert who can evaluate a given research study, presentation, or other finding because that expert is not directly involved in the work.

For starters, not all medical journals are created equal; some are considered **predatory**[6], in that they prey on academics' need to publish for career advancement. Such journals are known to publish low-quality content with minimal or no review. Here's a short list of some predatory journals (a full list can be found at **predatoryjournals.com**[7]):

- *American International Journal of Contemporary Scientific Research*
- *American Journal of Advanced Drug Delivery*
- *Annals of Clinical Case Reports*
- *Clinics in Surgery*
- *European Journal of Biomedical and Pharmaceutical Sciences*

By contrast, other journals have rigorous processes and are respected for their high academic standards and credibility. Such journals include:

- *Annals of Internal Medicine*
- *The Journal of the American Medical Association*
- *The New England Journal of Medicine*
- *The Lancet*
- *Nature Medicine*

One might draw the conclusion that every study published in one of the high-caliber journals listed above is going to be a high-caliber study. Such an assumption would be wrong. Studies exist along a continuum from weak to strong based on a panoply of factors, including the number of participants, their demographic makeup, and the study's design. In general, the larger, more well-controlled, and lengthier the study, the stronger it is. Here are some indicators of high-quality research:

- Involves large, diverse groups of people
- Takes place over long periods of time
- Involves a control group that did not receive the treatment
- Follows people over time rather than looking back retroactively
- Randomly assigns participants to either the control group or the test group

Not all research follows this gold standard. In fact, there are different kinds of studies that adhere more or less to these best practices. They include these categories, from weakest to strongest:

Case reports: A collection of stories, often compiled by doctors, about individual patients that describes their medical histories. When stories of multiple patients with similar symptoms or histories are gathered, the case report is called a case series. Case reports cannot demonstrate or prove causality, but rather merely describe a phenomenon or observation.

Case-control studies: Case-control studies start with a given outcome, look back in time, and compare two groups to see what may have contributed to the outcome. For example, researchers who observed high rates of asthma in a given community might compare the high-asthma population with a low-asthma population. They might survey the two groups to get a sense of earlier behaviors or environmental factors that could have influenced the groups' divergent health outcomes.

Cohort studies: Also called prospective studies, cohort studies involve following multiple groups (or cohorts) over time and comparing their outcomes. In contrast to case-control studies, which look backward in time, cohort studies look forward. For example, researchers might start with two populations, both with low rates of asthma, and then survey them at regular intervals over years or decades to see whether the groups go on to show any significant differences in rates of disease.

Randomized controlled trials (RCTs): RCTs are widely considered to be the gold standard of medical research. They involve randomly assigning one group of patients to receive a treatment and another group to receive a placebo, and then following and comparing the groups over time. The randomness is critical to ensuring that the treatment is the only variable influencing the different outcomes the two groups experience. When possible, the strongest RCTs also involve what is known as "blinding," in which either the participants, the researchers, or both groups do not know which participants were given a treatment or a placebo. This strengthens the research by ensuring that neither the researchers nor the participants are influenced by their perceptions or assumptions about a given treatment.

Systematic reviews and meta-analyses: The strongest of all of the studies we'll review here, systematic reviews and meta-analyses weigh the contributions of multiple studies to assess a given treatment or other outcome. For example, researchers looking to evaluate how well a digital diabetes program worked to help patients lose weight might review a handful of previous studies that sought to evaluate individual programs. By looking at the studies together, researchers can use statistical analyses to get a sense of how well the treatment worked.

Sometimes even the most-admired newsrooms can mishandle reporting on studies, such as when, in July 2020, during the Covid-19 epidemic, *The New York Times* took a small, weak study and misrepresented it as a large, well-controlled study.

In the **article**[8], reporters attempted to rate the evidence behind some of the most talked-about treatments for Covid-19. The first version of the story, which was almost immediately altered on the basis of expert feedback, placed 20 treatments into the following six categories, from best to worst:

- Strong evidence
- Promising evidence
- Mixed evidence
- Not promising
- Ineffective or harmful
- Pseudoscience

Because of the way it presented the findings, the story received wide criticism from clinicians and other experts, many of whom argued on social media that the *Times* had overstepped its bounds and assumed the role of medical expert with a story that appeared to recommend or flag unproven, experimental treatments. Especially concerning was the problematic way it initially presented one early-stage experimental treatment involving blood plasma taken from recovered Covid-19 patients.

In the first version of the story, this treatment was labeled "promising evidence." The authors cited positive results from early "trials" as the evidence for their claims. But the word "trials" in the story did not refer to clinical trials; rather, it referred to a small case-control study — the second-weakest type of study — and involved just 39 people. That kind of study is far too preliminary to label as "promising," especially in the context of different kinds of studies of other treatments. You can think of it as labeling both a toddler and a high-school student "promising" in terms of their scholarly potential. You simply don't know enough, and the two are not comparable.

To the *Times*'s credit, **an earlier article**[9], published in May, about convalescent plasma headlined "Uncertain Results in Study of Convalescent Serum for Covid-19" was clear about the limitations of the study, carefully describing caveats and noting that the only available evidence was from a small, early-stage study.

"Analyses like these are fraught with difficulties," the earlier story read. "The only way to know for sure if the treatment works is to randomly assign patients to receive [the treatment] or a placebo."

But the July story did not devote adequate attention to these key limitations. In an updated version of the story, posted on July 17, the authors changed the treatment labels entirely. For convalescent plasma, the dark-green "strong evidence" label was replaced with an orange one that read "tentative or mixed evidence."

What could an editor have done? At minimum, an editor should have suggested a more appropriate label for convalescent-plasma treatment, since one small case-control study does not constitute "promising evidence" for a treatment that remains highly experimental, not to mention possibly expensive or inaccessible.

An editor could have also chosen to strike the word "trials" in the description of the treatment, since it could lead readers to wrongly believe that convalescent plasma had been studied in a well-designed study, such as a randomized controlled trial.

An editor needs to be careful not only with the examples, facts, or figures contained within a story, but also with the overall impression or take away it provides.

The Research Process

Let's take a look at a related research process that produces most of the approved treatments we have today.

Clinical trials are privately or publicly funded research studies that involve testing an experimental treatment in volunteers. These trials generally happen in a series of four steps, known as "phases." Each phase has a distinct purpose and is designed to help researchers answer specific questions. As with all medical research, editors should be mindful of the limitations of clinical trials. One important limitation that influences later-stage clinical trials is that they tend to be made up predominantly of white males. This can either directly or indirectly disadvantage members of underrepresented groups, particularly women, Black people, and other people of color.

General Questions for Reporters

- What level of research or clinical trial is it?
- Has it been peer-reviewed?
- What are the limitations of the study?

- Who are the study subjects, and what is their demographic makeup?
- What do outside experts think of it?
- Do the study authors have conflicts of interest?

Take the example of clinical trials on multiple myeloma, a kind of cancer that causes a buildup of cancer cells in bone marrow: Black Americans make up 20 percent of multiple-myeloma patients and are **twice as likely**[10] as white patients to be diagnosed with the disease. Yet since 2003, Black participants have **accounted for**[11] less than 5 percent of patients in multiple-myeloma trials.

How does this underrepresentation affect potential treatments? Let's take a look at another example, involving asthma. Most asthma research has focused on people of white European descent, even though asthma has a higher prevalence among Black people and other people of color. Several studies also suggest that different ethnic groups — white Europeans included — have varying genetic mutations that affect how they respond to treatments. The problem is that the research focuses overwhelmingly on only those mutations that affect white Europeans and their descendants. A 2016 study in the journal *Immunogenetics,* for example, concluded that of all the recognized genetic mutations tied to asthma, just 5 percent apply to Black people. Were more late-stage clinical trials of asthma done to include Black people, researchers might come to learn of a different set of genetic mutations that are more strongly tied to asthma in Black people. Eventually, those data could lead to the creation of better-designed and more-efficacious treatments.

Besides trial demographics, editors should also pay attention to effect sizes, which allow reporters to describe the magnitude of a new treatment's impact. For example, if a reporter says a new drug *halves* the risk of heart attack, be skeptical: That language implies that the drug has what's known as an "effect size" of 50 percent, which is very high and could well warrant a "breakthrough" label. However, that is rarely the case; it's more likely the reporter is conflating two types of risk — *relative* and *absolute*.

The chapter on statistics goes into greater detail on this, but you should know that absolute risk describes the real change a treatment might make in a patient's life, while relative risk merely describes a treatment's unspecified potential. Let's pretend there's a study involving two groups of 100 people. In the first group — our control — two people out of 100 have a heart attack. In the second group, the one receiving the proposed treatment, one person out of 100 has a heart attack.

It is mathematically true, then that the number of heart attacks was halved, or decreased by 50 percent – from two to one. However, that is the relative risk. In absolute terms, the decrease was by one person in 100, so the absolute risk reduc-

tion was one percentage point. In a population of 320 million people, that could still be significant — more than three million lives — but it's definitely not *half.*

As a result, it's generally better to talk about the change in absolute risk rather than relative risk.

Here's another way of looking at it, from Health News Review, a watchdog group that was dedicated to reviewing the claims of health news stories and was run by Gary Schwitzer, an adjunct associate professor at the University of Minnesota's School of Public Health. (The site shut down in 2018.) Imagine you get a "50-percent off" coupon that doesn't specify what it can be used on. If the coupon can be used in, say, a jewelry store, the money you'd save could be in the hundreds or thousands of dollars. If it can be used only on snacks at a checkout counter, however, at most you'd save a few dollars. The coupon's true value — what it can be used on — represents its absolute risk, while the 50-percent figure would represent the relative risk.

Relative risk is unhelpful in reporting because it could involve comparing two very different groups — sedentary people and active people, for example. Absolute risk, on the other hand, describes the likelihood that something will happen under specific conditions.

The Four Phases of Research Studies

It's common for researchers to talk about these phases as if their definitions were broadly understood. While the public is unlikely to know the differences, you should, so that you can translate research-speak into something meaningful for your audiences.

Phase I: In Phase I, researchers are testing an intervention for the very first time, typically in a very small group (20 to 80 people). The primary goal of this research is merely to test the intervention's safety and identify side effects, not to show whether the intervention works to treat a condition. In general, editors may want to discourage reporters from covering Phase I research, as most interventions in this stage will still fail before reaching the market.

Phase II: In this phase, which may, in rare cases, merit limited coverage, researchers test an intervention in a larger group (100 to 300 people) to determine the drug's efficacy and further study its safety. I'll draw a parallel here to the *case-report* level of peer-reviewed research: in Phase II, just as with case reports, results do not involve comparing the intervention with other treatments. As a result, these studies give no indication as to whether the drug is an improvement over any alternatives. What they can do, however, is show whether an intervention may be superior to no treatment. In 2010, the proportion

of interventions that made it through this phase was **18 percent**[12], although some estimates suggest that figure is increasing and rose to **31 percent**[13] in 2015.

Phase III: In Phase III, researchers give an intervention to 300 to 3,000 people. At this stage, researchers may also compare the experimental intervention to existing treatments, meaning that these studies can take the form of the randomized controlled trials. It is generally at this point that regulators approve new treatments and make them available, making the Phase III trial stage the most pivotal phase of research. Still, one must not get caught up in any hype. Be sure that reporters covering Phase III trials thoroughly discuss any findings about harmful side effects, costs, or lackluster results.

Phase IV: After the drug has been released, this final phase is used to track the safety of the drug as it's taken up by the general population.

Appropriately, most clinical-trial coverage focuses on Phase III. An example of appropriate coverage can be found in Biopharmadive's reporting on the then-experimental depression treatment esketamine, a (now-approved) nasal spray developed by Johnson & Johnson.

For Biopharmadive's **story**[14], the publishers used the headline "J&J's ketamine-based antidepressant sees mixed results in Phase III." Avoiding hype and fear-mongering, the headline provides the type of balance you want to see in medical stories.

That headline was an appropriate choice: The treatment appeared to help significantly curb the symptoms of depression in the Phase III study, which involved a large group of patients who did not respond to other treatments. However, another part of the trial, which involved testing the therapy in a more challenging group of older adults, fell short of showing a clear benefit for people receiving the treatment compared with people who did not get it.

Editors should be especially careful with headlines related to clinical trials. Sometimes, small tweaks can make a headline misleading, too sensational, or just plain wrong. For example, one might have been tempted to term the esketamine trial a "success" because some — but not all — of the elements were indeed successful. Since headlines carry outsize influence on reader's perceptions, care must be taken not to overstate results.

Editors must also be mindful of potential conflicts of interest that may influence a study's design, process, and outcomes.

Many clinical trials involving pharmaceutical treatments are designed and funded by the companies themselves, meaning journalists must treat the

outcomes with extra caution. For example, Janssen Research & Development, the biotechnology company that designed and funded the esketamine study, is owned by Johnson & Johnson, maker of the drug that was tested. In the study's conflict-of-interest disclosure section, which for this journal was located in a tab titled "article information," two-thirds of the authors are listed as employees of Janssen. Although the study was well-designed, and some measures were taken to avoid undue bias, the potential for conflict of interest was inarguable and must be made clear to readers.

Often, reporters will turn to outside analysts, academics, or other researchers for perspectives on new drugs or treatments. This is smart and appropriate journalism, but in a field rife with collaborations, conflicts, and competition, beware. Analysts may be influenced when they stand to benefit from the approval of a particular treatment.

"Yes, some [analysts] may have doctorate degrees and medical degrees, and some may also have a solid understanding of the science supporting these projections," said Randi Hernandez, oncology editor at *Cancer Therapy Advisor*. "Still, you can't know their motivations" when they comment on something that could have implications for companies' stock prices.

Although this may seem like obvious advice for editing, just make doubly sure reporters have fact-checked analysts' statements, and encourage them to include relevant data, placing any quotes in the proper context.

Preprint Servers

Research studies and the publishing process are notoriously slow. Journals must evaluate submissions and then put them through the peer-review process and the publishing process. During that time, the researchers are usually forbidden to discuss their research, instead reserving publicity for when the study is published. In some cases, like during a public-health emergency such as the coronavirus pandemic, researchers may take to publishing their findings outside of the peer-review process. These findings are typically found in what are known as "preprint servers," online repositories that house early studies and data associated with papers that have not yet been accepted by traditional academic journals. Rather than a thorough review process, preprints are typically checked only for plagiarism, although they may undergo other basic screening requirements.

Because preprints have not been thoroughly vetted, you should always take extra caution when reporters choose to cover them. Be sure to provide proper context for your audience.

Not surprisingly, preprint papers were the cause of some consternation during the pandemic, when researchers were working at breakneck speed to publish their findings.

"Rather than a thorough review process, preprints are typically checked only for plagiarism.

"We've seen some crazy claims and predictions about things that might treat Covid-19," Richard Sever, a co-founder of two of the most popular servers, bioRxiv and medRxiv, said to *Nature News*. (*Nature* is one of the world's largest publishers of peer-reviewed articles).

One preprint study that attracted controversy was a **paper**[15] written by Stanford researchers that suggested that the number of Covid-19 cases in Santa Clara County, California, was 50 to 85 times higher than the number of confirmed cases in the region. Published on the preprint server medRxiv, the findings were contested by public-health experts. A group of external reviewers from the Johns Hopkins Bloomberg School of Public Health — who came together specifically to address the flood of preprint coronavirus research — **determined that the preprint**[16] lacked the evidence necessary to bolster such dramatic claims.

Avoid Contributing to Stigma

Ensuring that reporters are properly vetting science is one way to avoid doing harm. Another involves editing sensitive subjects carefully. Those subjects include but are not limited to suicide, substance overuse and treatment, homelessness, disability, trauma, sexual violence, and mental illness. Language matters. Choosing the proper terms and phrasing to talk about these issues can sometimes mean the difference between someone's getting help and not getting it.

This is an issue that is especially important in headlines, in which editors must balance brevity and clarity. Sometimes the best word choice may not be the shortest. For example, the word "addict" is commonly used in headlines to describe people who use certain drugs, often opioids, cocaine, heroin, or methamphetamine. Someone who uses drugs certainly has a life outside of those drugs, however, and using the term "addict" defines them only by their drug use. Similarly, some clinicians and advocates prefer to use the term drug "overuse" rather than drug "abuse," because "abuse" carries a moralistic or judgmental connotation.

Another example involves the use of certain words and phrases with regard to suicide. A common phrase is "committed suicide" when reporting on the death of people who take their own lives. However, that phrase implies that the person committed a crime, when in reality most suicides are the result of long and difficult struggles with mental illnesses. A better phrase is "died by suicide."

Moreover, when editing stories about suicide, it is important to ensure that reporters do not describe the process by which a person died. Several peer-reviewed studies have found significant evidence of a "copycat effect" — after a highly publicized suicide, clusters of similar-looking suicides take place as people repeat the method.

"How we talk about, write about, and report on suicide matters," wrote Luna Greenstein in a 2018 blog post for the National Alliance on Mental Illness. "For someone already considering suicide, it's possible to change their thoughts into action by exposing them to detailed suicide-related content, including graphic depictions or explanations of the death or revealing the method used."

When the fashion designer Kate Spade died by suicide, in 2018, several news outlets reported graphic details of how she died, including the method and the contents of a suicide note that she left, photos showing her body being transported on a gurney, and headlines that included the means of death.

The website **Reporting on Suicide**[17] maintains a list, compiled by a variety of experts, of dos and don'ts for reporters and editors.

Dos

- Report the death as a suicide; keep information about the location general.
- If a note or letter was found, report that a note was found and is under review.
- Keep information about the person general.
- Report that coping skills, support, and treatment help most people who have thoughts of suicide.
- Describe suicide warning signs and risk factors (such as mental illness and relationship problems) that give the suicide context.
- Report on the death using facts and language that are sensitive to grieving family members and friends.
- Provide context and facts to counter perceptions that the suicide was tied to heroism, honor, or loyalty.
- Research the best available data on suicide epidemiology and use words like "increase" or "rise" rather than words like "skyrocketing."

Don'ts

- Describe or depict the method or location of the suicide.
- Share the content of a note or letter discovered with the person who died.
- Describe personal details about the person who died.
- Present suicide as a common or acceptable response to hardship.
- Oversimplify or speculate on the reason for the suicide.
- Sensationalize details in the headline or story.
- Glamorize or romanticize suicide.
- Overstate the problem of suicide with words like "epidemic" or "skyrocketing."

Another frequent source of stigma in health-care reporting is reporting on people with disabilities. Again, it is important to use the most accurate terminology to avoid perpetuating negative stereotypes and beliefs. One general rule involves using what is known as "person-first" language. This sentence construction, which involves placing the word "person" before any descriptions of a disability, avoids implying victimhood or inappropriately defining someone with a disability by that disability.

For example, when referring to someone who uses a wheelchair, do not use the phrase "wheelchair-bound." Instead, use "person who uses a wheelchair."

"I personally am not 'bound' by my wheelchair," one person **told**[18] the University of Kansas' Research and Training Center on Independent Living. "It is a very liberating device that allows me to work, play, maintain a household, connect with family and friends, and 'have a life.'"

Editors should also pay close attention to photography choices, because pictures can influence the way readers think about potentially important public-health interventions, such as vaccines, says the freelance writer and editor Jaime Greenring.

Scary photos — even when used without the intention of scaring people — can have a powerful impact on the general public. If you're editing a story about vaccinations, for example, avoid images that feature dramatic needles or screaming babies. Instead, perhaps, include images of healthy children getting stickers from the clinician or modeling their Band-Aids.

The **National Institutes of Health**[19] and the **National Alliance on Mental Illness**[20] are good resources for reporting on any of those subjects. Some journalism schools and groups, such as the **Association of Health Care Journalists**[21] and the **University of Southern California's Annenberg Center for Health Journalism**[22], are also excellent resources.

The Rules Apply to Silicon Valley, Too

In recent years, more than a few new companies have entered the health-care sector. Once dominated by hospitals, insurance companies, medical-device makers, and pharmaceutical companies, the medical landscape is increasingly influenced by technology giants, including Facebook, Apple, Alphabet (the parent company of Google), Amazon, and Microsoft, as well as upstarts funded by venture capital.

When editing stories about new health products being developed by Silicon Valley, extend to them the same level of scrutiny as you might to an experimental drug.

Do not mistake innovation for scientific rigor.

Theranos provides one of the most notorious recent examples of the harm that can result when powerful financial interests obscure the risks and efficacy of a health-care product.

As you probably recall, the blood-testing start-up claimed that it would revolutionize health care by doing away with "big bad needles." It had solid financial backing; investors had placed hundreds of millions of dollars behind the idea of the simple, convenient blood test supposedly in development by the company's founder, Elizabeth Holmes. News media such as *Forbes* were quick to slap modifiers like "breakthrough" and "revolutionary" on the company and Holmes. They ran uncritical stories that failed to discuss the advanced technology or the scientific research.

None of these outlets provided any of the key information we've described throughout this chapter: not the test's accuracy; not its potential risks and benefits; not any comparisons to existing blood tests. Before it was revealed that the advanced technology required for Theranos's concept simply did not exist, Holmes had amassed a net worth of $4.5 billion, and the company had been valued at $9 billion. Eventually, **unrelenting reporting**[23] by John Carreyrou, of *The Wall Street Journal*, and others exposed Theranos for the fraud it was.

But while Theranos provides a clear example of how a lack of transparency can accompany colossal failure, even successful products made by technology companies merit extra scrutiny.

Let's take an example involving Apple. The iPhone maker officially ventured into the health-care realm in 2018 with the creation of the Apple Watch, which allows users to monitor certain aspects of their cardiac health. The device, cleared by the Food and Drug Administration, was an extraordinary achievement: By running several large studies, including one unprecedented, entirely virtual clinical trial, Apple became the first tech giant to sell a consumer gadget with the regulatory clearance necessary to give it truly medical-grade capabilities. But those capabilities still come with important limitations.

For example, while the Apple Watch and embedded electrocardiogram were cleared by the FDA, they were not *approved* — a key distinction reserved for devices that are considered to be high-risk but have been thoroughly vetted because they provide a clear medical use, such as an implantable pacemaker. Although the FDA cleared the technologies that the company submitted for review, the agency specified two key limitations of the device: first, that it cannot be used to diagnose any heart conditions, and second, that it should not be used as a substitute for clinical care. Not all reporting made these distinctions clear.

In addition, while the clinical trial that the company ran to support the notification component of the Apple Watch was truly unprecedented for its size, design, and scope, it's important to keep in mind that Apple has the resources and the funding to run a trial of that scope. And despite those clear strengths, the study still came with limitations of its own, including the fact that Apple had funded the study, and the authors of the report included Apple employees.

As should be obvious by now, any reporting should disclose those facts.

Additional Reading and Resources

Understanding Structural Inequity

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- "An Early Look at the Potential Implications of the COVID-19 Pandemic for Health Insurance Coverage," S. Collins, M. Gunja, G. Aboulafia, et al., Commonwealth Fund, 2020.
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- "Racial Disparities in the Prevalence of Monoclonal Gammopathies," O. Landgren, B. Graubard, J. Katzmann, et al., *Leukemia,* 2014.
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Covering Health Research

- "The One Chart You Need to Understand Any Health Study," J. Belluz, S. Hoffman, Vox, 2015.
- "Sticking with the truth: How 'Balanced' Coverage Helped Sustain the Bogus Claim that Childhood Vaccines Can Cause Autism," Curtis Brainard, *Columbia Journalism Review,* 2013.
- "Glossary of Common Terms: NIH Clinical Research Trials and You," National Institutes of Health, 2016.
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"First, do no harm," Robert H. Shmerling , Harvard Health Blog, 2015.

"Tips for analyzing studies, medical evidence, and health care claims," Health News Review, 2016.

"Peer Review: The Nuts and Bolts," Julia Wilson, Sense About Science, 2012.

Covering Stigmatized Subjects

- "11 Resources for Responsibly Reporting on Rape," Kristen Hare, Poynter, 2014.
- "Disability Language Style Guide," Amy Silverman, National Center on Disability and Journalism, 2018.
- Getting to the Truth When Covering Measles Outbreak," Bara Vaida, Association of Health Care Journalists' Center for Excellence in Health Care Journalism, 2019.
- "Needles, screams and vials — those vaccination photos," Lauren Whaley, University of Southern California Annenberg Center for Health Journalism, 2015.

About the Author

Erin Brodwin is a health-tech reporter at STAT, a health-and-medicine news site affiliated with *The Boston Globe*. Based in the San Francisco Bay Area, she focuses her reporting on Silicon Valley power players like Apple, Amazon, Google, Facebook, and Microsoft and their ambitions in health care. Before joining STAT, Erin spent five years as a health-and-science reporter at Business Insider, where she wrote the definitive account of what went wrong at the microbiome start-up uBiome, leading to an FBI investigation and the company's eventual bankruptcy. She has been interviewed on NPR and the BBC and has had her work cited by outlets including *The New York Times* and the World Economic Forum.

Endnotes

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19 https://www.nih.gov/about-nih/what-we-do/science-health-public-trust/resources

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09

Climate and the Environment

By Fen Montaigne

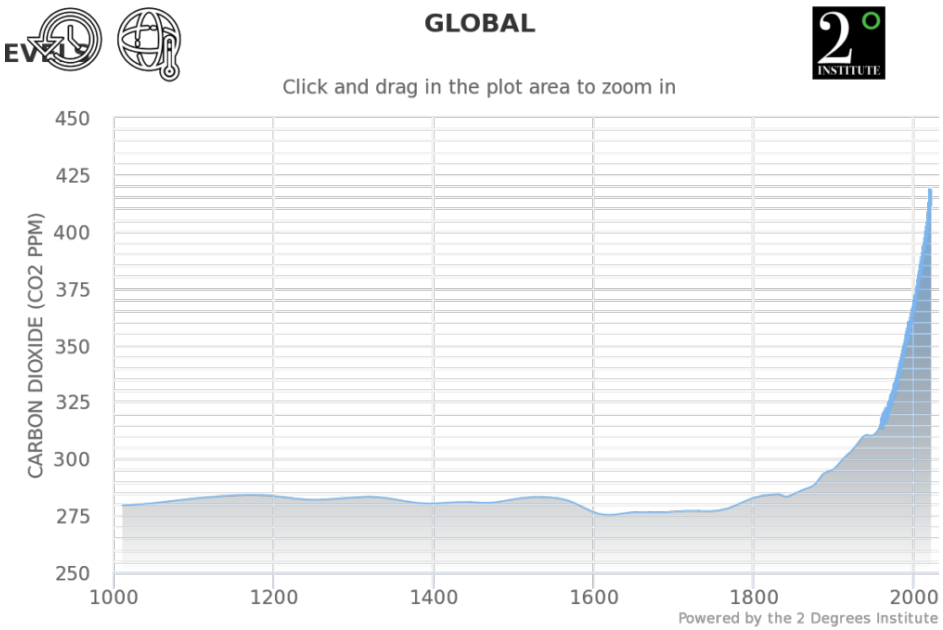
Introduction

In the coming decades, few science stories — with the exception of the threat of new pandemics in the post-Covid-19 era — will command as much reader and viewer attention as global warming and the environment. The reason is simple: Even though Covid-19 is about biology and disease, and climate change can be understood as physics and the laws of the natural world, the public relies on science journalists to help understand the ways in which humanity runs up against these realities and how it can handle the resulting perils and challenges.

In the case of climate change, the physics is clear. The more fossil fuels we burn and the more CO_2 we pour into the atmosphere, the hotter the planet gets. Atmospheric CO_2 levels have been soaring for a few decades and in 50 years could very well be double those of the pre-industrial era.

As for the broader environment story, it can also be reduced to some core facts. Global population has more than tripled in the past 70 years — from 2.5 billion in 1950 to 7.6 billion today — and is projected to reach 10 billion by century's end. As humanity's numbers grow and affluence increases, we take ever-larger bites out of nature, degrading ecosystems and diminishing biodiversity.

So, as science editors, you are now confronted by a Gordian knot made up of three major strands: a burgeoning global population, a warming planet, and the decline of ecosystems and biodiversity. Covid-19 stems, in part, from this assault on nature, as relentless incursions into previously wild lands bring people into greater contact with animal diseases, which then affect humans. And while the parallels are hardly exact, there are strong similarities to keep in mind when editing stories about the novel coronavirus or about global warming. Both are



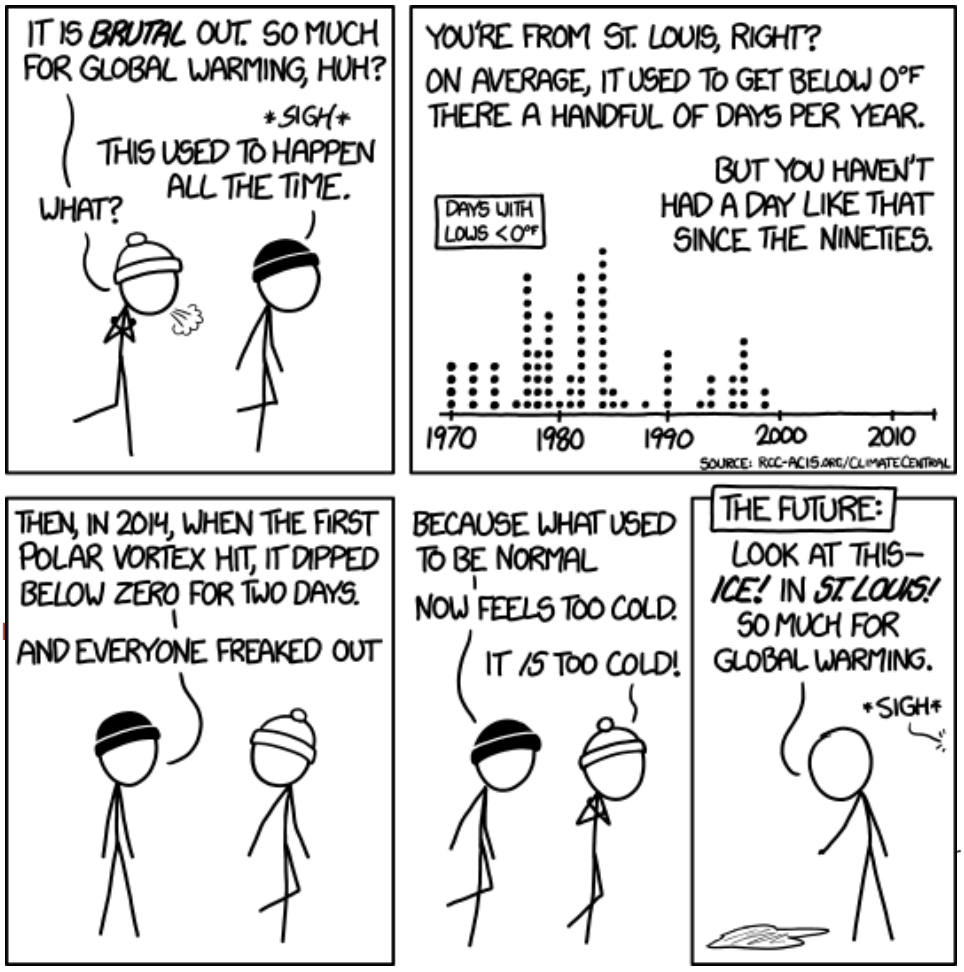
Atmospheric CO_2 levels over the past 1,000 years. Source: The 2° Institute.

phenomena that scientists amply warned us about, but that we did not do nearly enough to combat. Both subjects have, in the U.S., become politicized and plagued by a denial of basic science and a flood of disinformation. And both are stories that must rely on covering the give-and-take of the scientific process, requiring reporters and editors to use nuance and sophistication when describing the current state of affairs and projecting what might lie ahead.

The Climate Story

As you assign and edit stories about global warming, a few basics are worth keeping in mind:

- **The science is settled.** Human-caused emissions of greenhouse gases, most notably carbon dioxide, are the major reason the planet is warming at a rate not seen in millions of years. There are not two sides to this story, so don't worry about inserting "balance" into your coverage. Doing so would actually be propagating misinformation. When it comes to the details and timing of the impact of global warming, things are less certain. Keep in mind, though, that to date the scientific community and the Intergovernmental Panel on Climate Change have generally been too conservative in projecting how rapidly global warming is altering the earth.



From xkcd.com

- **The climate-change story is everywhere.** As the effects of global warming intensify — worsening floods, mass die-offs of trees from insect infestations, rising seas causing an increase in coastal flooding — climate change is intruding into everyone's lives and muscling its way into nearly every beat: agriculture, health, the economy, politics, social justice.

- **The climate-change story is increasingly a local story.** Few regions of the world remain untouched by global warming. In the United States, the frequency and severity of wildfires, from Colorado to California, is having an impact on tens of millions of people. So called "sunny day" flooding, from sea-level rise, is affecting coastal residents along the East Coast. The Upper Midwest has been subjected in recent years to extreme rain events and deluges. And nearly everywhere, winters are milder, summers hotter, and weather more extreme. The more you can bring coverage down to the local level, while also tying it to larger global trends, the more you will engage readers and viewers where it matters most to them — in their backyards.

- **Look the problem in the eye and give the news to your readers and viewers straight.** Cover the impacts of a warming world, but also cover possible solutions. While global warming is a politically contentious issue among some segments of American society, the overwhelming majority of people agree that developing renewable energy is a good thing. At the same time, don't hype potentially promising developments or oversimplify the challenge of decarbonizing the global economy. But keep in mind that many scientists, entrepreneurs, and officials at the local, national, and international levels are working to solve this problem, and it's good to keep readers, viewers, and listeners informed.

Science and Denial

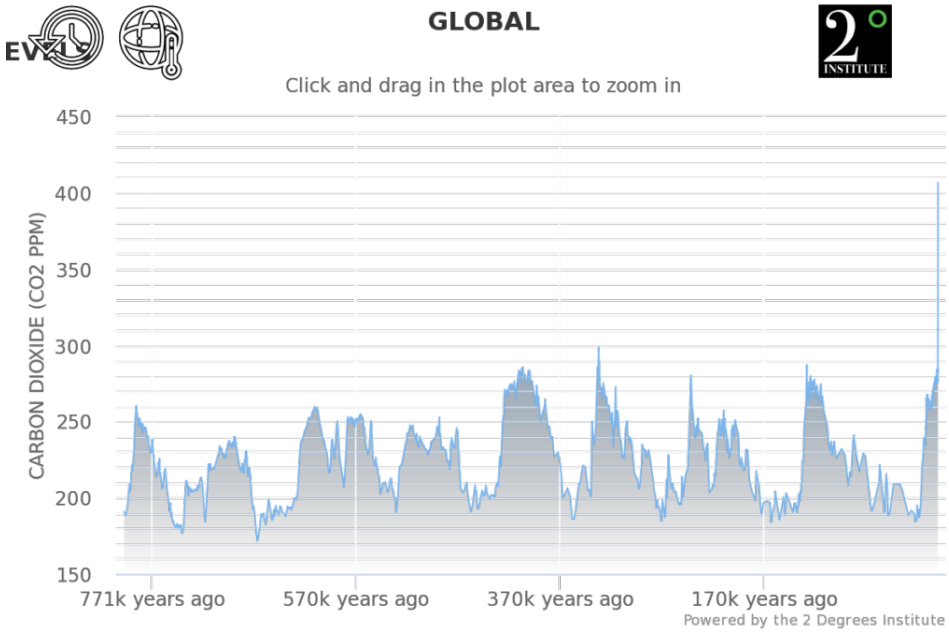
The reason the earth is rapidly warming is grounded in a law of physics as immutable as the law of gravity. The greenhouse effect, which has been an established scientific principle since the 19th century, says that certain gases — most notably carbon dioxide and methane — can, at even small concentrations, trap heat in the atmosphere. Based on studies of air bubbles in polar ice cores, scientists know that atmospheric CO_2 concentrations are at their highest levels in at least 800,000 years, as human activity pumps 30 billion to 35 billion tons of CO_2 into the atmosphere annually. Global temperatures are rising accordingly.

As of the summer of 2020, the five hottest years since reliable record-keeping began, 140 years ago, were from 2015 to 2019, and **nine of the 10 hottest years have occurred since 2005**[1], according to the U.S. National Oceanic and Atmospheric Administration. Atmospheric concentrations of CO_2 have been increasing at the rapid pace of two to three parts per million annually, reaching about 415 parts per million (PPM) today — compared with 280 PPM when the Industrial Revolution began. These scientific fundamentals are indisputable, as is the extreme warming taking place in the world's ice zones, especially at the poles.

Satellite imaging shows that the extent of Arctic Ocean ice has shrunk by 10 percent per decade since 1979. Record warmth in Greenland is now causing its massive ice sheet to shed hundreds of billions of tons a year, raising global sea levels. The West Antarctic Ice Sheet, whose eventual disappearance could raise sea levels by 16 feet, is becoming unstable as air and ocean temperatures rise. Mountain glaciers worldwide, from the Alps to the Himalayas, are melting.

Climate-change skeptics raise a number of arguments that purport to show that the current rates of warming are somehow not related to human activity. One of the most common is that the earth's climate has undergone cycles of climate

change for hundreds of millions of years. That is indeed true. Vast and prolonged outpourings of basaltic lava from inside the planet's mantle, such as occurred about 250 million years ago in Siberia, can warm the climate by filling the atmosphere with greenhouse gases. For the past 800,000 years, the earth has undergone regular cycles of glaciation and deglaciation roughly every 100,000 years.



Atmospheric CO_2 levels over the past 800,000 years. Notice the spike on the right. Source: The 2° Institute.

These shifts — known as **Milankovitch cycles**[2] for the Serbian scientist who discovered them — involve changes in the tilt of the earth's axis that allow more, or less, of the sun's energy to strike the Northern Hemisphere, which has considerably more heat-absorbing land masses than the Southern Hemisphere. The peak of the most recent glacial period occurred about 22,000 years ago, after which the earth gradually warmed. But now, in fact, the planet should be moving, over tens of thousands of years, into a new Ice Age — not rapidly warming.

Nearly 100 percent of climate scientists say that the only possible explanation for today's soaring atmospheric concentrations of CO_2 and resulting temperature increases — both of which, based on the geological record, have not been seen in tens of millions of years — is human-generated carbon-dioxide emissions.

(For a list of other common climate change-denial talking points, and rebuttals to them, see **here**[3].)

What Counts, and What Doesn't, In Covering Climate Denial

The career of Justin Gillis, who reported on climate change for *The New York* Times in the early 2010s, tracked — and indeed helped shape — the arc of global-warming coverage in recent years. Gillis wrote an award-winning series of articles[4] called "Temperature Rising[5]," which explained the science of climate change and chronicled its impacts. Then, in 2014, he was the principal writer of another series, "The Big Fix[6]," which delved into possible solutions to the climate crisis. He is now writing a book on that subject.

As Gillis's coverage demonstrates, the climate-change story has shifted from establishing that global warming is unquestionably a human-caused phenomenon to the tale of how those impacts are playing out in many locales and what can be done about it. "You can sort of predict the overall temperature evolution of the planet," he told me, on the basis of different projections of future CO_2 emissions. But as to how exactly that warming is going to change the planet, and how quickly, "there is less clarity." There is uncertainty, for example, regarding what rising temperatures of the ocean and the air will mean in terms of the number and severity of hurricanes. The role that clouds will play in moderating, or exacerbating, human-driven temperature increases is also a subject of intensive study. How high global sea levels will rise by 2100 — three feet? six feet? — depends on still-uncertain rates of ice sheet melting and collapse.

Responsibly covering this legitimate scientific uncertainty is one challenge for editors and reporters. But reporting on whether human-caused climate change is real is not a matter of debate.

"I've drawn a circle on a blackboard in front of students and said, `Within this circle, we have legitimate science going on. There's a lot of uncertainty within this circle,'" Gillis says. "Then, over on the far right side, I draw another circle and say, `OK, here you have a bunch of crackpots.' The stupidest of these crackpots say things like, 'Carbon dioxide is not a greenhouse gas' or, 'The planet is not actually warming' — all this stuff that's completely nuts. If you're writing a science story, this can be completely dismissed.

"But what if I'm writing about the politics of climate change? Suddenly these people who are irrelevant to the science are highly relevant to the politics. A third of the U.S. Congress comprises climate deniers, and part of them go about babbling complete nonsense."

Nevertheless, when such people hold office, they have the power to affect policies as crucial as carbon taxes and incentives for renewable energy. Tracking the influence of powerful libertarian and anti-regulatory interests that peddle climate denial — like the Koch Brothers[7] and the Heartland Institute[8] — on politicians and policy

> ***"Climate denial has really taken hold in this country, to the point where it is a touchstone of one of our major political parties, and where tens of millions of Americans don't accept climate change.***
>
> *Neela Banerjee, supervising climate editor, NPR*

is an important part of climate coverage, on the national and local level. (A list of organizations and individuals who fund groups disseminating false and misleading information about climate change can be found at the **Union of Concerned Scientists**[9], **California's Office of Planning and Research**[10], and **Greenpeace**[11].)

Neela Banerjee, the supervising climate editor at NPR and formerly a reporter at InsideClimate News, says that even though the pseudoscience behind climate-change denial has been discredited, the forces attempting to sow doubt about the reality of global warming still wield influence. "Climate denial has really taken hold in this country, to the point where it is a touchstone of one of our major political parties, and where tens of millions of Americans don't accept climate change."

The key to covering climate denial, Banerjee says, is holding corporations, organizations, and politicians accountable: "It pulls back the curtain and tells how it's affecting our lives."

At InsideClimate News, Banerjee worked on two series that exposed important instances of climate denial and the influence of the fossil-fuel industry in American politics. The **first series**[12] showed that well before Exxon became a leading architect and funder of climate-change denial, the company's scientists and top executives — thanks to studies by its own researchers — fully understood and accepted that burning fossil fuels would harm the climate. The **second series**[13] showed that for decades, the American Farm Bureau Federation, a major farm lobby, worked, as she put it, "to defeat treaties and regulations to slow global warming, to deny the science in tandem with fossil fuel interests, and to defend business as usual, putting at risk the very farmers it represents." Given the significant greenhouse-gas emissions associated with agriculture and livestock production, the farm bureau's stance has been a significant impediment to fighting global warming in the U.S.

"So, if you live in an agricultural state, your state farm bureau could be doing things to address climate change and to prepare their farmers, like implementing crop cover and other steps to address carbon storage and the soil," says Banerjee. "But if the bureau is still giving money through campaign donations to politicians who deny climate change, then that's a good accountability story. Which is it? Are you going to help your farmers adapt to or mitigate climate change? Or are you going to elevate people whose policies are going to make the lives of your farmers even worse?"

Kate Sheppard, a senior enterprise editor at HuffPost, who previously covered climate change and the environment for *Mother Jones* and Grist, cited another example that reporters at HuffPost published in 2020: how misinformation about climate change has made its way into public-school textbooks. As part of a nine-story series, **"Are We Ready?"**[14], HuffPost ran an **article**[15] that reviewed 32 middle- and high-school textbooks and digital curricula being used in Florida, Texas, Oklahoma, and California.

The article cited numerous instances of false or misleading information that were included in widely used textbooks issued by major publishers, such as Houghton Mifflin Harcourt and McGraw Hill. Twelve of the textbooks contained statements that were erroneous or misleading, four did not discuss global warming at all, and others "downplayed the scientific consensus that human activities are causing the current climate crisis." The Texas State Board of Education, known for its record of anti-science views on evolution and global warming, has an especially egregious record of approving textbooks that cast doubt on climate science.

Among the assertions in the 32 textbooks HuffPost reviewed were that climate change "is one of the most debated issues in modern science"; that "scientists hypothesize" that rising CO_2 emissions have "contributed to the recent rise in global temperature"; and that "some critics say that this warming is just part of the Earth's natural cycle." Those are common tropes put out by climate-change-denying groups, and all of them are false. There is virtually no debate in the scientific community over whether human-caused emissions are the overwhelming reason for today's planetary warming. The greenhouse effect is not a hypothesis; it is an established principle of physics. And there is near-unanimous agreement among climate scientists that the climate change now sweeping the globe is not part of a natural warming cycle, but rather the result of enormous quantities of carbon dioxide being pumped into the atmosphere by human activities.

"It's important to know who's behind this denial and what their motivations are, ideological and financial," says Sheppard. "What kind of influence are they having, and how are they reaching people out in the world?"

All Climate Change Is Local

The 2020 Pulitzer Prize in Explanatory Reporting was awarded to the staff of *The Washington Post* for a **compelling series of articles**[16] titled "2 Degrees C: Beyond the Limit" — a reference to the looming 2 degrees Celsius (3.6° Fahrenheit) increase in temperatures beyond which scientists warn the world could face destabilizing global warming. The fact is, however, that as greenhouse-gas emissions continue to soar, many places around the world are already experiencing the effects of reaching or exceeding the 2° C increase in temperatures. *The Washington Post's* staff visited a dozen of these places — from **California**[17] to **Siberia**[18], from **Qatar**[19] to **Australia**[20] — to chronicle how temperature increases are affecting the environment and people's lives.

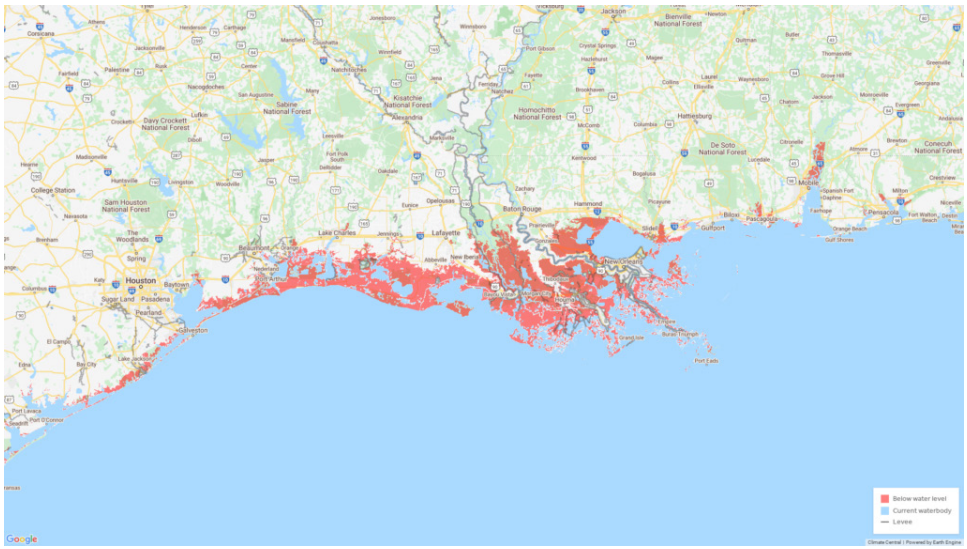
The series highlighted a fundamental truth about climate-change coverage: rising temperatures are already affecting nearly every region of the U.S. and the world. This global approach was impressive, but it's not required to cover this issue. Lo-

cal publications, TV and radio stations, and other storytellers need look no farther than their own counties, states, or regions to find these stories.

Along overbuilt coastlines, rising seas will be felt by everyone in the coming decades, with sea levels expected to increase as much as six feet by 2100. In the Rocky Mountain West, steadily rising temperatures and intensifying drought are leading to more intense and frequent wildfires. In many parts of the country, extreme precipitation events and flooding are on the rise because a warmer atmosphere holds more moisture.

If you are an editor or reporter and can't find the evidence of climate change in your city or state, you're not looking hard enough. Seasons are shifting, species are on the move, and extreme weather events are on the rise. The list of possible stories includes what local officials are doing to mitigate intensifying floods; changes needed in building codes to deal with the effects of climate change; the impact on insurance rates; the effects on agriculture; and the potentially devastating effects on the municipal budgets of coastal communities as rising sea levels force the funding of costly projects to hold back the sea.

Climate Central[21], a nonprofit research-and-news organization, understands better than most the powerful impact of showing readers how global warming is already changing their towns and cities, and what is likely to come. The site has posted **interactive maps and graphs**[22] illustrating how different regions are being affected by rising temperatures, increased precipitation, and other weather extremes. A widely viewed interactive tool, **Surging Seas**[23], showed how different coastal locales will be affected by sea levels as they rise this century by one foot, three feet, and beyond.



Climate Central's Surging Seas interactive map shows much of coastal Louisiana is projected to be lower than the annual flood levels projected for 2050. Source: Climate Central

Among many other examples of news reports on the growing impact of climate change in local regions:

- The California-based nonprofit news organization **Reveal**[24], partnering with the San Francisco public-radio station **KQED**[25], did a series of **podcasts**[26] and **written reports**[27] on the devastating Northern California wildfires in 2017 that killed 44 people and destroyed thousands of buildings.

- The nonprofit Pulitzer Center supports a project called **Connected Coastlines**[28], which works with a consortium of newsrooms and independent journalists to cover the impact of climate change on U.S. coastal regions.

- A similar effort, **The Invading Sea**[29], is a collaboration of 25 Florida news organizations — including the *Miami Herald, Orlando Sentinel,* and the South Florida public-radio station WLRN — reporting on global warming and sea-level rise in the state.

- National Public Radio did a **report**[30] showing that the urban "heat island" effect is most pronounced in low-income, minority neighborhoods that have historically been subjected to redlining — the practice by which banks and other institutions withhold mortgages and other investments from certain communities.

Among the editors and writers who have grasped the importance of bringing global-warming coverage to the local level is Lyndsey Gilpin, founder of **Southerly**[31], a nonprofit news organization covering ecology and environmental justice in the South. Working in a region where skepticism about climate change runs deeper than in many parts of the country, Gilpin has learned that a key way to connect with readers is to listen to their stories about how a changing climate is affecting their communities.

"The view of climate change has changed a lot in the South in just the last few years," says Gilpin, who started Southerly in 2016. "But because of the fossil-fuel disinformation campaign and the [conservative] media for years giving climate deniers platforms, the subject is politicized. That conversation has alienated so many people. But there are ways to `balance' this out by talking about climate change in ways that are more acceptable, so often we focus our stories around extreme weather, like flooding, heat waves, the impact of rain or drought on farmers or local businesses. Covering local impacts makes so much more sense to me, because people always want to protect what's around them.

"To be honest, I don't care what people call climate change, so long as they are willing to do what needs to be done to respond to it," Gilpin says. "They may not

be ready to jump into a climate strike, but they see what's happening where they live and how it's changing, and they are looking for people to listen to them. Looking at those kinds of community-level stories builds trust between journalists and readers."

Some of what Southerly has published on the local impacts of global warming include articles on the public-health problems created by **worsening floods in Appalachia**[32], on the dilemma faced by **residents of coastal Louisiana**[33] as their properties repeatedly flood in worsening hurricanes and tropical storms, and on the threat that increased flooding and rising seas pose to **historic African American sites**[34] in the South.

The article on the dangers facing neglected Black sites looked at historic and cultural locations, such as cemeteries, at risk in Texas, Florida, Mississippi, and North Carolina. By connecting circumstances across a state or region, Gilpin says, reporters and editors can inform and empower residents about how similar communities are dealing with problems created by climate change.

Another important lesson for editors, says Gilpin, is that when assigning and reporting on situations like the plight of neglected Black historical sites, it's vital to look at what inequities — both historical and current — have led to those problems. In the case of some African American cemeteries, Southerly's story noted that these burial sites had often been relegated to marginal areas vulnerable to floods and other forms of environmental degradation.

"When reporting on any low-income community dealing with environmental hazards or sea-level rise, you should look at the context of how they got there and what systems are keeping them there," she says. "And the people most at risk often have the fewest resources to do something about that. We're going to see these stories more and more, and we have to ask what are the political and economic systems that force people to be in these situations, and how do we hold the right people or agencies or companies accountable?"

That emphasis on the importance of speaking with people about how their own communities are changing, and what is behind it, was at the heart of a 2018 series, **"Finding Middle Ground: Conversations Across America,"**[35] in InsideClimate News. For the series, Meera Subramanian interviewed diverse groups — ranchers, fishermen, farmers, evangelical Christians — about how global warming was affecting their lives.

"It's very challenging to get someone interested in something that's too far away or too unclear," says Meaghan Parker, executive director of the Society of Environmental Journalists. "Focusing on stories locally is a powerful way to explain issues but also to connect to your audience. And it's not only about impacts but also about opportunities and solutions."

> ***"The view of climate change has changed a lot in the South in just the last few years.***
>
> *Lyndsey Gilpin, founder, Southerly*

Local Accountability, Local Experts

As the adverse effects of a warming world intensify, growing numbers of local, state, and national officials are pledging to do something about the threat. But the gap between words and deeds can be wide. Weaning modern economies off fossil fuels is a monumental challenge, and helping communities adapt to climate disruption is complex and expensive.

Still, in the coming years, editors and reporters will need to increase their efforts to hold officials accountable for failing to take steps to reduce emissions or help their communities live with climate change. For example, if places in South Florida are already regularly experiencing flooded streets from rising sea level, why do officials continue to approve billions of dollars in new construction? In the American West, why are local and state administrators still allowing houses to be built in areas vulnerable to a growing number of wildfires? As coastal storms get worse, why are local, state, and federal authorities allowing repeated rebuilding in vulnerable, storm-damaged communities like **Dauphin Island**[36], Alabama, or pursuing policies that are **bankrupting the federal flood-insurance program**[37]?

"The main thing is climate is not just an environmental story, and it's not just a science story," says Banerjee, of NPR. "It is everything. It's a real-estate story. It is a national-security story. It is a corruption story. It is a health story. One of the best ways to write about the climate, whether on the national level or local level, is through the lens of accountability."

The many scientists, agricultural-extension agents, conservationists, and other experts at the local or state level are an important resource. Every state has university researchers who study the regional impacts of climate change. State-government climatologists can be excellent sources. State and local agricultural experts know best how a changing climate is affecting farming.

Putting the Science Into Context

Some of the impacts of global warming are rapid, dramatic, and unequivocal, none more so than the changes that have swept across the Arctic over the past 40 years. While average global temperatures have **increased by close to 2 degrees**[38] Fahrenheit since 1880 — with two-thirds of that warming since 1975 — the Arctic has been **warming far more rapidly**[39]. The extent of Arctic Ocean ice in summer is about half what it was when satellite monitoring began, in 1979, and the volume of Arctic sea ice has declined as thick, multiyear ice disappears. The Arctic Ocean may largely be ice-free in summer by 2040 or 2050.

Other climatic changes, however, are less stark and less well understood. So when editing stories on the many shifts now underway globally, it's important to be wary of exaggeration (things are bad enough without exaggerating) and to put

the latest findings in context, showing readers and viewers that a range of future scenarios exists.

Although the overall trend of planetary warming is clear, scientists are still trying to sort out issues that involve the complex interaction of global atmospheric and ocean currents. When will rampant deforestation, increasing temperatures, and intensifying drought turn the vast Amazon rainforest from a massive absorber of CO_2, or sink, into a CO_2 source? Will the steady melting of Arctic permafrost lead to the release of a so-called "methane bomb" from thawing soil and wetlands, causing a catastrophic release of methane? (Methane lingers for only decades in the atmosphere, as opposed to carbon dioxide's centuries, but methane has a heat-trapping capability **roughly 30 times that of CO_2**[40].) How profoundly will marine ecosystems be affected by acidification caused by the world's oceans absorbing increasing amounts of carbon dioxide?

These and many other questions are under study. And when research comes out, stories should put the latest findings in a larger framework and not inflate any one study into a world-changing revelation.

"All of these impact questions are really hard, and there's a tremendous amount of uncertainty," says Justin Gillis, the former climate reporter at *The New York Times*. "Climate modeling is a legitimate enterprise. It gives us the best answers we're going to be able to have in current time to uncertain questions. But nobody pretends that climate modeling doesn't have big holes or big blind spots. I think the way to think about this is that's it's a problem in risk management. What the science has done is outline this distribution of risks.

"If you're confronting a new study and trying to figure out what to write about it," Gillis says, "the first thing I would tell my reporter to do is figure out where this fits in the longer thread, in the larger scientific context. *How might this study change the consensus? Will the study stand the test of time, or is there a history of outlier studies here that eventually get knocked down?* Any given study is just one data point in this complicated enterprise of producing human knowledge, where it's corrected and self-corrected. We routinely get things wrong but then, over the long run, we tack in the right direction."

This can be a challenge for journalists, who often latch on to outliers as opportunities for interesting stories. But, some outliers are just errors or even expected variances within a normal distribution. Putting the proper context on any single piece of data is critical in order to understand the broader truth.

Covering the Broader Environmental Story

Many of the suggestions and caveats that apply to the climate story also are relevant to wider coverage of the environment. Here are a few things to keep in mind:

- **Both the environment and climate story should be seen in the context of wider social and economic issues.** "The thing I would try to bring to these stories is showing that they are about power and equity and justice and health and race and class and gender," says Lyndsey Gilpin, founder of Southerly. "You don't have to say that about every single story, but I do think that coming to stories with that context is valid for showcasing these very complex issues." Environmental-justice stories should be an integral part of covering the environmental beat, and longtime patterns of racism, economic inequality, and government neglect have contributed to low-income communities' and minority communities' often being forced to bear the worst impacts of living near refineries, interstate highways, and other threats. When covering issues of environmental justice, ask your reporters, "How did things get this way? What's the back story of how a particular community wound up next to a heavily polluting enterprise, and what resources does the community possess to deal with the situation?"

- **The environment story in the U.S. is being shaped by the same trends that are leading to the deterioration of the global environment.** The population of the United States has more than doubled in 70 years, from 151 million in 1950 to 331 million in 2020. Development pressure is affecting everything from coastal wetlands to Rocky Mountain wilderness. Ask your reporters to put stories in the context of these longer-term environmental changes. For example, rising seas and intensifying storms unquestionably pose a major, and possibly existential, threat to coastal communities. Reporters should examine the factors, from federal flood-insurance programs to unconstrained development policies at the local level, that have put so many people and properties in harm's way in recent decades.

- **The fossil-fuel industry is not going away anytime soon, and covering its power and its environmental impact is key.** The vast majority of the world's scientists, and even many oil-company executives, acknowledge that the world's economies must largely wean themselves off fossil fuels if society is to escape the worst disruptions of global warming. However, the 21st-century fracking boom in the U.S. and the continuing construction of fossil-fuel infrastructure, such as pipelines and petrochemical plants, are just two examples of the continued reach of the oil-and-gas industry. Many examples of excellent journalism on this subject exist, such as ProPublica's tenacious reporting, led by Abrahm Lustgarten, on the **damage done to public health and the environment by fracking**[41]. One of the great economic, political, and

environmental stories of the 21st century will be the battle over decarbonizing the global economy, and editors and reporters should see many climate and environment stories through that prism.

- **Collaborations among news organizations are an important part of the beat's coverage.** This is especially true in an era when the power and resources of traditional newspapers have waned. Environmental stories can be "so complex and vary so much based on where we are, and they require so much data," that joining forces with other news organizations makes sense, says Gilpin. In 2019, Southerly, in partnership with Climate Central and *The Telegraph*, in Macon, Georgia, took an **in-depth look**[42] at how prescribed burning programs in Georgia and the Southeast have helped reduce the threat of wildfires. That same year, ProPublica, in collaboration with *The Times Picayune and New Orleans Advocate*, did a **series of articles**[43] titled "Polluters' Paradise," examining how a spate of new petrochemical plants in "Cancer Alley," along the Mississippi River, has led to an increase in emissions of cancer-causing chemicals in largely black and poor communities. When contemplating an environmental story or video with regional, state, or national impact, editors should consider whether collaborating with another web-based news site, newspaper, or radio or TV station would strengthen the work.

- **Hold governments and businesses accountable.** As it attempts to roll back environmental and climate regulations, the Trump administration was the subject of countless news reports outlining its pro-business, anti-regulatory initiatives. But there are many other examples of lax environmental oversight, at all levels of government. One strong example of calling officials to task has been the reporting of Jamie Satterfield at Tennessee's *Knoxville News-Sentinel.* In a **series of article**[44], she documented how the Tennessee Valley Authority, a federally owned corporation and utility, had failed to protect hundreds of workers who cleaned up the country's largest coal-ash spill — millions of cubic yards of sludge released after a dike at a TVA power plant gave way in 2008. As of late 2019, Satterfield reported, **44 workers had died**[45] from being exposed to the toxic coal ash, and more than 400 had been sickened. News organizations at all levels should examine the actions of corporations, too. While the efforts of some companies, such as Nike and Siemens, to reduce CO_2 emissions and adopt more-sustainable business practices are examples of solutions-oriented corporate action, other corporations, such as those **operating heavily polluting hog farms in North Carolina**[46], deserve close scrutiny. Editors at local publications should closely follow the actions of giant corporations, such as the Minnesota-based agricultural conglomerate Cargill, to **look at their impact on the environment**[47], from deforestation in the Amazon to the plastic pollution in the world's oceans, which is driven in part by corporations such as Coca-Cola and PepsiCo.

Solutions

For the most part, the climate and environment beats are fertile but grim terrain for reporters and editors. Vast areas of formerly pristine rainforest in Indonesia, Malaysia, Central Africa, and the Amazon have been destroyed to make way for palm-oil plantations and other agricultural enterprises. Species are rapidly disappearing, leading to what scientists call the "sixth great extinction" in the planet's history. The world community has so far failed to limit greenhouse-gas emissions.

All that said, a strong argument exists for leavening this depressing news with solutions-focused stories. For one thing, even the most concerned and well-intentioned readers and viewers may at some point throw up their hands in despair. But, more important, news organizations and other storytellers have an obligation to report on the many efforts to fight climate change and environmental destruction. The way out of the current mess will be a combination of government policies, such as carbon taxes and support for renewable energy; the research and innovation of scientists, engineers, and entrepreneurs; and the many initiatives being undertaken by conservation groups.

It would be hard to imagine a more challenging transition than the switch from fossil fuels to renewable energy, and the effort is worthy of intelligent coverage. For example, Scandinavian countries are leading the way in green energy, with Denmark **generating nearly half of its electricity**[48] from wind power in 2019 and electric vehicles in Norway **accounting for more than half**[49] of all new-car sales. Scandinavian economies are small and their societies wealthy, but their progress offers a road map for other, larger countries. Germany's economy is anything but small — it has the world's fourth-largest gross domestic product — but thanks to progressive government policies, innovative companies, and a public deeply committed to fighting climate change, it is now **a world leader in renewable energy**[50].

Many other solutions stories are there to be covered, including the steady progress being made **in improving batteries**[51] for cars, homes, and larger uses — a key component of the switch from fossil fuels to renewable energy — and a growing effort to develop technologies that would actually **remove CO_2 from the atmosphere**[52]. That's a daunting challenge on a global scale, but scientists and engineers are working on it. Such efforts need to be covered smartly, without falling prey to "silver bullet" thinking that any one solution will solve the problem.

Red Flags

- Before assigning any article or video, an editor will want to ask, **"What's new here, and how does this proposal advance the story?"** This is especially true with climate and the environment, because they are so intensively covered and the same issues come around again and again.

- **Don't do the same stories over and over.** Several editors cited two subjects that have been covered ad nauseam. One is the resettlement of Isle de Jean Charles, a small community in Louisana's Cajun country, because of rising seas and subsiding marshlands. The other is Shishmaref, an Inupiat village in Arctic Alaska, threatened by rising seas and erosion linked to a loss of sea ice. These were stories worth doing — the first dozen or so times. But the world doesn't need another article on the same places. Global warming is changing the face of many communities, so find fresh angles in your backyard and cover those.

- Especially in environment and climate coverage, **beware of advocacy that masquerades as reporting.** A story or video will have more impact if it fairly presents all sides of an issue (an exception being the debate over whether human-caused climate change is real) and does not champion a cause.

- **Beware of hyping one study or one technology.** Put new developments in context, and examine highly touted solutions with some skepticism.

- **Beware of stories that perpetuate stereotypes about certain communities or regions.** As Lyndsey Gilpin notes, "Climate change is incredibly complicated, and humans are incredibly complicated, so stories that oversimplify things or make generalizations about a community obviously raise a red flag. I see this problem with some national reporters who parachute in and get their quote and leave."

Additional Reading and Resources

Society of Environmental Journalists: A good starting point for editors is the **website** of the Society of Environmental Journalists. It has many good sections, including **Inside Story**, where environmental reporters and editors discuss their work and practices; **TipSheet,** which examines story ideas, reporting tools, and leads for story ideas; **Beat Basics,** which explores key environmental topics in depth and offers ideas on stories and valuable sources; and **EJ InSight**, a quarterly column about environmental reporting written for photographers and

videographers. The site also has a **Climate Change Guide**, which lists sources of information — and disinformation — on global warming, and a section on **how to use the Freedom of Information Act in environmental reporting**. A new addition to the website, Covering Your Climate, is designed to help editors and reporters in different regions. The first section, **The Emerald Corridor,** covers the Pacific Northwest, and the group will soon add sections on other U.S. regions.

Climate Central: This is an excellent **website**, with loads of information for journalists, policy makers, conservationists, and the general public. Climate Central has done groundbreaking work in graphics, charts, maps, and other visual tools to illustrate the current impacts of climate change and what can be expected later this century. Its **Interactives** section is home to much of this material, including the **Surging Seas** feature, which shows by year, elevation, and various water levels how sea-level rise will inundate coastlines. The **Maps section** has excellent interactive material delving into subjects as varied as shifting seasons and the growing damage caused by extreme weather events.

Earth Journalism Network: An important **organization**, representing thousands of members from 180 countries, with information about covering environmental and climate issues in the developing world. The web site contains **reporter resources** with information about key topics, such as the **spread of diseases** from animals to humans or reporting on **climate-change solutions**. The network also posts **many recent stories** on the environment and climate.

The Open Notebook: This is a valuable **site** for science editors and writers, featuring interviews with journalists, examples of top stories, and a section in which leading environmental journalists **talk about their work.**

Drilled: Founded by the journalist Amy Westervelt in 2018, **Drilled** features podcasts devoted exclusively to climate change.

National Climate Assessment: Prepared by scientists from the U.S. government, the **assessment** is an excellent source for editors looking for scientific grounding in how global warming is affecting the United States.

Intergovernmental Panel on Climate Change: The **mother of all climate-change organizations** and site of the most comprehensive **global reports** on the subject, the IPCC is working on a new global report, but meanwhile its 2014 **Synthesis Report for Policymakers** is good, if somewhat outdated, primer on the science of climate change.

About the Author

Fen Montaigne began his journalism career at the *Houma Courier*, a small daily in Louisiana's Cajun country. He went on to spend 20 years as a newspaper reporter, 15 of them at *The Philadelphia Inquirer.* He was the Moscow correspondent during the collapse of the Soviet Union and was a finalist for the Pulitzer Prize in feature writing. He spent a dozen years working as a freelance writer, with articles appearing in *National Geographic*, *The New Yorker, The Wall Street Journal*, and other publications. He is the author of several books, including the travel/adventure tale ***Reeling in Russia***, and an account of climate change in Antarctica, ***Fraser's Penguins***, for which he received a Guggenheim fellowship. He helped launch the magazine *Yale Environment 360* in 2008 and is its senior editor.

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10

Fact Checking Science Journalism: How to Make Sure Your Stories Are True

By Brooke Borel

Introduction

For an editor, there's hardly anything worse than spending weeks or months on a story — sifting through freelance pitches for a gem or thinking up an idea and assigning it to just the right journalist, shaping the narrative, reading draft after draft until the words start to blur, pushing for clarity, getting that last round of clean text into layout, finally publishing — and then facing a big, fat correction.

How can editors make sure all that beautiful copy is correct before a piece goes live?

Answer: fact-check it.

Fact-checking is a key element to any editorial team. The process may look a little different from one news outlet to the next, but the basics are always the same. It requires a step in the editorial process in which someone looks at a story line-by-line and asks *Where did we get this information? How do we know it is true?* Then that person goes back to the source, whether it's a scientific paper or an interview recording, and double-checks. The fact-checker also casts a gimlet eye on that source, asking: *Is this a good source? Can we do better?*

Here you will learn how fact-checking functions at various news outlets; how to incorporate fact-checking in your team's editorial process; how to adapt the process to the limits of time and resources, and more. And yes, we fact-checked it.

> ***"Fact-checking is more than checking facts: It's also about checking assumptions. Whether you're examining your own work or someone else's, the hardest part is identifying and interrogating the implicit ideas that tie a story together.***
>
> *Katie Palmer, science and health editor, Quartz*

The Three Models of Fact-Checking

This chapter will focus on editorial fact-checking, one of the layers of quality control you may find at a media outlet. It happens within the editorial team, using staff members or freelancers, and it involves double-checking the facts in a story before it publishes. We won't dig into political fact-checking, which has dominated most conversations on fact-checking in recent years. Political fact-checking mostly involves looking at politicians' claims after they've made it out into the world. (It's worth noting that there are political fact-checking groups that do check claims regarding science, including FactCheck.org's **SciCheck feature**[1] and **Snopes.com**[2].)

In American magazines, formal editorial fact-checking seems to have first appeared in the 1920s. *Time* **launched a fact-checking system**[3] in 1923, and *The New Yorker* reportedly started its fact-checking department several years later. The practice gradually expanded across print magazines, although **for decades**[4] fact-checking was considered women's work — important but largely unrecognized.

Today, although fact-checkers are more diverse than they used to be, the practice is still often overlooked or poorly understood. The job did get noticed in the 2014 book ***Invisibles: The Power of Anonymous Work in an Age of Relentless Self-Promotion***[5], in which David Zweig profiles people who do jobs that are important but go largely unnoticed — unless they make a grave mistake. (Such people also include structural engineers, interpreters at the United Nations, and orchestral piano tuners.)

Types and Models of Fact-Checking

Political fact-checking: A third-party watchdog, in which an organization double-checks claims made by politicians and other public figures.

Editorial fact-checking: In-house quality control, in which newsrooms double-check information before it is published. Editorial fact-checking generally follows one of these models:

The magazine model: A verification system in which a person other than the writer, editor, or copy editor is responsible for double-checking every fact in a story, including individual facts and larger arguments or narrative arcs. The fact-checker may rely on the journalist's sources and new sources — even including new interviews. Types of stories that use this model include:

- A long feature with multiple sources, including many interviews.

- A story of any length that accuses a scientist of misconduct, fraud, or a conflict of interest.
- A package with many smaller elements on a single theme, including explainers, expert Q&As, infographics, and photographs.
- A narrative podcast series.
- Any story published at an outlet that uses the magazine model.

The newspaper model: A verification system in which journalists are responsible for confirming each fact that appears in their own stories. Other people in the newsroom, including editors and copy editors, may do spot checks. Types of stories that use this model include:

- A hot tip from a solid source.
- A quick news item based on a new study with a looming embargo.
- A short, evergreen service piece.
- A quick explainer.
- A straightforward news piece by a beat reporter.
- A news round-up on a podcast or radio show.
- Any story published at an outlet that uses the newspaper model.

The Hybrid Model: A verification system in which a single newsroom deploys both the magazine model and newspaper model, depending on the type of story. Longer, complex pieces typically get the magazine model; shorter, newsier pieces get the newspaper model.

Editorial fact-checking has even managed to break into the broader public conversation here and there, making it into Hollywood movies such as *Bright Lights, Big City* (1988), *Almost Famous* (2000), and *Shattered Glass* (2003). And in 2018, fact-checking arrived on Broadway in the adaptation of the 2012 book ***The Lifespan of a Fact***[6].

Although hard data on fact-checking in journalism are hard to find, a **2018 report**[7] I wrote, with the help of a team of researchers and a fact-checker,

for the Knight Science Journalism Program at the Massachusetts Institute of Technology, looked at the practice within science journalism. The report synthesized 91 interviews and 301 surveys with editors, fact-checkers, journalists, and journalism professors and found, among other things, that only 34 percent of outlets that cover science use dedicated fact-checkers.

The report also clarified the three modern models of fact-checking. In the magazine model, fact-checkers often hold positions that are apart from the writers and journalists, editors and copy editors. The fact-checker checks everything in a near-finished piece, which includes individual facts as well as the big picture. For the latter, the fact-checker may ask, *Does the narrative make sense? Does it obscure the truth in some way? Does the evidence support the thesis? Are there errors of omission?* To confirm the discrete facts, as well as how they hang together, the fact-checker combs through the writer's source material and may re-interview the people who appear in the piece. The fact-checker will often uncover new sources to help prove or disprove a claim.

"The fact-checker checks everything in a near-finished piece, which includes individual facts as well as the big picture.

Today the magazine model isn't used only in print magazines. The approach is common across media — from print to digital magazines to podcasts to video — particularly for long and complex stories including narratives, long-form, packages, and investigations, as well as stories of any length that are legally sensitive.

But a lot of publications don't have fact-checkers to do this work. That doesn't mean these publications don't verify the information they publish. Rather, they are more likely on the newspaper model, in which journalists are responsible for double-checking their own facts. This model still has safety nets. Editors are supposed to push back when they read a claim that doesn't sound quite right, while copy editors — in cases where the job still exists — check basic facts, including spelling, titles, and geographic locations. But the process is not necessarily line-by-line or systematic. Rather, it's up to the journalist to figure out the process and make sure it's done right.

"The fact-checker, presumably, will not be as emotionally invested in a story as the people who put it together to begin with. The extra eyes can translate to fewer corrections — and the legal liabilities that may come with them.

As the name suggests, the newspaper model is common to most newspapers. But it's also found across other media, from short items on radio and television to brief online news.

Both the magazine and the newspaper models have advantages. The magazine model can help catch errors that the newspaper model simply won't. Although no one is truly objective, including journalists, having a separate person fact-check can add fresh, skeptical eyes, to help a piece of journalism approach objectivity. The fact-checker, presumably, will not be as emotionally invested in a story as the people who put it together to begin with. The extra eyes can translate to fewer corrections — and the legal liabilities that may come with them.

But the magazine model takes money and time. The newspaper model, for most

stories, won't cost as much, so it's helpful for short or simple pieces that don't call for a big investment. It is also nimbler, which means breaking news and other fast-paced stories can be published more quickly.

Increasingly, in order to adapt to digital publishing and the financial uncertainties of modern journalism, some publications are using a hybrid model for fact-checking. In the hybrid model, publications use the newspaper approach for stories that are time-sensitive or relatively short and simple, saving the more intensive magazine approach for more complex pieces. The hybrid model allows publications to allocate fact-checking resources where they are needed most while freeing reporters to keep up with breaking news.

The Fact-Checking Process

Fact-checking may seem straightforward, but you might be surprised at how many "facts" a fact-checker will see in a story. Below, download the six-paragraph passage from an Undark story and underline every fact. How many facts do you find?

Fact-Checking Example[8]

Once you've done that, download my "answer" sheet, showing every fact I've found. Did you get them all?

Fact-Checking Answers[9]

My guess is you might have missed a few. But, with a proper fact-checking process, you can ensure that your stories are well-checked and error-free. Ideally, that process would look more or less like this, which is based on the magazine model:

Step 1: The Writer and Editor Finalize the Story

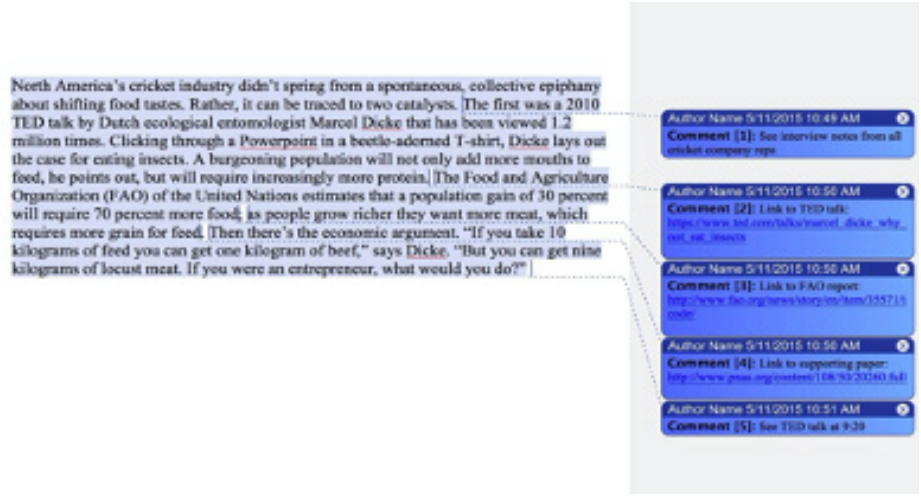
This isn't the absolute final version that will be published, of course. But when it comes to the overall structure and sourcing, this is the version that both the writer and editor feel is ready for scrutiny. In other words, they don't plan to keep tinkering with different ledes, move sections around, add a lot of reporting, or do any other major story surgery.

Step 2: The Writer Annotates a Copy of the Story and Sends It to the

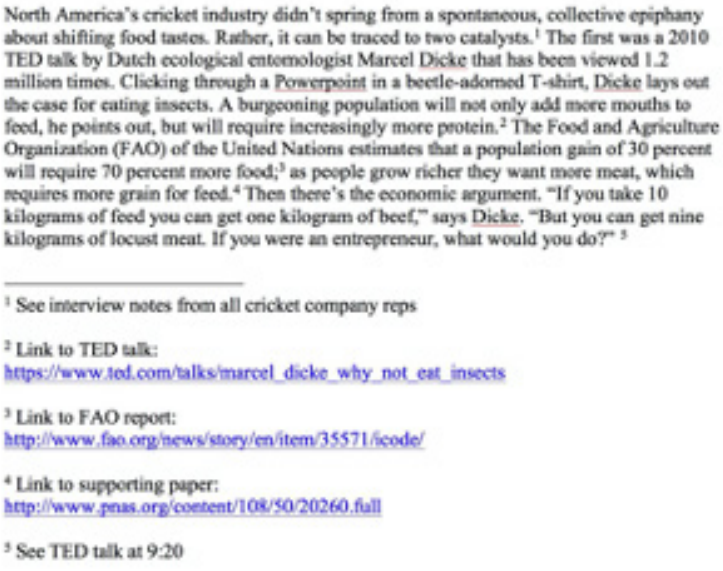
Fact-Checker

In order to help the fact-checking process move smoothly, it's vital for the writer to give the checker a clear road map of the reporting. The first step is to annotate a copy of the near-final story. Most drafts will appear in either Microsoft Word or Google Docs, which means the writer has two choices for annotations: footnotes and comments. Either way, the writer will use those tools to cite every source for every fact: contact information for experts or eyewitnesses; descriptions and file names for interview recordings, transcripts, journal articles, and email correspondence; titles of books or other print sources; and links to key websites (although screenshots or PDFs are also recommended, since websites can change).

Brief annotations shown as comments. Credit: Brooke Borel



Brief annotations shown as footnotes. Credit: Brooke Borel


North America's cricket industry didn't spring from a spontaneous, collective epiphany about shifting food tastes. Rather, it can be traced to two catalysts.[1] The first was a 2010 TED talk by Dutch ecological entomologist Marcel Dicke that has been viewed 1.2 million times. Clicking through a Powerpoint in a beetle-adorned T-shirt, Dicke lays out the case for eating insects. A burgeoning population will not only add more mouths to feed, he points out, but will require increasingly more protein.[2] The Food and Agriculture Organization (FAO) of the United Nations estimates that a population gain of 30 percent will require 70 percent more food;[3] as people grow richer they want more meat, which requires more grain for feed.[4] Then there's the economic argument. "If you take 10 kilograms of feed you can get one kilogram of beef," says Dicke. "But you can get nine kilograms of locust meat. If you were an entrepreneur, what would you do?" [5]

[1] See interview notes from all cricket company reps

[2] Link to TED talk:
https://www.ted.com/talks/marcel_dicke_why_not_eat_insects

[3] Link to FAO report:
http://www.fao.org/news/story/en/item/35571/icode/

[4] Link to supporting paper:
http://www.pnas.org/content/108/50/20260.full

[5] See TED talk at 9:20

> ***"One of my favorite fact-checking strategies is to save PDFs of the websites I visit for a story in a single file, and to add comments (bubbles) in the text of the story with chunks of the related facts from those websites/pdfs.***
>
> *Roxanne Khamsi, freelance science journalist*

The more detail the better. For instance, if a quote came from an interview recording, the writer should include the timestamp. If information came from a book, the writer should provide relevant page numbers.

Step 3: The Writer Provides the Fact-Checker With Sources

The next step is to identify the sourcing. For most sources, the writer should provide files that correspond to the citations in the annotation (with the exception being human sources; for those, contact information is fine). If the material isn't particularly sensitive, the writer could send it by email or with a file-sharing service such as Dropbox. If the sourcing includes sensitive information, the writer may want to use password protection and/or encryption. And if the material is especially sensitive — for example, if it includes documents and identification from a whistle blower — the writer may want to send a hard drive or laptop and request that the files not be transferred to a computer with an internet connection.

Step 4: The Fact-Checker Fact-Checks

The fact-checker reads through the piece at least once, then goes through it again line-by-line, checking each fact against its source. This may require phone calls with experts and other people who appear in the story or in the writer's notes. The fact-checker also assesses the quality of the back-up material and may look for new sources as needed.

Step 5: The Fact-Checker Proposes Changes

The fact-checker presents a list of proposed changes to the writer, the editor, or both. At many news outlets, the fact-checker will simply use tracked changes and comments in Microsoft Word or Google Docs to flag the changes and provide context. (Exception: If the fact-checker runs into major problems, such as errors that dissolve the premise of a story, or evidence of plagiarism, those shouldn't be saved until the final report. They should go to the editor immediately.)

Step 6: Review

The editor or writer — or, more likely, both — will review the proposed changes. There may be some back-and-forth with the fact-checker, both to negotiate precise wording and to collectively evaluate different sources. For instance, a fact-checker may push for a word that is more technically correct, while a writer may advocate for something that doesn't come across as jargon, and the team will

have to decide what word best serves the reader. Or the writer may have used one study to support a point, while the fact-checker may have found other solid research that contradicts it — here, the team will have to figure out how best to reflect this uncertainty in the text, or whether some of the studies are not worth citing, perhaps, for example, because their authors have serious conflicts of interest.

Step 7: Make Changes

Once everyone is in agreement on the facts, either the fact-checker or the editor makes the final changes in the document. But if there are disagreements, it is typically the editor's job to make the final call.

The Newspaper and Hybrid Models

The newspaper model may follow an abbreviated version of the lengthier magazine model. But, of course, this model doesn't involve a dedicated fact-checker. Here, the writer and editor typically finalize a story. During that process, the editor should push back on various claims and sources to make sure the writer is using solid evidence. Then it's passed on to a copy editor, who may also do a light fact-check for basic information.

To help build fact-checking into the system, the writer can add steps to the reporting and writing process. For instance, a writer should always make every effort to verify information with good sources before putting it in a story — especially if that information is key to the premise. Second, a writer should set aside time after the story is finished to go back through it line-by-line and double-check the sourcing for each fact.

The hybrid model combines the briefer newspaper process for short or time-sensitive pieces and the in-depth magazine model for more-complex pieces, including long-form, narratives, and legally sensitive stories.

> ***"Remember that you are working on behalf of both the reader and the writer. You want to be sure the reader sees correct information, but you are also making sure the writer can tell a compelling story, so suggest accurate edits that are true to the writer's voice.***
>
> *Brad Scriber, deputy research director, National Geographic*

Fact-Checking Best Practices

Fact-checking works best when you have a consistent and clear editorial process for your staff and freelancers.

- Create a work flow — including clear stages and responsibilities for editing, top-editing, fact-checking, and copy editing. All stories should go through this process.

- Avoid letting journalists, sources, editors, or fact-checkers bend the rules or the process.
- Always make sure your journalist has strong evidence for big claims, which include:
  - Sweeping “scientists say” statements.
  - Scientific findings that counter the majority of existing relevant studies.
  - Information that suggests, or outright says, that someone committed a crime, ethical breach, or anything else that could get you sued for libel if it proves to be wrong.
  - Information about medical devices, diets, and any other product or practice that could harm a reader if it proves to be wrong or misleading.
- Create checklists for reporters that they can tape to their computer screens, reminding them to *always* double-check sourcing for:
  - Spelling of names and places
  - Titles and affiliations
  - Ages (be sure to check if a source will have a birthday before publication)
  - Gender and preferred pronouns
  - Dates
  - Basic numbers and statistics
  - Geographical locations
  - Common typos (should that be millions or billions?)
  - And any other quick, easy facts that are easy to double-check — and easy to get wrong

Setting Up a Fact-Checking System

Some science editors will land at a publication that already has a fact-checking system. But if you find yourself at a publication that doesn't have such a system, and you have the interest — and the budget — to set one up, here are some things to consider.

First: Think about your group's editorial process. How many editors typically look at a writer's draft? How much time do you usually have between when a story is assigned and when you want to publish? Also: What kinds of stories do you typically publish — mostly quick, newsy items, or mostly long, complex narratives, or a mix?

No matter how big your team is, or how quickly you plan to turn around stories, the fact-checking should go close to the end of the editing process. Of course, everyone on the team should report, write, and edit with an eye toward facts and verification. But the line-by-line fact-check will be most effective if it happens after the story is more or less in its final form. If you have only one editor look at a story before it publishes, then the fact-check should come after that editor feels the story's structure is in place and all of the editor's questions answered. And if you have a whole line of editors — an assigning editor, an outside editor, a top editor — the fact-check should happen after the top editor has finished with it. (Of course, at least one editor will also typically look at a story after the fact-check, to make final changes and confirm that everything is in place.)

> ***"Always make sure to run the final draft by the writer for a final review before publishing the story. I have had editors publish without getting the chance to do a final fact-check only to discover too late that errors had been introduced.***
>
> *Kendra Pierre-Louis, climate reporter*

3 Things to Watch Out For

A fact-check usually turns up at least a handful of errors — typos, garbled quotes, a claim that doesn't have the appropriate caveat. But the worst case is a fact-checker's turning up something that shakes the foundation of a story. Editors can avert such a story-killing fate long before the work goes to the checker by keeping an eye out for:

- **False balance**: If a story gives a lot of play to an outlandish-sounding theory or a contrarian opinion, ask: Based on the direction of the scientific literature on this subject, is there actual evidence to support this point of view? Example: A feature story on researchers who say they have proven that climate change isn't happening, when most other research says the opposite.

- **Big claims**: Always kick the tires when the writer makes a sweeping statement, especially if the writer doesn't cite a source. Ask: Where did this come from? What other research or experts support or refute it? Example: An unsupported claim like: "The Covid-19 crisis will eventually infect at least 300 million people worldwide."

- **Single-source claims**: Does it sound as if the writer is basing some pretty important stuff on a single person or paper? If so, ask for the sourcing. If it seems thin, tell the writer that a fact-check will require corroboration — and that it's needed now. Example: A story that accuses a scientist of fraud, but the only evidence supporting the claim is a quote from another scientist.

As for the mix of content at your publication: If you publish mostly long, complicated stories, you probably want to follow the magazine model. If you publish mostly short items, breaking news, and other quick pieces, you should probably stick with the newspaper model. And if you publish a little bit of everything, you might want either the magazine model or the hybrid model, depending on your budget.

Next: If you've come this far and have decided that, yes, you need to set up a magazine-style or hybrid fact-checking system, here are some key steps:

- Make sure everyone on your team, including freelancers, understands how stories make their way through the editorial process — and how and when fact-checking takes place.
- Alert your writers, including freelancers, about the types of material you will collect from them for the fact-check. Many publications include this information in their freelancer contracts.
- Provide clear guidelines to your fact-checkers. (Some publications have in-house documents describing this practice; others prefer not to keep written instructions.)
- Decide whether you are following a magazine or hybrid model. If the latter, designate which types of stories will fall under the magazine or newspaper approaches.
- Designate someone on staff to oversee the fact-checking team. This could be a research editor, a managing editor, a copy editor, or any other team member who can keep the process moving thoroughly and efficiently.
- Hire fact-checkers, as either staff members or freelancers.
- Incorporate fact-checking into your publication schedule.
- Make sure to fact-check not only story text but also anything else that you publish, including headlines and subheads, photographs and captions, illustrations, infographics, and video clips.

And even if you decide to stick with the newspaper model, make sure your team — again, including freelancers — understands the process and the expectations. When possible, give your writers time to fact-check their work before their stories are published.

Working With Fact-Checkers

Fact-checking is an excellent career path for many journalists — some, for instance, build robust freelance businesses by fact-checking for multiple outlets or book authors, while others may become the research editor or director at a glossy magazine.

But many fact-checkers are early-career journalists, so they may not have as much clout as, say, a well-known writer or a longtime editor. One of the many duties of an editor is to know how fact-checkers fit into the larger ecosystem at your publication — and to make sure they have the respect they need in order to do their job. Let your checkers know that you have their back when they need support.

One of the most infamous recent examples of how this system can break down comes from *Rolling Stone*. In 2014, the magazine published a story titled "A Rape on Campus," which outlined an alleged rape at a University of Virginia fraternity party. After the story was published, it fell apart: Key reporting was poorly sourced or inaccurate. The fraternity, individual members of the fraternity, and an associate dean at UVa successfully sued *Rolling Stone* for millions in a settlement.

Rolling Stone has a fact-checking department. So what went wrong? A **lengthy report**[10] from the *Columbia Journalism Review* presented a list of problems. One particularly salient issue: The fact-checking department did question some thinly sourced material in drafts of the story. But the fact-checkers were overruled. According to the *CJR* report, the head of the fact-checking department at the time noted that decisions on sourcing for the story "were made by editors above my pay grade."

If these more powerful editors had listened to the fact-checking team, they may have avoided an expensive and damaging mistake.

There's a flip side, too. Fact-checkers fill an important role, but because their job is to specifically question claims and make sure they hold up under scrutiny, sometimes they can swing too far in the other extreme. They can be a little too pedantic. Maybe, in a science story, the fact-checker will ask for a caveat or a deeper explanation for every single point of science in a story. Here, it's the

> ***"Notate, notate, and notate. If questions arise, carefully documenting your work will come in handy. (You won't remember it in six months if you are like me!) Check everything, especially the things you think you know.***
>
> *Michelle Harris, freelance fact-checker*

editor's job to push back, because your goal is to produce something that is not only accurate but also readable and compelling. If no one wants to read a piece, what's the point?

No matter what: As an editor, make sure you are also acting as a diplomat for your entire team. Be respectful of everyone's efforts on a story, and be thoughtful in how you include — or don't include — the fact-checkers' recommendations.

How to Find Fact-Checkers, and What to Pay Them

It's not always easy to find a fact-checker, especially if you're in a pinch and need someone fast. For the most part, editors find their staff and freelance fact-checkers through word of mouth. So one approach is to simply ask colleagues for recommendations, even if they work for another publication. If you are looking for a fact-checker with experience in science journalism — or in a specific scientific discipline — it's especially helpful to know colleagues at other science publications who can help.

Freelance journalists also often supplement their income with fact-checking gigs, so it doesn't hurt to ask your pool of writers, too. The Knight Science Journalism Program at MIT is working on a fact-checking website that will include a public database of fact-checkers, which will make some of these searches easier. The fact-checking database should be live by 2021.

As for what to pay fact-checkers, it varies. According to the **Editorial Freelancers Association**[11], fact-checking rates as of now range from $46 to $50 per hour. The 2018 KSJ fact-checking report found an average of $27.76 to $34.27, ranging from $15 to $75 an hour, though the data were limited. Expect to pay more for rush jobs, weekend work, and fact-checkers with lots of experience or expertise in a specific field. Some outlets also pay fact-checkers by project rather than by the hour.

With Great Power Comes Great Fact-Checking Responsibility

As an editor, you hold a lot of power over your team. It may not always feel that way, but when it comes to ushering a story through to publication, you are the boss (or at least *a* boss). You are a gatekeeper in assigning stories. You also have final say over what makes it into a published piece and what doesn't. Don't throw this power around just for the sake of being powerful; use it wisely.

When it comes to fact-checking, there are many opportunities for an editor to make sure a story is right. You can tactfully and diplomatically ensure that your journalists and fact-checkers are paying attention at each of these steps.

The first opportunity is at the stage of pitching or assigning. Make sure the stories you pick up are sound and worthy of coverage. If the reporting in a story pitch seems too thin, ask the reporter for more information — relevant studies, for example, or other solid sources in support. Vet freelancers to make sure they are the right people to tell given stories — look at their potential conflicts of interest, which could skew their reporting or how it is perceived, and look at the quality of the information they have published elsewhere or posted on social media. Also, be clear upfront about your publication's fact-checking policies, so the writer isn't surprised when the story gets to that stage.

Editors also have an opportunity to help with fact-checking every time they read a draft of a story. This doesn't mean you need to look up every fact line-by-line, as a fact-checker would. Instead, ask the writer tough questions, and make sure to clarify murky claims: Where did this come from? Says who? Source? And if you know a topic fairly well and you think a view or key source is missing, prod the writer as to why it's been left it out. (Remember: You may think you know more than the writer, but you often don't. Always be respectful in these interactions.)

Editors sometimes have to play referee between writers and fact-checkers. Ideally, of course, everyone who touches a story will be a team player, cooperating to make the story as good and as accurate as possible. Still, a writer may dislike a source the fact-checker picked or may prefer a certain phrasing that is more literary, if less accurate. And a fact-checker may get a little lost in the weeds. You'll be the tiebreaker in these disagreements, so make sure you understand everyone's reasoning and sources.

> ***"Science can get complicated fast. Don't be afraid to ask questions, even seemingly basic ones. A willingness to say 'I don't understand' or 'I don't know' is a superpower.***
>
> *Emily Krieger, freelance fact-checker, editor, and writer*

The Scary Legal Stuff

Fact-checking is useful for more than getting accurate information to readers. It can also help save your publication from an expensive lawsuit. But first: Do not use this guide for legal advice. For that, you're going to need a media lawyer. Second: We aren't getting into legal definitions here. Rather, briefly, these are the potential legal issues that fact-checking could help catch:

- **Defamation:** If a journalist publishes or airs damaging information about someone and it turns out to be untrue, the journalist and the publication could face a defamation lawsuit. (The law varies, so it depends on whether the story is about a person who is a public figure, like a politician or a celebrity, or a private citizen; public figures face more hurdles to win a defamation case.) Fact-checkers could stop misinformation from appearing in a story, particularly if they are clarifying information by re-interviewing sources and finding new ones.

- **Invasion of privacy:** The line between newsworthiness — information that's in the public's interest to publish — and a reasonable expectation of privacy isn't always clear. Fact-checkers can weigh in on individual cases, particularly since they will be familiar with the source material and could catch potential problems — for instance, information gathered through illicit means, such as illegal surveillance or trespassing.

- **Copyright infringement:** For the most part, it's OK for journalists to refer to published works in their writing. The practice typically falls under what is called fair use. But there are exceptions. You shouldn't expect a fact-checker to know the legal distinctions. Still, they can help flag passages in which a story republishes other work, which can help you decide if you need to contact a lawyer.

- **Plagiarism:** While lifting someone else's writing isn't technically illegal, there are some cases in which plagiarism could edge into copyright infringement. Even when it doesn't, it's still considered a major journalistic sin. A fact-checker can help catch plagiarism — for instance, by recognizing phrases or ideas taken from source material.

Keeping Records

By keeping source material from each story you publish, you can help address errors caught by your eagle-eyed readers. You could also help protect your publication from a lawsuit. Whether you keep an old filing cabinet or have a digital system on a shared drive or in the cloud, remember to:

- Keep it organized, so you can find a specific source days, months, or even years after a story publishes.

- Keep it secure, particularly for sensitive material such as leaked documents and contact information for anonymous sources and whistle blowers.

- Keep it for the appropriate amount of time. Look up the statutes of limitation in your state and make sure your records stay intact for at least that long.

Fact-Checking on a Budget

After making your way through this chapter, you may be thinking: *Wow, fact-checking sounds time-consuming. And expensive. I don't know if we have the resources to do this*. It's an understandable reaction. After all, news outlets still

haven't quite figured out the best way to survive in the online era, and so most editors are dealing with shrinking resources.

So how do you fact-check if you can't afford a fleet of magazine-style checkers?

Here are a few tips:

- **Apply the hybrid model** to free up time and money for shorter pieces and help support longer stories. Those longer stories already took up a lot of resources; if you have major errors, that investment won't pay off.

- **Put a high priority on potential liabilities.** In other words, if one of your stories accuses someone of a crime or other misdeed, you'd better make sure you have solid sourcing that proves you're right.

- **Create a reporting checklist** of facts that are especially easy to confirm — and also easy to mess up. For instance: spelling, geographical location, typos (was that supposed to be millions or billions?), and dates. Every writer should reference the checklist for every story.

- **Encourage your writers to read their stories with fresh eyes.** In other words, once they finish a draft, they should build in a little time to step away. Coming back after a break may make errors easier to spot. (As an editor, you should do the same.)

- **Make sure multiple people read each story.** Emphasize that they should push back on claims that don't add up.

- **Track errors and corrections** to help identify weak spots.

Fact-checking can be tedious. It can be expensive. It can take a long time. But putting resources toward fact-checking — in a smart way that fits both your outlet and a particular story — is vital. Fact-checking can help save your publication's reputation as well as the reputations of your journalists. It can help save you from a lawsuit.

I'd also argue that when any individual journalist or publication makes a mistake, it can damage the reputation of the media collectively. The media, of course, aren't monolithic. Still, many readers still see us that way, so every time one major outlet makes a well-publicized mistake, it makes it that much easier for people to say, *See? This is why it's all fake news.*

Most important: We owe it to the readers to do our best to present them with accurate information on the world around them. That's the purpose journalism claims to fill.

Additional Reading and Resources

Books

- ***The Chicago Guide to Fact-Checking***, Brooke Borel, University of Chicago Press (2016).

Editors who want to set up a fact-checking process or department will find plenty of advice here.

Books

- "**Checking in on Fact Checking in Science Journalism**," Brooke Borel et al., Knight Science Journalism Program at MIT (2018).

This report gives a good sense of how and where fact-checking functions at publications that cover science, health, tech, or the environment — including general interest outlets.

Articles

- "**The Pocket Guide to Bullshit Prevention**," Michelle Nijhuis, The Last Word on Nothing (April 29, 2014).

Any journalist or editor would do well to remember these steps, which are conveniently listed in a pocket-shaped chart to tuck in your back pocket.

- "**Checkpoints**," John McPhee, *The New Yorker* (February 2009).

A classic read on fact-checking, which gives insight into not only the storied fact-check department at *The New Yorker* but also the lengths to which a checker may go to confirm an anecdote — and how things can occasionally go wrong.

Radio

- "**In Praise of Radically Transparent Journalism**," WNYC's *On The Media* (December 1, 2017).

An interview with Margaret Sullivan, of *The Washington Post*, in which she calls for more transparency in journalism.

About the Author

Brooke Borel is a journalist and author specializing in science and technology. She's the articles editor at Undark Magazine and has written for *Popular Science*, BuzzFeedNews, the *Guardian*, TheAtlantic.com, *Scientific American*, Medium's OneZero, FiveThirtyEight, Slate, and others. The Alicia Patterson Foundation, the Alfred P. Sloan Foundation, and the Gordon and Betty Moore Foundation have funded her work. She teaches writing workshops at the Arthur L. Carter Journalism Institute at New York University and speaks on journalism and fact-checking nationally and internationally. In 2019 her *Scientific American* article "Clicks, Lies and Videotape" received the American Society for Journalists and Authors award for outstanding science or Technology article, and she was a finalist in the National Academies Communication Awards. Her work has been anthologized in *What Future*. Her books are *Infested: How the Bed Bug Infiltrated Our Bedrooms and Took Over the World* and *The Chicago Guide to Fact-Checking*, both from the University of Chicago Press.

Endnotes

1 https://www.factcheck.org/scicheck/

2 https://www.snopes.com/

3 https://time.com/4858683/fact-checking-history/

4 https://www.cjr.org/special_report/rise-and-fall-of-fact-checking.php

5 http://www.invisiblesbook.com/

6 https://wwnorton.com/books/The-Lifespan-of-a-Fact/about-the-book/description

7 https://www.moore.org/docs/default-source/default-document-library/fact-checking-in-science-journalism_mit-ksj.pdf?sfvrsn=a6346e0c_2

8 https://ksjhandbook.linchpin.site/wp-content/uploads/sites/5/2020/08/Fact-Checking-Module-Example.pdf

9 https://ksjhandbook.linchpin.site/wp-content/uploads/sites/5/2020/08/Fact-Checking-Module-Answers.pdf

10 https://www.cjr.org/investigation/rolling_stone_investigation.php

11 https://www.the-efa.org/rates/

11 Illustrating Complex Science Stories

By Jen Christiansen

Introduction

It's not uncommon for editors to turn to visuals only after the words are solidly underway. The thought process could be described as, *The reporting is complete, a story arc is in place, and it's time to move on to the finishing touches*. And for me, as a graphics editor at *Scientific American*, the reality is that I often don't dive into graphics development until after the first draft of a long-form feature story has been submitted.

For news pieces with faster turnaround, however, graphics need to get rolling before such a milestone is reached. There's often not time to wait until after a clean draft is in hand.

And, as graphics editors continue to distance themselves from the classic "service desk" model — especially as data reporting and data visualization become more intertwined — it's important to remember that visuals can be the driving force behind top-notch science journalism.

Memorable examples include:

- "Coronavirus Tracker: The Latest Figures as Countries Fight Covid-19 Resurgence[1]," featuring charts by John Burn-Murdoch and others, in the *Financial Times*
- "Why Outbreaks Like Coronavirus Spread Exponentially, and How to 'Flatten the Curve[2]'," by Harry Stevens, in the *Washington Post*
- "What's Really Warming the World?[3]" by Eric Roston and Blacki Migliozzi, in *Bloomberg Businessweek*

- "Here's Every Total Solar Eclipse Happening in Your Lifetime. Is This Year Your Best Chance?[4]" by Denise Lu, in the *Washington Post*

- "What is the Higgs?[5]" with drawings by Nigel Holmes and graphics by Jonathan Corum, Alicia DeSantis, Xaquín G.V., and Josh Williams, in *The New York Times*

What can you do as an editor to make sure graphics and other visuals reflect the same standard you would demand of any text? To realize your graphics aspirations, you may be leaning on sources for raw data, photos related to experiments, and reviews of artists' sketches. To do that, efficient and coordinated communication among text editor, image editor, and your expert sources is key.

This chapter is graphics-centric, based on my own experience with input from others on photography, editorial illustration, and motion graphics. As all editors know — generalists and specialists alike — how the reader encounters a story is particularly important when it comes to illustrated content. One solution rarely fits all, so thinking about different ways to serve the same content via different media — printed page, desktop computer, mobile-phone screen — as well as to different audiences is critical. That challenge is not specific to science-centric content, so I don't dive into making the material legible across many platforms. Instead, I focus on the process of determining when visuals might be a useful addition to a science-centric story, along with tips for producing and editing them.

The Role of Visuals in Science Journalism

More often than not, science-centric content is complex. Visuals are a powerful tool for helping your audiences make sense of complex stories. In creating or commissioning such visuals, your first instinct may be to simplify the information in order to make it more broadly accessible. Yet simplification may erase the latest key finding, distilling things in a way that doesn't honor the cool new discovery you're trying to highlight. I find it more productive to focus on *clarifying, not simplifying* (with a nod to the designer Nigel Holmes[6], the author Alberto Cairo[7], and many others who have spoken and written about this idea).

For example, for a print article on gene expression in the brain[8] by the scientists Ed Lein and Mike Hawrylycz, I was given a complex chart provided by one of the authors. The goal of this reference chart was to communicate results within a peer group — an audience of other neuroscientists who were highly motivated to read and understand the image. The chart used a visual vocabulary of symbols and colors that would be familiar to other neuroscientists, but not to a lay audi-

ence. I liken such symbols to "visual jargon." Jargon can be useful for those who understand it; words and imagery that carry a highly specific meaning within a specific context can be an efficient way to present complex information to others within a community. But it also serves as an impenetrable wall to people who are not fluent in that language.

I hired the data designer Jan Willem Tulp to develop something more broadly accessible. In this case, that didn't mean a different chart form or eliminating data. Instead, we stripped away visual barriers to entry and added welcoming gestures. The full data set remained intact. Tulp simply removed insider conventions (such as a full-spectrum rainbow color palette), replacing it with a more intuitive and less complicated monochromatic tonal scale. We included a few brain illustrations to make abstract terms for brain regions relatable. And we explained in plain language how to read the graphic, with leader lines pointing directly to referenced spots in the chart.

Every visual decision, style guides aside, should be considered with reader comprehension in mind. I happened to find the tonal scale that Tulp used more aesthetically pleasing than the original full palette. But that's not the reason we used it. The scale was constructed to minimize the appearance of artificial jumps in the data, one of the **pitfalls of full-spectrum palettes**[9]. Honoring perception-science research findings is good visualization practice across all subject areas. It's particularly pertinent when covering the evidence-centric science beat.

Lucy Reading-Ikkanda, a graphic designer at the Flatiron Institute, says editors should also choose the rendering style of a graphic with care. "When a client shares a minimalist, monochromatic, wordless graphic of 'How to Make a Cup of Coffee' as style inspiration for a scientific figure, I worry. The graphic looks lovely, I agree, and because most everyone recognizes the motifs for coffee making, the simple style is appropriate, and labels and captioning are unnecessary. The language of coffee-making is pretty well understood. But the language of science is not. Whittling scientific content down to the level of icons and symbols can leave room for confusion and misinterpretation." On the other hand, she adds, overly detailed and hyperrealistic renderings "can raise questions that we (and our fact-checker) do not want — or need — to tackle."

Learn More

For more on the science of perception as it relates to developing graphics, check out the ***Datastories* podcast**[10] archive for interviews with perception scientists, the blog "**Multiple Views: Visualization Research Explained**[11]," and Kennedy Elliot's post "**39 studies about human perception in 30 minutes**[12]."

With an eye to clarity, the graphics editor becomes a translator, or a guide. The focus shifts away from watering down the information and toward knocking down

barriers and beckoning the reader in. The goal is to make complex and specialized information accessible to a nonspecialist audience.

Images are powerful in part because of their ability to immediately engage people. Science-centric graphics are crucial tools to provide context, to show what otherwise can't be seen, and — as put so well by Olena Shmahalo in "**Galaxy Leggings, Truth Serum, & the Visibility Cloak**[13]" — to provide a welcoming entry point for folks who may be predisposed to think of science as being dense and impenetrable.

The Process of Building Science-Centric Graphics

As a science-graphics editor at a magazine, I specialize in making advances in science and technology accessible to nonspecialist audiences. That includes developing illustrated explanatory diagrams and data visualizations that explain the latest research findings in depth and place those findings in context of the larger research arc. That may sound straightforward, but many newsworthy topics in science stand on a foundation of lots of incremental research findings, most of which I can't assume that readers already know.

When developing science-centric graphics, background research is key, as is consulting with content experts, such as research scientists, to make sure that information is portrayed correctly. During my time as a graphics editor at *Scientific American*, and my past experiences as a researcher and art director at *National Geographic*, I've developed several strategies for illustrating technical topics for broad audiences, on deadline. What follows is an idealized version of my process for working on graphics that are rooted in cutting-edge science.

First, I should note that many graphics in *Scientific American* are developed by freelance artists. The eight stages below apply in all cases, but the details of each stage reflect my own approach to pieces that I render from start to finish. Others should have the freedom within this framework to adjust the details to work best for them.

Also, I recognize that different organizations have different timelines and levels of resources. These steps work regardless of deadlines or organization size, or even story scope. Those differences just indicate whether one can work through these steps in hours or in weeks.

Stage 1: Establish the Basic Goal of the Graphic

In general at *Scientific American*, text manuscripts take the lead. Upon reading a draft story, I identify which concepts I think would be best served with an illustration. My animating question is: Would a graphic be useful in helping to convey this information?

When are graphics useful?

1. When images can tell the story more efficiently, effectively, or completely than words can. Take the iconic **Feynman diagrams**[14], which show subatomic particles' movement, collision, and energy transfer. In these cases, the visuals stand in for abstract formulas.

2. When the narrative involves complex and intertwining relationships, and an image map can help the reader track connections. An example is a diagram that explains the intricacies of photosynthesis.

3. When the reader might benefit from seeing and exploring trends and patterns of the complete data set rather than be served up a few key numbers in the text, such as a chart showing the daily number of new Covid-19 infections.

4. When a direct and immediate visual comparison is useful in highlighting change, or differences between states, such as competing hypotheses or before-and-after views.

After I identify potential graphics topics, I confer with the text editor to make sure we're in agreement, and to confirm that the intended text and image paths haven't diverged.

Stage 2: Research

Whenever possible, I begin with the primary source: ideally the key journal paper that describes the latest research, or direct communication with a scientist. Then I expand from there, starting with papers that catch my eye in the primary paper's citations, and basic searches on the lead scientist and his or her collaborators. Then I move on to the bigger picture: How does this latest finding fit in with other research in this area? More often than not, I need to do some basic searches on core concepts, to make sure that I'm not misinterpreting things, and that I have a basic understanding of the terminology. Keyword-driven Google image searches help me sort out what other graphics have already been produced on the topic, and often help me to identify weaknesses or holes in the broader coverage — helping to focus my line of thought on how we can add something new to the conversation.

Assistance from the text editor and writer is useful at this point, as they often already have key references in hand, along with a list of possible sources. This stage is perhaps the most variable of all in terms of time span. If the graphic will be focused and narrow in scope, this stage can be quick and efficient, taking no more than a few hours. Larger, epic projects that aim to bring many lines of research together — like the *National Geographic* projects described by the art researcher Amanda Hobbs in her post "**My answer to the question: 'So, what do you do?**[15]**"** — take more time; think many weeks.

Stage 3: Concept Sketch Development (Gestural Pencil – Sketch Equivalent)

Now it's time to put that research to use and translate my written notes and doodles into a cohesive sketch. I begin with articulating what, exactly, the graphic aims to explain, starting with the wide view. Am I comparing and contrasting competing hypotheses? If so, two side-by-side panels might make sense. Showing change over time? A linear or cyclical step-by-step approach may be useful. Showing how something works? The physicality of the subject may help inform the layout. This step often comes together over the course of hours or days, since it's rooted in the thought and work already completed in Stage 2.

Once I've spent some time thinking through the basic form, I develop a rough layout, with straightforward and descriptive headlines and subheads, so that I can better communicate my intentions to my colleagues and expert consultants.

All the while, I'm thinking in terms of:

1. centering the new research finding;
2. supporting the new information with broader context;
3. considering what additional details might help engage a reader who is initially unfamiliar with the broader topic;
4. shaking out label jargon (by using plain language); and
5. shaking out visual jargon (by avoiding icons familiar only to scientists in a specific discipline).

Stage 4: Concept Sketch Review

Once I'm happy with the concept sketch, I share it with colleagues to make sure that preliminary plans for the text and graphic are still cohesive. Coordination be-

tween the text editor and graphics editor is critical at this point, since this is the time for changes in the graphic's concept. The graphics don't need to echo the text, but the pieces should be complementary. Then the concept sketch gets sent out to an expert, such as a research scientist, for review. Feedback loops with outside experts can be slow, so I try to accelerate the process by including questions designed to prompt immediate and focused attention on the validity of the overall goal of the graphic, as well as anything that I'm particularly hesitant about.

In some cases, if my initial interpretations don't pass muster with the content experts, I'll need to loop back to Stage 3. If revisions are needed, I'll ask the content expert for more reference material, to help guide the revised plan.

Stage 5: Tight Sketch Development (Detailed Pencil Drawing, Rough 3D Render, or Equivalent)

Once the concept sketch is approved by colleagues and content expert, the next stage is all about folding specific notes and change requests into a tight sketch. At this point, I sharpen the illustrative details and flesh out the labels. Meanwhile, the text editor drafts captions.

Stage 6: Tight Sketch Review

Once I'm happy with the tight sketch, I send it out for another round of reviews. Feedback that focuses on specific details of the illustration are fine at this stage, but the composition and overall plan should not be changing. If there was a fundamental problem with the content — and therefore a fundamental problem with the composition — that should have been flagged at Stage 4. To avoid the need to backtrack, I find that being transparent with outside reviewers and colleagues about the review process is key. I generally let them know that they'll see three rounds, and that each review step is designed to build on the previous step. If folks know that the first review may be their only opportunity to flag a fundamental problem with the conceit of the illustration, they're more likely to review that step with the big picture in mind, as opposed to getting lost in reviewing smaller details from the start.

Stage 7: Final Graphic

Once the technical details are in place, the focus shifts to the final rendering and final captions. In my experience, the text editor often writes captions, although in some cases — and in some newsrooms — captions are the responsibility of the writer or graphics editor.

Stage 8: Final Graphic Review

The final rendering is sent around for a last look by colleagues (including a copy editor and a fact-checker) and the expert consultant to ensure that no errors were introduced in the final rendering stage. At *Scientific American*, we're often working with scientist authors, so an official fact-check at this late stage is generally sufficient. But other publications, with different production work flows, may want fact-checkers to weigh in earlier, perhaps at Stage 4.

By working through these stages, with concept sketches that start as broad-stroke composition guides that are rooted in the concept being explained, I find that I'm forced to think through the content before getting distracted by drawing details. If the organization of the graphic is solid, then the illustrative details can develop organically within that framework. In the spirit of an anatomical artist, I strive to get the bones organized properly before fleshing things out.

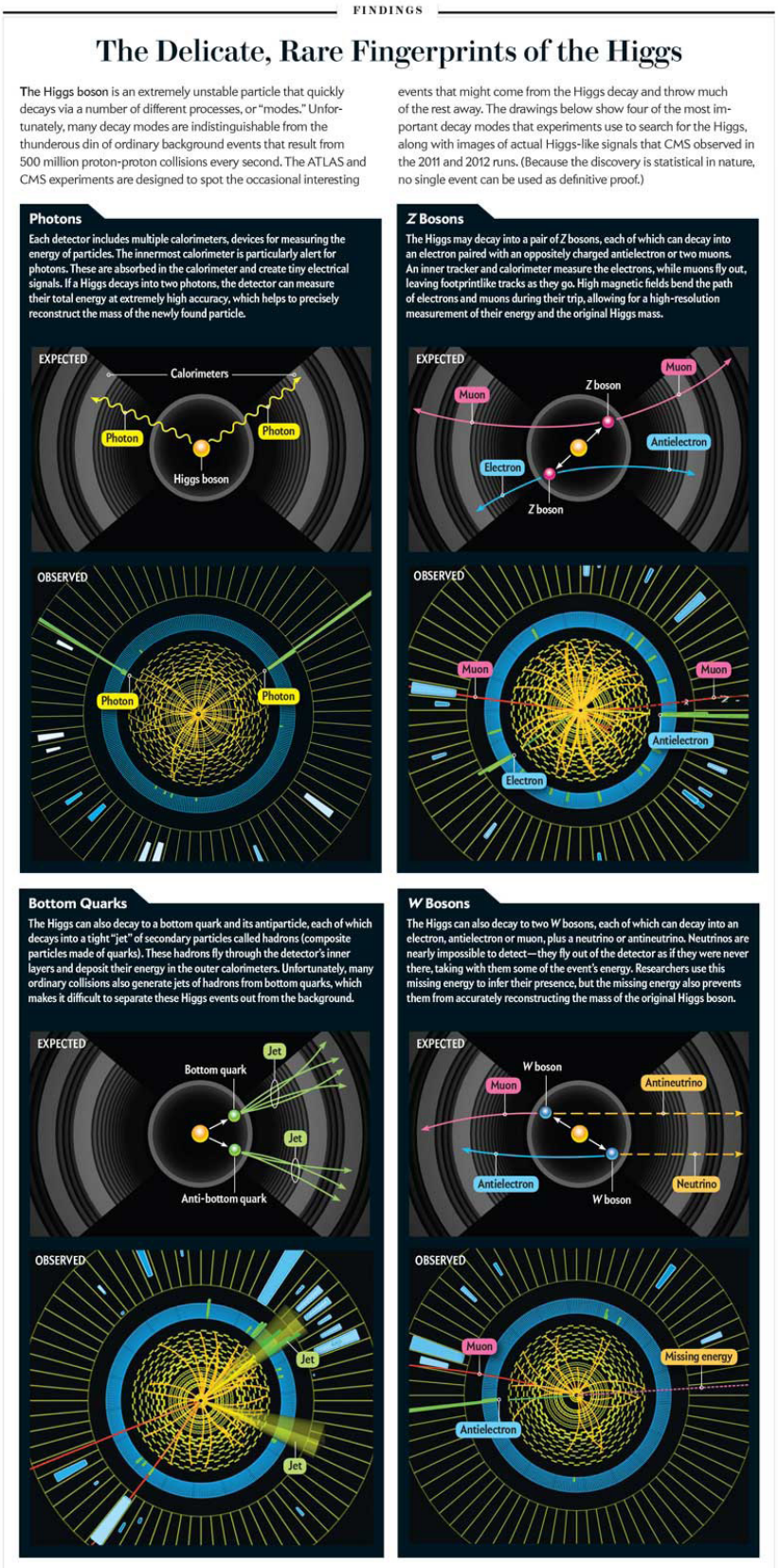
Strategies for Using Visuals to Put Breaking Science in Context

As I've noted, newsworthy scientific discoveries generally stand on a foundation of lots of incremental research findings. Although it's often tempting to dive right into showing the latest results, a nonspecialist reader may not be primed to understand or appreciate the breakthrough without background information. Here are three strategies for providing your readers with the context they need in order to better understand the latest development.

Strategy 1: Annotate the Primary Source Material Directly, in Plain Language

Press releases and academic publications often include key visualizations that highlight the latest development. For example, you may have seen some **abstract images related to the Higgs boson**[16] that circulated widely in July 2012, when evidence of the previously hypothetical subatomic particle was announced. They depicted oblique and cross-sectional views of a semi-transparent blue cylinder on a black background, with orange lines constrained within the cylinder and a few green lines busting through. Many news outlets ran the pickup images as is. How many people really understood what they were seeing? My guess: not many.

But with a little additional work by a graphics editor, those images could have been **annotated with key points**[17] to clarify what was being depicted. A few labels can go a long way in helping readers better understand an image's significance.



Graphic by George Retseck, including imagery from CERN (observed signals from CMS detector). Originally produced for "The Higgs at Last," by Michael Riordan, Guido Tonelli, and Sau Lan Wu, in Scientific American (October 2012).

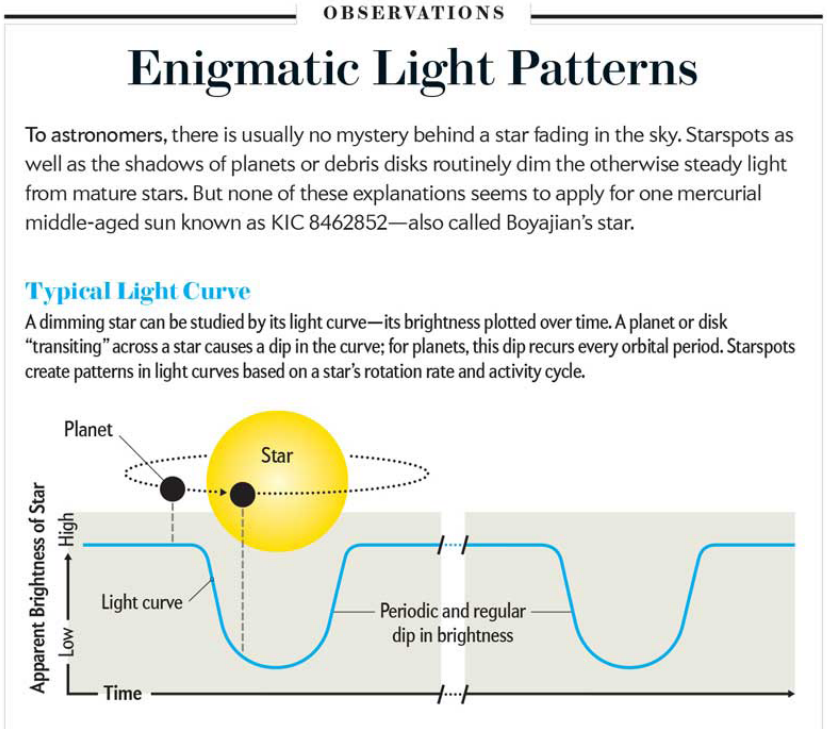
The same goes for other figures presented in academic papers. If you choose to pick up an original chart directly, think about how annotations might be able to help a reader focus on the critical takeaways. If you don't immediately understand the graphic — even if it's beautiful — your readers won't either. That's when annotations can be helpful.

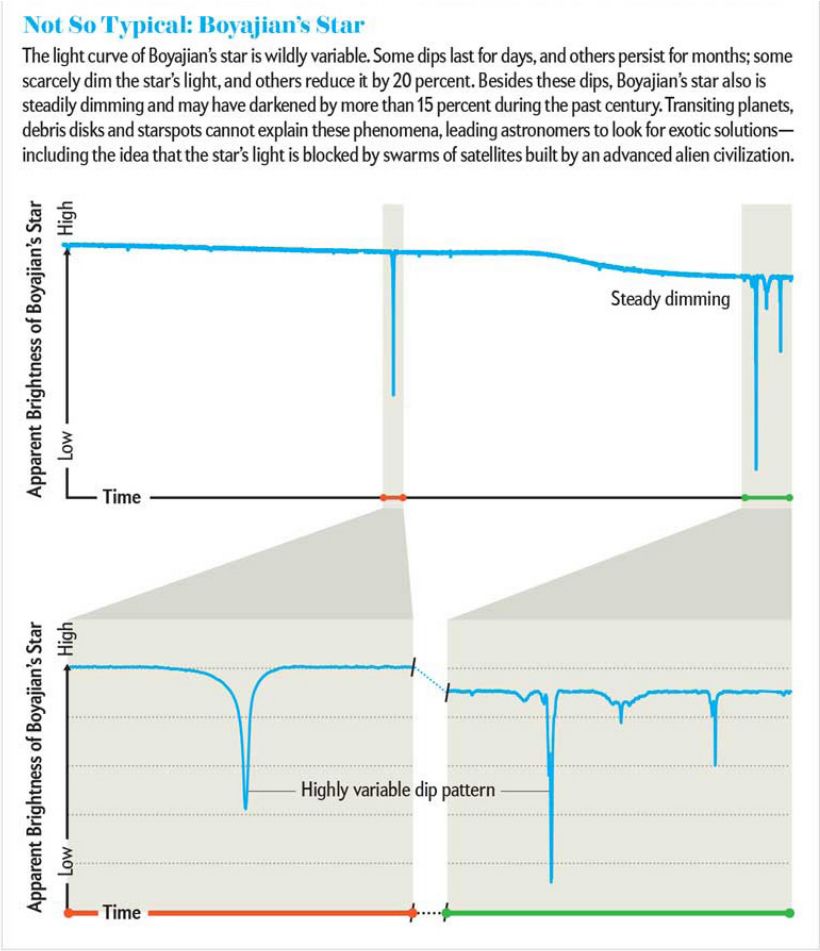
Strategy 2: Fold Background Information Into the Main Graphic

Sometimes a few explanatory annotations aren't enough, and companion schematics are needed. If you find that it takes paragraphs of text to explain a concept, consider relying on a visual to carry that burden.

Perhaps you have heard of Boyajian's star, also known as Tabby's star, after the astronomer Tabetha Boyajian, who first noted the odd fluctuations in its apparent brightness when viewed from Earth. If you don't know it by name, you might recall it from the headlines suggesting that the dimming could be the result of alien superstructures in orbit around the star.

For an article in which **Kimberly Cartier and Jason T. Wright explored the hypotheses in play**[18], we decided to create a data visualization to tell one piece of the story: Why is the dimming pattern perplexing? Presenting a graph of perceived light intensity from Tabby's star was a start, but that would only demonstrate the pattern, not explain why it was unusual. To do that, we needed to represent a more common star-dimming situation — a pattern of regular dips caused by a planet passing in front of the star in a fixed orbit. Armed with that information, the reader can then see why the irregular pattern exhibited by Tabby's star is so odd.





Graphic by Tiffany Farrant-Gonzalez; Source: "KIC 8462852 Faded throughout the Kepler Mission," by Benjamin T. Montet and Joshua D. Simon, in Astrophysical Journal Letters, Vol. 830, No. 2, Article No. L39; October 20, 2016. Originally produced for "Strange News from Another Star" by Kimberly Cartier and Jason T. Wright, in Scientific American (May 2017).

Folding in contextual information can help prevent "information overload" when too much is presented all at once. That was a strategy we used with a diagram I developed for an **article by Helen Branswell**[19] about the Ebola virus. The goals of the graphic were to show why the Ebola virus is so deadly and to highlight stages of the disease that could be targets for treatment. In this case, I aimed to keep the virus as the focus by having the reader track it across the page as if through time. This timeline became the spine of the composition. Then I introduced human cells and the body's immune response as they became relevant in the timeline. Then two key concepts — major points in the main text — were highlighted in yellow. Isolating those two points in yellow circles reinforced the hierarchy of information: context as background, critical new details as overlay.

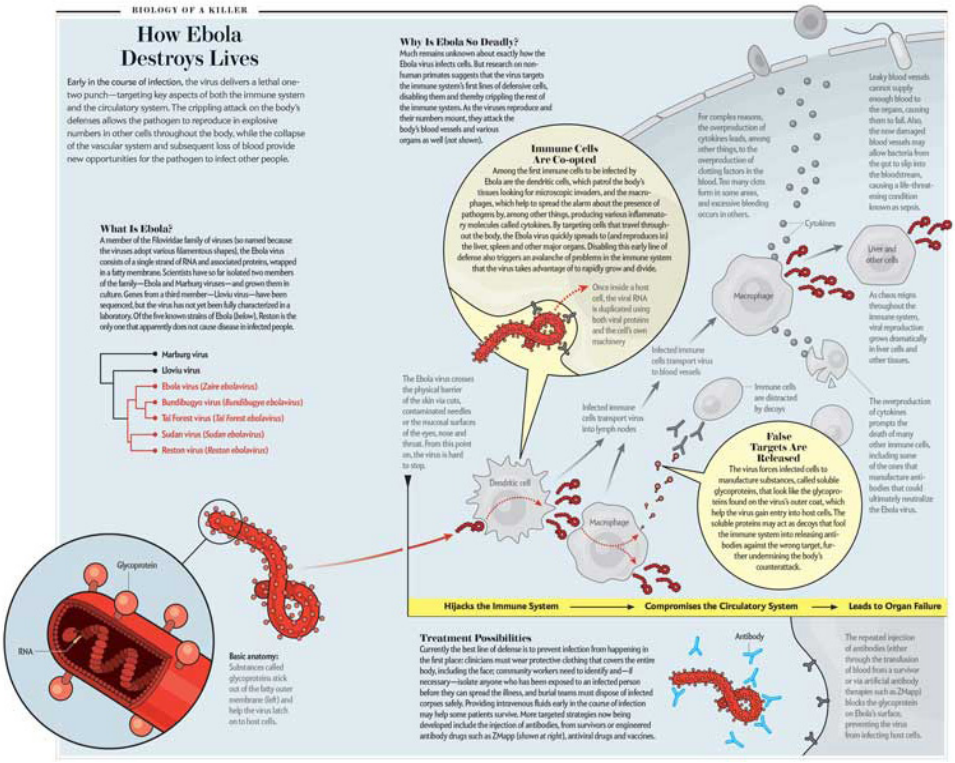


Illustration by Jen Christiansen. Originally produced for "Ebola War," by Helen Branswell, in Scientific American (March 2015).

Strategy 3: Include a Primer Box

Torn between the need to provide background material and the desire to get right to it with information on the latest discovery? Consider breaking things down into separate graphics. A primer box can introduce basic concepts to readers who may need more context. Those more familiar with the topic can jump straight to the new stuff. For an **article on the 2009 H1N1 flu pandemic**[20], for example, we included a basic graphic showing how and when flu viruses get into human cells and under what circumstances different strains can mix and match genes with one another. Later in the story, we ran a more specific graphic on the specific biology of the 2009 H1N1 flu strain. Thanks to the previous graphic, this one didn't have to carry the burden of details on basic virus infection and replication.

Special Considerations for Data Visualization

Data visualization can come in many forms, from simple charts to complicated

online interactives. While time, skill, and story scope will determine where on that spectrum you land, the fundamentals are the same.

On the science beat, much of the data you'll be working with have been analyzed and peer-reviewed. That doesn't mean it's flawless, though, so you must still retain a critical eye. Read the "methods" sections of papers and data portals. Become familiar with the questions that guided data collection, as well as the subjects of the study — particularly relevant in regard to health stories, as the results may be rooted in a homogeneous sampling of people, a detail that should inform how you frame the data.

"I often find it useful to pinpoint which figure in a scientific paper presents the crux of the findings.

Spot-check data provided by scientists against their published figures, keeping an eye out for red flags. Are outliers simply dropped from final figures without note in the published paper? Ask the corresponding author (that is, the scientist flagged on that paper as the point person for queries) for an explanation. Having a hard time replicating straightforward figures from a published paper? Ask the corresponding author about the methods as a reality check before moving forward with other visualization solutions.

Increasingly, data are being made available for direct download in tandem with published research articles. The quality of the data available in open access formats can vary. Sometimes they're the raw data, sometimes they're already processed. Ask the corresponding author for guidance if anything is unclear. When dealing with highly processed and specialized data — genetics and astronomy pop to mind — I find it useful to work with freelance data visualizers who are domain experts.

Nadja Popovich, a graphics editor on *The New York Times*'s climate team, notes that "one of the best parts of working on science-centric graphics is that scientists and other researchers by and large want to talk to you. They are often more than happy to help you better understand the data, so that you can represent it correctly." Her best advice for science-centric graphics is her best advice for all data graphics, "When in doubt, talk to an expert."

Overwhelmed by the possibilities, and faced with a fast-approaching deadline? I often find it useful to pinpoint which figure in a scientific paper presents the crux of the findings. Then ask the researchers for the data they used to build that specific graphic, and think through how to present the same data in a format that would make sense to your nonspecialist audience. Look at figures in the supplemental information repository for this purpose. You can often find gems hidden there. Such was the case with one of my favorite visualizations, by the designer Jan Willem Tulp, for the story "**Trillions of Insects Migrate**[21]," which was inspired by reviewing a figure hidden in a paper's supplementary information.

As with all data visualizations, be cognizant of data-collection methodologies. This is especially true with global health data, in which the methods are rarely consistent

over space and time. Seek advice from content experts when trying to determine which authoritative source is considered the best option for the subject and/or regional focus of your story. Upon plotting out the data in your preliminary explorations, question any and all surprising patterns. Does the prevalence of a disease rapidly change? Check the documentation to make sure that the shift isn't due to a change in data-collection methods, and then check with a content expert before jumping to conclusions. Sometimes the right decision is to not visualize the data at all. Or, as Amanda Makulec writes in "**Ten Considerations Before You Create Another Chart About COVID-19**[22]," "do more to understand the numbers."

Katie Peek, an independent data-visualization designer and science journalist, notes that the following principles — which she learned during her time as a scientist — continue to serve her well as a graphics editor.

- **If something seems too good to be true, it often is.** Cast a careful eye on any surprising results, and make sure they're right.
- **Check your work.** Do the calculation another way, or find another data set or expert, to confirm that your result is reasonable.
- **Just because something is published doesn't mean it's right.** A peer-reviewed journal article can still be wrong.
- **Keep your analysis approachable.** If you can't easily explain what you've done to the data to present them in the graphic, you're probably doing too much.

Uncertainty and Misinformation

Two topics are of particular importance in editing and visualizing science stories: showing uncertainty and avoiding misinformation.

Visualizing Uncertainty

Uncertainty is a critical concept as it relates to stories like climate change and global pandemics. Yet I think it's fair to say that until recently, visual journalists — including myself — too often swept the notion of uncertainty under a rug. How many of us have chosen to ignore confidence intervals when preparing a chart for publication? And when we do represent aspects of uncertainty, how many of us have defaulted to ubiquitous graphical solutions — like the hurricane-projection cone described in one of the **chapters on statistics**[23] — without further thought, failing to question its efficacy?

And yet, as Barauch Fischhoff and Alex L. Davis write[24], "All science has uncertainty. Unless that uncertainty is communicated effectively, decision makers may put too much or too little faith in it."

In 2015, a conversation with the geographer Diana Sinton at the Gordon Research Conference for visualization in science and education[25] caused me to step back and more critically think about how I depict uncertainty. We kicked off a collaboration (with support by a minigrant from NASA) in the hopes of adding another perspective to the broader conversation on visualizing uncertainty. As Sinton and I wrote for a poster session at that conference a few years later:

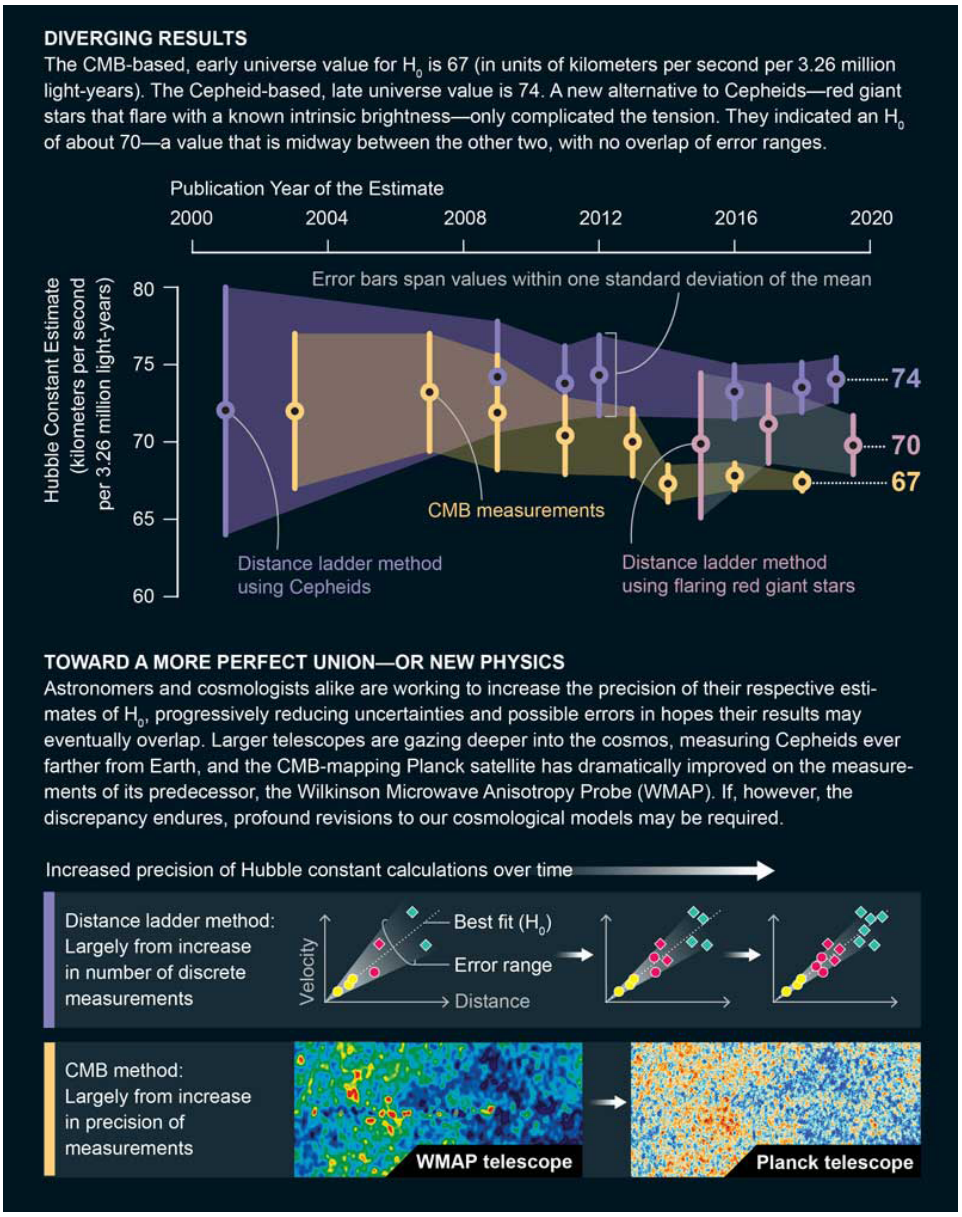
> *Scientific illustrations, diagrams, and charts show what is known — and, sometimes, how it is known. Not surprisingly, little attention is paid to representing what is not known. Perhaps more importantly, the categories of "known" and "unknown" are not as binary as the words suggest.... Within the practice of science, the extent to which something is known is a function of what question was asked and how it was answered.... Ambiguous or unclear answers may be just as common as definitive results at the conclusion of an experiment. So the question becomes, How can we provide lay audiences with jargon-free tools with which to interpret critical scientific findings?*

I'm afraid that I don't have clean solutions to every aspect of this challenge, although I include some resources and examples of effective approaches in the "Additional Reading" section. The key, to my mind, is to be aware — and critical — of the uncertainties that exist within the data set that you're visualizing or the process that you're illustrating. In practice, I've started by embracing uncertainty as an element to be addressed head-on.

For example, in an article on maternal mortality[26], the article team — the author, Monica McLemore; the text editor, Jen Schwartz; the data designer, Valentina D'Efilippo; the graphics editor, Amanda Montañez; and me — opted to show conflicting statistics from two sources (the World Health Organization and the Institute for Health Metrics and Evaluation). The very act of presenting very different estimates from different agencies underscored the uncertain nature of the measurement. Had we simply whittled things down to a single source, we would've lost an opportunity to present the reader with a clear and direct representation of the fact that powerful health organizations have not developed a reliable and consistent way to measure and track maternal-mortality statistics across space and time.

Likewise, for an article on calculating the expansion rate of the cosmos[27], the author, Richard Panek, wrote about two different measuring techniques. Initial calculations included large, overlapping error bars: It was presumed that the different measuring techniques would eventually arrive at the same answer. But over time, as the error bars shrank, it became clear that the data were diverging. Like many other news outlets covering the same topic, we opted to include a chart plotting the measurements over time for each method, including error bars.

But in order to help our readers more fully understand *why* the error bars changed in size over time, I also included an explanatory diagram on precision.



Graphic by Jen Christiansen (schematics); ESA and PLANCK Collaboration (Planck CMB); NASA and WMAP Science Team (WMAP CMB detail); Source: "The Carnegie-Chicago Hubble Program. VIII. An Independent Determination of the Hubble Constant Based on Tip of the Red Giant Branch," By Wendy L. Freedman et al., in Astrophysical Journal, Vol. 882, No. 1; August 29, 2019 (diverging results chart). Originally produced for "A Cosmic Crisis," by Richard Panek, in Scientific American (March 2020).

For one method, the error-bar reduction was due largely to an increase in the number of discrete measurements. For the other method, it was due largely to an increase in the resolution of each discrete measurement, thanks to more-powerful telescopes. A

visual explainer allowed us to acknowledge why uncertainty exists in projects of this nature, and some of the ways in which uncertainty can be reduced over time.

Avoiding Misinformation Pitfalls

Because nuance and explanation are easily stripped away from visuals, it is all too easy for people acting in bad faith to share misleading elements. My default position is to simply **not honor misinformation**[28] with a graphic. It's simply too easy for folks to remove the graphic from the context of the article or caption and disseminate it through social media. Nevertheless, gray areas exist, particularly when a graphic was created in good faith but, as a result of unintentional mistakes or revised data, proves to be erroneous.

"My goal is to make it as hard as possible for someone to isolate and amplify what we know to be incorrect.

Occasionally I find that representing the old (mistaken) and new (corrected) views side-by-side can help readers understand how the errors led to a faulty analysis, and why the newer interpretation is more solid. But in cases like this, I move forward with an eye to how the graphic could be used by folks with ill intent. My goal is to make it as hard as possible for someone to isolate and amplify what we know to be incorrect. For example, for an **article by Melinda Moyer on guns and public health**[29], we wanted to address some oft-cited gun-control studies directly. Subsequent analysis revealed serious errors in some classic papers that are often referenced by the pro-gun lobby: The data actually show that more firearms do not keep people safe.

Rather than brush aside the earlier studies that implied otherwise, we decided to go ahead and show the original analysis with a critique baked into the visual presentation. Annotations addressed the statistical errors that influenced the initial interpretations, along with companion charts on the same topic with updated information. The annotations were placed in bold inset circles that were dropped directly onto the charts, making it a bit more difficult to crop and share out of context.

Editorial Illustration, Photography, and Moving Images

When it comes to science visuals, static information graphics are not always the right solution. Graphics can be a great way to convey specific information in a concise manner. But they're rarely the best solution as the opening image for a story, for example. An editorial illustration or photograph can be a more effective way to capture people's attention, pique their curiosity, and entice them to engage more fully with the article's content.

Michael Mrak, creative director at *Scientific American*, notes that "[editorial] illustrations can be used to convey broader concepts about a specific subject and can

address parts of nature that may not be able to be seen or that are difficult to show. … You can't send a photographer to a black hole or to see how the quantum realm works, but you can get an artist to envision how they might work or appear."

When commissioning editorial illustrations, Olena Shmahalo, art director of *Quanta Magazine,* writes: "I don't look exclusively for artists who seem comfortable with science — I'd rather hire an artist who's great at what they do, and I'll help them with the scientific or mathematical aspects as needed." In order to set everyone up for success, however, she recommends that editors "ask questions until you understand [the scientific concept at hand] — especially because if you don't understand, it's likely the reader won't either!" That said, "take care not to become a 'pair of hands' for the researcher or author you're working with. … Sometimes those closest to the material want to relay absolutely everything about it in great detail and can be persistent about everything being 'just so,'" losing sight of the main takeaway.

Bill Douthitt, photography managing editor at *Science* magazine, notes that certain types of stories lend themselves to photography over illustration — profiles, stories in which the protagonist is going on a trip of some kind, and accounts of fieldwork that can affordably be covered.

Ernie Mastroianni, formerly photo editor at *Discover* magazine, says the decision to use photography should be made as early as possible. "If we have a personality-driven feature story, we need to develop a concept, hire a photographer, and do the shoot when the subject is either in place at an academic institution or doing fieldwork. … We don't want to find out that the subject left the archaeological site just a week prior to our query."

Sources for Science-Centric Imagery

1. **Alamy**
2. **Animals Animals**
3. **AP**
4. **Bridgeman Images** (deep library of fine art)
5. **CERN**
6. **Everett Digital** (historic entertainment and movie stills)
7. **Getty**
8. **Granger NY** (archival imagery)

9. **Mary Evans Picture** (historic shots with European angle)
10. **Minden**
11. **NASA images**
12. **NatGeo**
13. **Nature Picture Library**
14. **Redux**
15. **Science Photo Library**
16. **Science Source**
17. **Shutterstock**
18. **Smithsonian**
19. **European Southern Observatory**
20. **European Space Agency**
21. **Library of Congress** (archival imagery)
22. **Wellcome Images**

Photo editors recommend signing up with services before you need to use them. That way, if you're trying to get a photo on deadline, you're not also dealing with the bureaucracy of signing up.

When selecting photos for science stories, the photo editors I queried agreed on one thing: double-check everything for accuracy. "That's important in anything you do as a journalist," Bill Douthitt writes, "but particularly so with science, where the results are read by a very highly educated group."

Liz Tormes, assistant photo editor at *Scientific American*, notes that when you're looking for photos of flora and fauna, "it's important to ask if the photo needs to show a specific species and/or a specific location. Also, be aware that stock sites often misidentify the subject and/or use incorrect keywords." She recommends doing a few minutes of basic research on the topic before hitting the stock-image portals , especially if you are dealing with something that is rare, so you know exactly what you are looking for. Douthitt adds that the need to check for accuracy isn't limited to flora and fauna. Are the scientists in your photos using the right gear correctly? You don't want to undermine your authority with a

photo that shows something that scientists will quickly identify as unrealistic.

Meanwhile, video is in the unique position of being able to leverage the best of all three image approaches in one package: weaving together information graphics, conceptual illustrations, and footage of real people and places into self-contained visual stories. In determining the feasibility of using video to tell a science story, Jeffery DelViscio, senior multimedia editor at *Scientific American*, recommends that you think through the following:

- **Logistics:** Video really benefits from being considered at the outset of a project rather than as an add-on. Video is time-consuming — and even if you can quickly acquire it, the post-production process can be complicated. Video may also require field reporting and additional technical skills, depending on what is to be visualized. So a decision about including video should be made as early as possible, when choices about how best to focus the filming or video-asset collection can be made while the reporting plan is still being conceptualized.

- **Sourcing:** Researchers make more video these days, sometimes as part of the actual science, sometimes as a sort of diary of the process. You should be prepared to leverage this kind of work in your reporting if it is of sufficient quality, and if it actually documents the processes you are reporting on. This could be anything from GoPro footage to extremely slow motion (high frame rate) video. These can be compelling additions, when used appropriately and contextually. But you probably will not know that they exist if you never ask your sources.

- **Story goals:** Video can excel at visualizing complicated scientific processes and augmenting the story experience. But it can also complete for reader attention and sometimes just tread the same narrative steps as the story. Doing so is a waste. Video should work in harmony with the text, pictures, and audio components, not simply mimic them.

The most important question to answer, DelViscio argues, is "Does this story need or significantly benefit from video?" Only experience will help you develop these video reflexes, so don't be afraid to experiment, which means you will sometimes try things that don't work. To help guide your decisions, follow his checklist:

Video Decision Checklist

- Where are we in the story process? (Early? Mid-reporting? Soon to publish?)

- How much do I know about what this story looks like? (Lab? Field?)

- Do we have staff capable of shooting, editing video or creating animation?
- What are the other visual contributions, such as photography and graphics?
- Is the reporter naturally flexible for or amenable to adding video collection to the reporting process? Having a video producer, editor or reporter collaborate or double up on the project? Making extra requests of sources for video files and contextual information?

Additional Reading and Resources

- **Science Visualization Resources**: An evolving Google Sheet of selected organizations, conferences, videos, and readings that I've maintained in response to specific requests from students, scientists, and artists interested in learning more about scientific visualization — from illustration to data visualization — and the work I do as a science-graphics editor.
- **Style.org**: Collection of posts and talks by Jonathan Corum, an information designer and science-graphics editor at *The New York Times.* (Start with **Design for an Audience**)
- ***Data Stories*, episode 59: Behind the Scenes of "What's Really Warming The World?" with the Bloomberg Team**: The hosts, Moritz Stefaner and Enrico Bertini, chat with the journalists Blacki Migliozzi and Eric Roston about how they developed the climate explainer, including interactions with the scientists behind the model, and the challenge of translating complex information into something accessible to a broad audience.
- "**Advocating for Your Reader**": A presentation by Lucy Reading-Ikkanda for SciVizNYC 2018, in which she discusses developing science graphics for a lay audience.
- "**Uncertainty + Visualization, Explained**": A series of posts by Jessica Hullman and Matthew Kay that summarize what empirical studies tell us about visualizing uncertainty in data, and strategies for representing it. This series is fairly technical and detailed. For a more succinct breakdown, see Hullman's *Scientific American* article "**How to Get Better at Embracing Unknowns**."

About the Author

Jen Christiansen is senior graphics editor at *Scientific American*, where she art-directs and produces illustrated explanatory diagrams and data visualizations. She began her publishing career in 1996 at *Scientific American*, in New York, moved to Washington to join the staff of *National Geographic* (first as an assistant art director/researcher and then as a designer), spent four years as a freelance science communicator, and returned to *Scientific American* in 2007. Jen writes and presents on topics ranging from visualizing uncertainty to her quest to learn more about the **pulsar chart** on Joy Division's *Unknown Pleasures* album cover. She holds a graduate certificate in science communication from the University of California at Santa Cruz and a B.A. in geology and studio art from Smith College.

Endnotes

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12

Social Media & Reader Engagement

By Katie Fleeman

Introduction

You've gone through the hard work of assigning, refining, and finishing a story. How do you make sure that it reaches an audience?

Audience development is complex, and there isn't a "one size fits all" guide. This chapter will present ways that engagement editors, social-media managers, and other newsroom colleagues approach and execute audience strategy for science stories. Not everything will be a fit for every newsroom, but there may well be ideas, advice, and actionable tactics that will make sense for you.

Social-media platforms are constantly changing, as tech companies roll out new products and features, and as users change their behavior and preferences. Wherever I can, I point to existing resources that do the work of keeping up, to help you find the most useful information.

Nothing is constant, of course, and audience development is a continuing education. Consider this to be a snapshot of best practices and advice, not the be-all and end-all.

What Is "Audience Engagement"? Three Perspectives

> *"The shorthand way that I describe it is being the representative, spokesperson, advocate for the audience in the editorial team.*

Anna Jay, chief editor, digital and engagement, Nature

> *"Social is like the intersection of both [editorial and marketing]. By promoting your stuff on social media, you are engaging in marketing on some level. And I worked at small newsrooms where those people are all combined into one person: marketing, branding, audience development, audience engagement.*

Brandon Echter, engagement editor, Snopes.com

> *"For me it starts with content. The content itself, the journalism itself, the art and everything that goes into the magazine. For me that's the thing that will make people both want to read it to begin with, but then also want to share it on social media and through other means.*

Thomas Lin, editor-in-chief, Quanta

Strategies and Goals

You have probably been in a meeting where someone asks a question like, "Should we launch a TikTok?" Or, "How much time should I spend tweeting?" Or maybe even "Why are we even ***on*** Facebook anymore?"

Those good questions get to an underlying concern: It is impossible to be everywhere, in every way, and to do it all well. Even if you are fortunate enough to have ample time, budget, and resources, you will have to make decisions about which platforms to invest in, to what degree to invest, and how you will package your stories to fit those platforms. How do you choose?

Identifying your strategic vision, setting goals in line with that vision, and then crafting tactics to meet your goals will help you make those decisions.

There are generally three business areas that social media can help with. Though they are presented here as distinct items, they are inevitably intertwined:

- **Editorial:** Finding sources, telling stories, sharing articles, breaking news, driving traffic

- **Audience/Marketing:** Building and engaging audiences, increasing brand awareness, promoting products (subscriptions, newsletters, events, etc.)

- **Revenue:** Driving consumption, selling products, sponsored advertising, converting subscriptions

The editorial mission, business model, and organizational structure of a publication will shape which goals you are pursuing and the tactics you use. For example, revenue goals may not be appropriate for an assigning editor, but they are relevant for a social-media manager or for an editor tasked with executing tactics related to broader strategies, like increasing return visits. Regardless, establishing your goals will help you stay on target and measure your success.

Social Media and the Bottom Line

Based on the business model and where social media sit in an organization, social media can and should be part of a revenue strategy. But if **recent history is a guide**[1], don't look for it to be a revenue driver.

For subscription-based publications, social-media engagement might be part of a **customer funnel or ladder**[2]. For nonprofit newsrooms, social-media reach can demonstrate audience interest — useful for grant proposals.

Conversely, revenue goals may shape what you do *not* do on social media: For example, a "behind the scenes" video might best be saved for a members-only portal instead of a Facebook upload.

For the purposes of this chapter, we will focus on the editorial side of things (with a touch of "marketing") and methods you can use to find sources and build and engage with your audience.

Defining Your Audience

Who are your readers? What new people do you want to reach? What content will appeal specifically to *them*, and what format is the best fit? Those are the kinds of questions you are probably already thinking about while assigning or editing a story.

When it comes to science coverage, I think about audiences in broad groupings based on comfort with scientific material:

- **Broad interest:** People with little to no previous knowledge who are not

necessarily inclined to seek out science coverage but may encounter it as part of a more generalized news diet. Examples: followers of the "main" Facebook page of a local news outlet; newsletter subscribers for a general-interest magazine.

- **Science-interested:** People with at least some previous knowledge who have already shown interest in — or opted into following — science coverage. Examples: members of a science-enthusiast Facebook group; listeners of a popular science podcast or radio program; readers of a science or health section of Apple News.

- **Specialized interest:** People with expertise in specific or related fields who have a vested interest in following developments. Examples: scientists reading the front matter of a journal to learn about progress in other disciplines; practitioners subscribed to a trade publication.

This is more of a spectrum than strict categorization, and your audience will very likely span these different groupings.

Surveys, focus groups, or other analyses of audience behavior can help you verify these assumptions vis-à-vis your publication and readers. Of course, all of that may vary on the basis of platform or traffic channel, which we discuss more in the section **Different Platforms, Different Audiences**[3].

Crafting Social-Media Posts for Science

As a tool, social media can serve a number of purposes:

- **Broadcast/distribution:** Reach (and increase) your audiences where they already are. This can include enticing readers to return to your site, attracting new audiences in a target demographic, and establishing your publication's authority on a particular topic.

- **Monitor:** Spot emerging stories, identify information needs within your audience, and find and cultivate sources. Interacting with readers can foster trust and help you check your own biases and weak spots.

- **Storytelling in its own right:** Use tools particular to the platform to get information to your audience without sending them back to your own site. For example, news might first break via a tweet, with the full reported story to follow.

What makes a good social-media post? Although each platform has its own specifications, these are the elements that routinely show up in most link-based social-media posts:

- **Headline**: With a few exceptions, it will always appear whenever the story is shared on social, whether it's a post from the publication's handle or from readers sharing it on their own feeds. If you want any crucial information to follow the story around the internet, this is the place to write it.

- **Preview image**: Auto-populates from the site. Similar to the headline, this will show up on most social-media platforms, regardless of who is sharing the link.

- **Deck:** This line of text that sometimes follows the headline is often cut off on mobile, so don't rely on it to convey information on social**.**

- **Post text**: The copy that is written and published directly onto the social-media platform. It's the Instagram caption, the text of a tweet, the text accompanying a Facebook video, etc.

The hed, preview image, and deck are usually populated via metadata on your site. (On Twitter, these constitute a "**card**[4]**.**") Some content-management systems give you the ability to customize the hed, deck, and preview image for social media and/or search-engine optimization (SEO).

With an understanding of the elements that get shared online, it's time to think about the criteria that a social-media post must meet:

- **It's accurate:** While this may seem obvious, when you're moving quickly and trying to condense a tricky, technical topic into a few characters, errors can creep in. Avoiding misleading sensationalism as well: if a headline unduly scares the reader of a social post, then it is probably inaccurate.

- **It's self-contained**: Social media's click-through rates are typically low (think **1.64%**[5]), and social-media consumers are notorious for absorbing only the packaging. So craft every post with the goal of someone's skimming it and walking away with an accurate understanding of the facts.

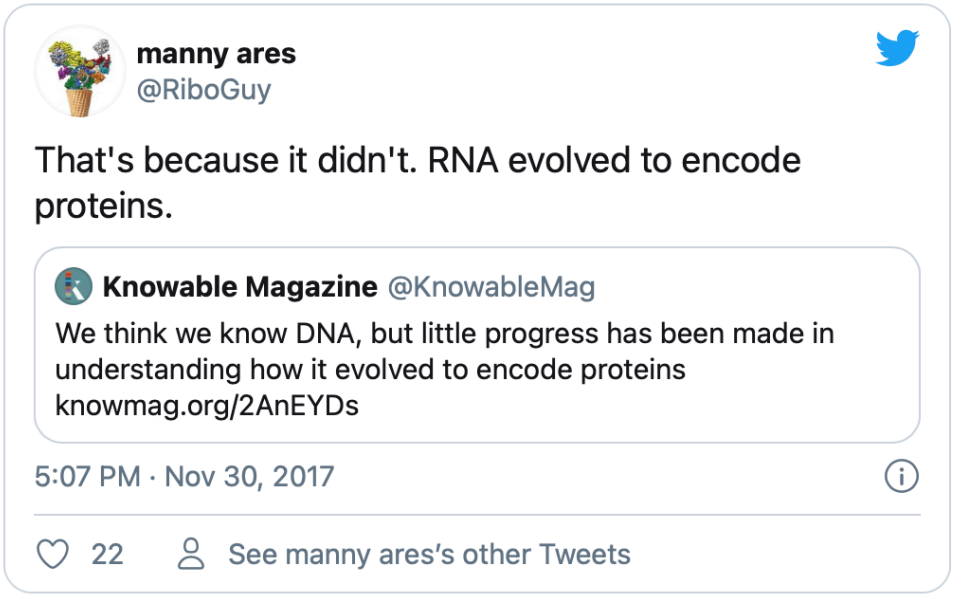
- **It's within the length limits:** Twitter has a 280-character limit. LinkedIn's limit is 600. Heds will get lopped off if they run long. Other platforms without stringent character counts have limitations as well; Facebook has a "fold," at which some of a post will turn into a "read more." It's important to get the crux of your message in before it's cut off. (For an up-to-date list of character limits, check out Sprout Social's **Know Your Limit: The Ideal Length of Every Social Media Post**[6])

How long should my post be? There are different schools of thought when it comes to the ideal length. Conventional wisdom[7] is "the shorter the better" – but you may encounter stories in which including additional context is wise. Editorial discretion comes into play: A lighthearted story may be well-served with just a few quippy words or emoji, but a serious or complicated topic may call for more.

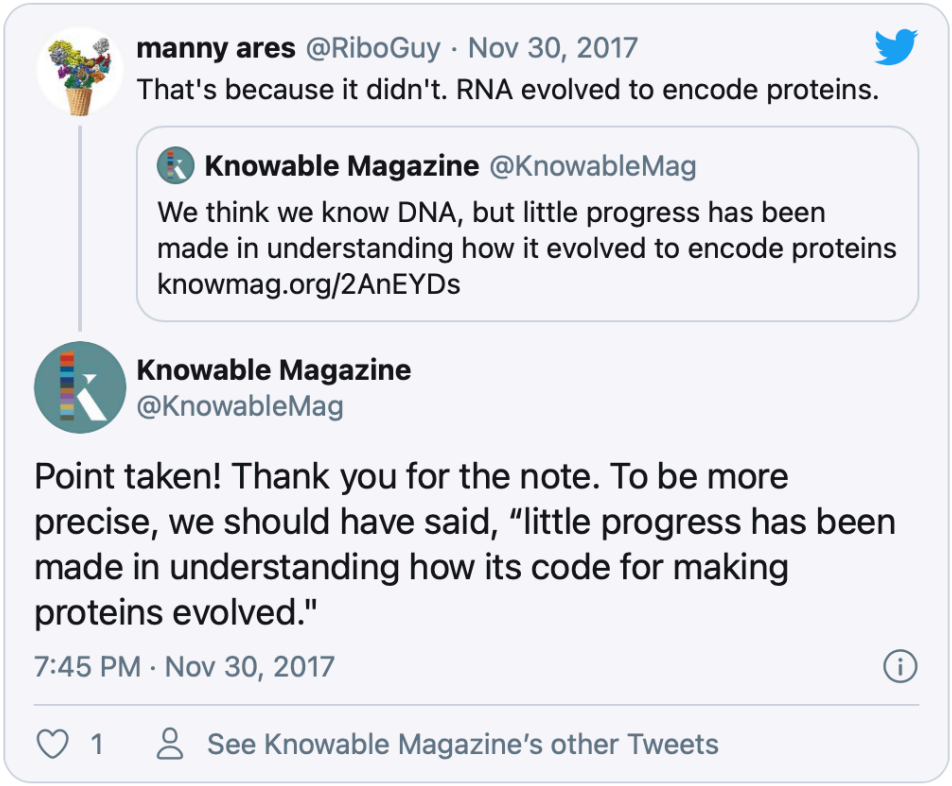
Take care not to shorten or oversimplify to the point of creating an error or obfuscating the facts. See, for example, this Twitter post about the evolution of cells to encode proteins:

Biologists were quick to point out the error:

Note, though, that the source handled it with a friendly tone, so as not to alienate the audience.



A common trope in social media is to post question-style headlines. There's an old headline mantra that says, "If the headline is a question, then the answer is 'no.'"



But, for social media, question headlines can be even more problematic, turning them into misleading implications. As Brandon Echter, engagement editor at Snopes.com puts it:

> *If a rumor is: Does Brandon Echter eat five-day-old rotten lettuce? I would put in a tweet to that [story] either a ‘false’ notification or say, ‘It’s absurd that Brandon would even think of eating lettuce, eating rotten lettuce is literally bad for you.’ [I want to include] something that will be a background indication that this is false, because what you don’t want to happen is [for] me to share this fact check: ‘Does Brandon eat five day old rotten lettuce?’ And have an emoji of a gasping face 😱. Because that makes it look like, ‘Oh my god, you won’t believe the answer! Of course Brandon does it!’ and can be very easily pulled out of context.*

Of course, those are just minimum standards. Once you’ve cleared those basic hurdles, you can start working to make a post sparkle and stand out — especially if you’re able to test posts to see which ones work the best.

Zapping the Jargon

Frankie Schembri, audience-engagement editor at Undark, encapsulates the goals and challenges of communicating using social media's brief, quippy format:

> *One, your objective is to get the reader or the user to notice the tweet. Two, get them to read the tweet. And then from the tweet, ingest, and get some sort of fact or interesting quote or anecdote from the story. And within that self-contained message, come away with something that is accurate and actionable. If all goes well, they will then click the link and actually read the story, but even if they don't, even if they just retweet it without reading it — which you hope they never do, but people likely always do — you want that self-contained package of the hed, the deck, the image, and the copy to be an accurate, self-contained representation of what the article is. And that's a very tall order for 280 characters.*

In meeting that goal, you have a fraction of a second to catch a potential reader's eye. Technical, complicated, or unfamiliar language can cause them to scroll on past.

Plus, you rarely have the space on social media to define complex scientific jargon. So it's important to make your posts accessible.

That said, "accessible" is a subjective term, and setting parameters is tricky: Just how technical you can get in your social-media copy depends on your editorial goals, your audience, and in some cases the platform:

- If your audience consists of broader population, or you hope to communicate beyond the science-savvy, you may have to be careful with seemingly straightforward scientific terms. For example, if a study was conducted using *C. elegans*, then consider referencing "worms" or "animal trials" instead.

- But if you are trying to reach a more scientifically sophisticated audience, defining or avoiding precise terms may come across as condescending. For example, a discipline-specific subreddit may consider it patronizing to refer to *C. elegans* as "worms."

Echter points out that some words might not seem obviously "inaccessible." For example, the use of "theory" might not raise a flag, but as he points out, scientists and the general public interpret this word very differently. "For a scientist or researcher, 'theory' means that this is like 100 percent. This is basically as good as it gets. It's very solid. Versus a regular person who isn't a scientist, 'theory' [might mean], 'Oh, we don't actually know yet.'"

This is an area where your readers will help you out: Monitor comments and replies to assess whether you are using too much jargon, and adjust accordingly.

> ***"If we're writing about a new species of deer, I'd much rather have 'New Species of Deer' [in the headline] than 'New Species of Whatever the Binomial Nomenclature' is.***
>
> *Sukee Bennett, audience-engagement editor, NOVA*

Showcasing the Story — Accurately

This should be obvious, but it needs to be said anyway: Don't bait and switch your audience. Provide a good and honest taste of the story you're promoting, and make sure to match the tone of your social post with the tone of the story

Start by using the same language and framing that are in the original article. If you, the reporter, or another editor has already labored over the precise wording, then why redo the work for the social-media post?

As a general work-flow principle, I suggest you task writers with providing three or more prewritten social-media posts. But to whomever the responsibility falls, there are a few places in a story you can mine for social-media gold:

- The lede
- The nut graf
- Interesting data or stats (contextualized properly)
- Image captions
- Quotes from a researcher (explaining the significance)
- Quotes from someone affected by the science (e.g., a patient describing the impact)

Asking a writer "How would you describe this as at a cocktail party?" can also elicit conversational gems about the work.

Incorporating Visuals

Social media are highly visual, and compelling imagery will help your posts pop on the feed. **Some estimates**[8] are that, at least on Twitter, including an image can boost a Tweet's engagement by 35 percent.

When adding images, make sure your link posts populate with preview images that fit the platform's ideal dimensions. (For the most current image specs, check out Sprout Social's **Always Up-to-Date Guide to Social Media Image Sizes**[9]).

You can also create standalone posts using gifs, photographs, graphics, data visualizations, illustrations, and videos. The upside is that they are highly share-able, which can help with the reach of your content. The downside is that even if

you point back to the story in the text, they are not as easily clickable as a pure "link" post. Think of them as part of a diverse mix that will keep your followers engaged with the page.

It should go without saying that you should put as much thought into selecting the appropriate image as you do in crafting the social-media text. Things to be thinking about include:

- **What does the preview image look like with the social headline?** Remember that the caption on your website will not show up. Consider whether the combination of the preview image and the headline would create a misleading package.

- **Does the image evoke an emotion — and if so, is that emotion appropriate to the story?** Vaccine stories are a popular example of misalignment of images and text. (Read Glendon Mellow's **critique of frightening vaccine images in news stories**[10] and accompanying list of alternative image sources.)

- **Is the image accurate?** Check that scientists are wearing proper lab gear and correctly using their equipment; and that the species being described is the same species as the one being shown.

- **Is it accessible for all users?** Adding "alt text" to images, and captions to videos, are tools for making posts **inclusive to individuals with disabilities**[11].

- **Are you applying the same editorial-art best practices for your social-media images that you use on the article?** See our chapter on **graphics and other visuals**[12].

Data Visualizations on Instagram

***The Economist*'s Guidelines for Charts on Instagram**[13] describes data visualizations on the platform:

- Have strong, recognizable branding that will stand out while users scroll.

- Simplify charts from articles so users can easily absorb the main point.

- Share graphics that users can "find" themselves in (e.g., a map of the top 10 most and least livable cities) .

Encouraging Click-Through

This is where the "marketing" side of audience engagement kicks in. You have to step back from a story and critically ask yourself: What would make me ***want*** to read this story?

One way is by taking advantage of the "curiosity gap," a term coined in the early 1990s by George Loewenstein, of Carnegie-Mellon University. Curiosity comes when we feel a gap "between what we know and what we want to know." By taking advantage of this framework, you can give readers a nibble of what they will learn if they click through and read the article.

10 Tips for Providing Context in a Post

1. **Put pertinent information at the beginning** — it might be the only thing someone reads.

2. **Use a word or two to contextualize a study:** What year was it published? Is it preliminary? A preprint? **In mice**[14]?

3. **Replace "scientist" or "researcher" with a more specific title:** "biologist," "astrophysicist," "physician."

4. **Tag the sources and/or their affiliations.** That can point followers to more information about who people are and what their credentials are.

5. **Clearly label opinion pieces.**

6. If there is debate, **be thoughtful with word choice:** Is the field "divided"? The science "unsettled"? Or is it just "one outspoken critic"? "Proponents" versus "critics" are potential frames.

7. If something *is* settled — **remove potentially misleading hedging terms**.

8. **Can you phrase something as a question?**

9. **Add signposts** to indicate that there is more to the post (e.g. "Read more" or "An analysis by…)

10. **Consider threads.** Each individual post should be self-contained (posts can be reshared without the context of the rest of the thread), but threads allow you to include more information. (For structure, a thread can follow the narrative arc of a story and incorporate outside links from the articles, graphics, gifs, and videos.)

In the cringiest form, the curiosity gap manifests as clickbait — "Scientists Studied Headlines on Social Media… And You'll Never Guess What They Found!" — that preys upon readers' curiosity and manipulates them into clicking. That's not what I'm advocating, of course.

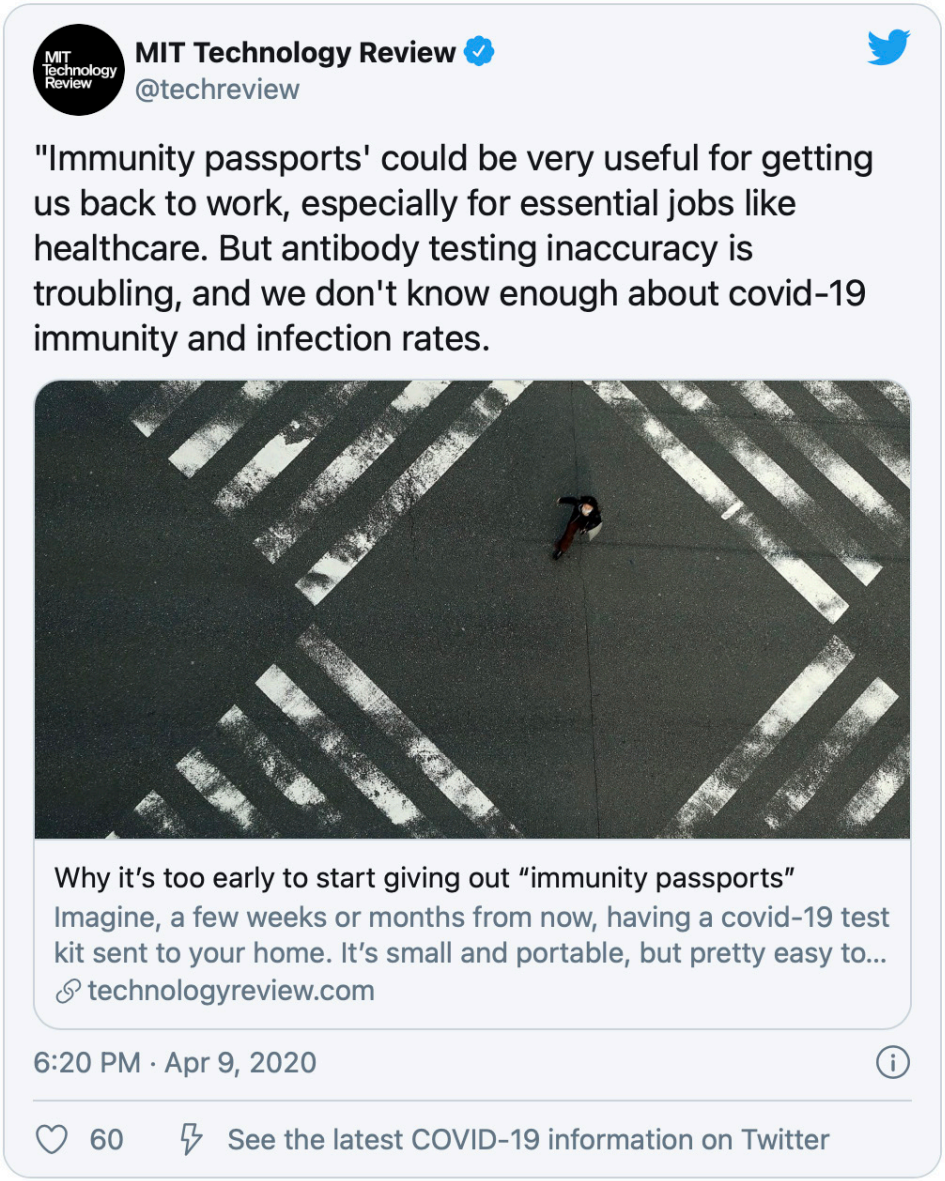
You want to be specific and interesting enough to be enticing, but without giving everything away. If a headline or post is too vague, potential readers may not realize that the story is something they would want to read; if the headline explains everything, they are given no reason to read more.

This *Scientific American* tweet avoids both pitfalls and works well to entice the reader:

In some cases, reserving information for the click-through might not be appropriate. Editors and reports should decide if there's anything in particular that should *not* be gapped — is there "need to know" info that needs to be in the social-media post?

That's what this *MIT Technology Review* tweet about immunity passports and Covid-19 does, providing the essential piece of information (that at the time of posting, not enough was known about antibody-testing reliability and infection rates). Readers of the story will get more details, but even those who see just the social-media post will learn the key takeaways.

In this example, the magazine opted not to "go hard" with a curiosity gap, because the reporter wanted the drawbacks of immunity passports to be evident without having to read the story.



Testing or Previewing Posts

When you've worked closely on a story, it can be difficult to pull back and consider what readers who don't know anything about the story might think of it when they see it in their feeds. Put yourself in the user's shoes:

- **Before a story is published:** Use the platform's advertising portal (e.g. Facebook's "Creative Hub[15]") to build a mock-up of a social post to see how the packaging options look.
- **After a story is published:** You can create a private account to test what something will look like (e.g., a "Test" Twitter account) to see how the various elements in the social-media preview load onto the platform. Private accounts can't be seen by people without the account owner's approval. You can also preview what URLs will look like when shared by using Twitter's validator tool[16].

Making Sure it's Time-Appropriate

The news moves faster than ever, so it's important that your social-media posts are created with an awareness of current events. If you post directly, in real time, you will probably already be thinking about the context in which your item appears. You can also consider resharing strong evergreen content that can provide crucial context to the news.

However, many organizations use tools to schedule social-media posts to promote new articles and resurface archival pieces. If you use a scheduling tool, it's important to keep tabs on queued content, in case it becomes irrelevant or inappropriate to breaking news.

During natural disasters or other breaking-news events, it's my philosophy to observe how people are using social media before jumping in with content. For example, if people in the midst of a wildfire are using certain hashtags to share evacuation information, I steer clear of using those hashtags on related — but not immediately relevant — stories that could slow down vital communication channels.

Humanizing Your Approach

Human experiences can make for compelling social-media content by showcasing the personal side of science, even when — or maybe especially when — the topic is technical. Highlighting the "people" (such as scientists or patients) and/or weaving a more casual, conversational tone into your social media helps keep the content more approachable. That's an especially good tactic if you have to apologize for a technical error[17].

Demonstrating Respect

Crafting posts that touch on personal or sensitive subjects, consider what the emotional experience might be for your audience — especially someone who might have difficulty encountering that content.

Suicide is one such topic. Care must be given to how suicide is discussed, as mental-health experts have pointed out a direct correlation between media references and an increase in suicides. It's a phenomenon known as "**suicide contagion**[18]." In addition, the conventional term, "committed suicide," suggests that someone has committed a crime or sin, which carries with it blame or stigma. **Experts recommend**[19] using the phrase "died by suicide."

Likewise, various communities have strong feelings about how they are described or the labels used to identify them. This is an issue that Chelsey Coombs, engagement editor at Spectrum, has dealt with in stories about people with autism.

"Within the [autism] community, a lot of autistic people want to be referred to as 'autistic people,'" Coombs says. "They don't want to be referred to as 'people with autism.' And there are people on the other side of that as well."

Coombs says she wants to make sure people understand that her newsroom is listening to them, and that it refers to them using their preferred terms. That can be challenging when there is disagreement within the community itself. "There are some people who want to use solely 'autistic people' and some people who want to use 'person with autism' language," she says. "But from my experience on social media, most autistic people want to be referred to as 'autistic people,' because reflects the fact that being an autistic person is something that informs like their entire self. They don't think it's a disease — which it's not; it's just another way that people think."

The *Conscious Style Guide* addresses this issue with an essay from AutisticaHoya.com, "**The Significance of Semantics: Person-First Language: Why It Matters**[20]". It sides with the "autistic person" framing but also points to other perspectives.

Style Guides for Inclusion

Need more information on terminology that is accurate, respectful, and inclusive? Here are a few style guides that provide just that.

- The ***Conscious Style Guide***[21] collates resources for thoughtful approaches to language, such as **ability and disability**[22], **health**[23] (both mental and physical) and **plain language**[24]

- *The Diversity Style Guide*[25]: This resource provides an excellent guide to a broad array of terms.
- "Diversity Style Guides for Journalists[26]": This collection of style guides and guidelines is maintained by *The Open Notebook*.

Finally, keep in mind that if you enter online spaces that center vulnerable communities — characteristics such as medical conditions, neurodiversity, race, and gender — you are an outsider there. Take the time to consider respectful ways of speaking and interacting.

Allow Yourself to Be Creative — and Test, Test, Test

Guidelines are just those — guidelines. When it comes to your specific content and audiences, you will very likely find that you will have your own customized approaches. To that end, it is important to test and monitor different social-media tactics to see what works best for you. (Jump ahead to **Analytics** for more about analyzing results.) And don't assume that what works today will work in six months. Tastes and norms evolve, so you want to keep testing your assumptions, updating them as necessary.

When "Hedging" Goes Awry

Including Writer Names/Handles in Social-Media Copy

Depending on your philosophy, you may consider including your writer's handle when posting non-opinion pieces as well. Some of it comes down to style.

Here are some of the issues seen by Chaseedaw Giles, social-media manager at Kaiser Health News:

> *Say the tweet goes viral: A lot of times people will like or retweet something without even reading the story, and they'll have no idea who wrote it. We want the reporters to get credit. Another part of our job, as I see it, is really highlighting these writers, because it's their work, and they spend so long on the stories, and they want to be seen for the work that they did.*

Other considerations: Are you trying to build up your own writer's social-media profile? Do you have a "celebrity" writer whose byline might attract readers? Practically speaking, do you just want to notify writers when you've shared their stories? Excluding the handle is also common, so this is by no means a requirement.

Different Platforms, Different Audiences

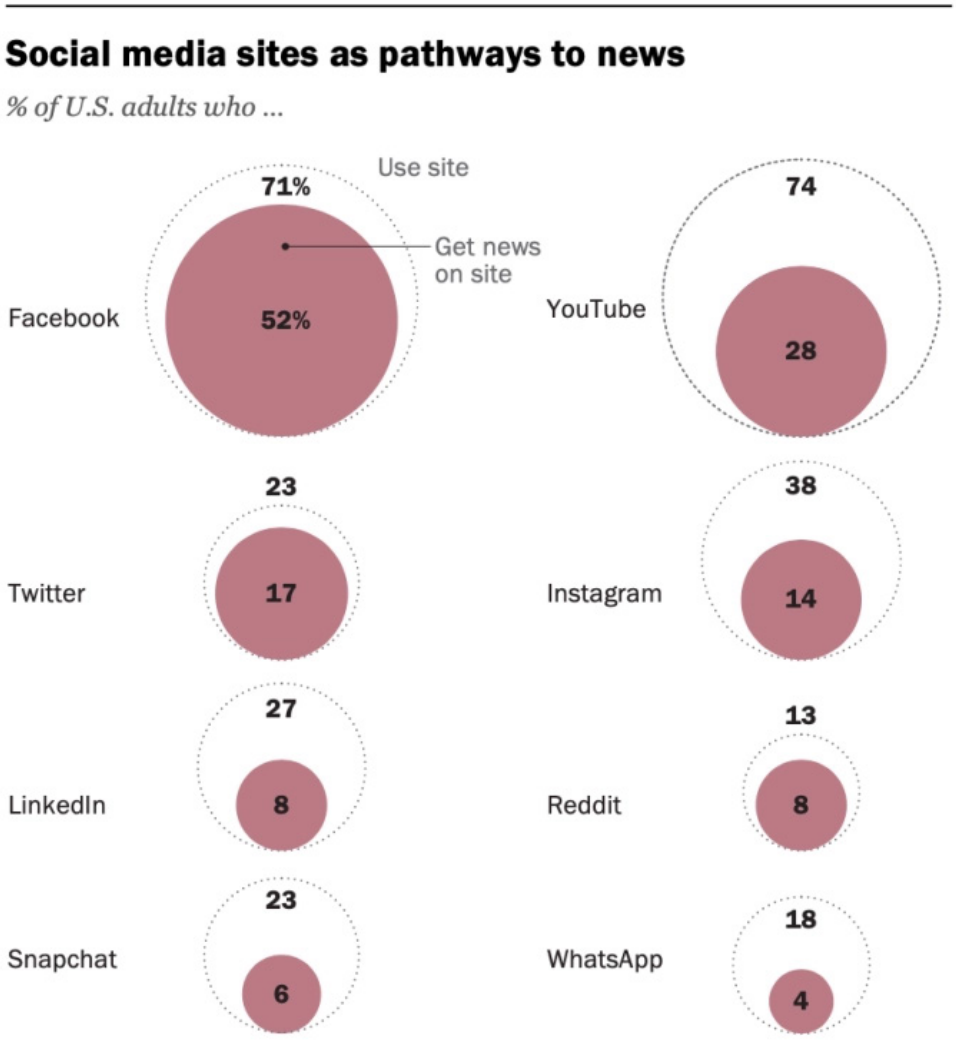
People consume content differently on different platforms. The variation is due in part to the nature of the platforms and the characteristics of the people they at-

tract. And users often change their engagement with social media from app to app. For example, here are different ways people tend to engage with various platforms:

- **Twitter:** Catching up on breaking news.
- **Google:** Searching for background information.
- **Reddit:** Skimming the latest headlines.
- **Instagram:** Browsing beautiful photography.
- **Facebook:** Engaging in discussions with friends.

Getting a feel for those nuances can make your approaches more tailored and more effective.

Below, in this 2019 Pew report, you can see the relationships between various social-media platforms and the news-consuming public.



Source: Survey conducted July 8-21, 2019.
"Americans Are Wary of the Role Social Media Sites Play in Delivering the News"

PEW RESEARCH CENTER

Jessica Hubbard manages social media at *Science*, which publishes journalism as well as content for research journals. She crafts what she posts to match the dynamics of each platform and its audience:

> *When I craft social media, I think of the audiences of the social-media platforms more so than the audiences of the different publications. When I'm writing for Facebook for both News From Science and Science, I think of writing things in more of a general context. How would I talk about this to my mom, for example? And I share content that my family or the general public would have interest in.*

> *Twitter I see more as a realm for academics and scientists, where they talk about their own research and other people's research. I see more discussions about that. I will mostly, but not exclusively, promote our research articles, reviews or perspectives, which don't necessarily have more jargon, but they're a little harder to break down than the News From Science stories.*

Social-Media Platforms: What to Know

Each platform has its own culture, its own jargon, its own audience. Here's a primer.

Facebook

The behemoth, Facebook has the largest and broadest user base. It's your high-school prom date, your mom's cousin, your former colleague, your best friend – all mixed together with brands, media companies, and people you've never met. Meanwhile, about **half of American adults get their news through Facebook**[27], according to Pew Research.

Facebook is primarily used as a distribution platform for getting content in front of your followers by posting on a Facebook page. Visuals and video tend to do well on Facebook, although these are primarily "on-platform" content types and do not necessarily lead back to your own website, raising the question: Is Facebook worth it?

You may be able to find stories based on the conversations happening on Facebook. For example, Buzzfeed used the Facebook-owned tool CrowdTangle[28] to find and analyze misinformation relating to the Australia bushfires[29].

Another way to use Facebook is by creating a Facebook Group. *PBS NewsHour*, for example, has the Science Squad[30] Group, and Vox used a group is to find sources to talk about Obamacare[31]. These will require more moderation than a standard page, so think about what you hope to get from a group before investing the time in building one.

Alternatively, you can also find existing communities around a particular topic. For example, users of a houseplant page might be interested in sharing a botany story, and patient-support groups might be interested in a story about their condition.

Ways of surfacing these communities include:

- **Ask your reporters:** If they are deeply involved in a beat, they may already know whom to reach out to, or they can ask their sources for recommendations. They may be able to warn you of untrustworthy or disreputable actors.

- **Use CrowdTangle[32] to find pages or groups** that have shared your content in the past, or content from another publisher on a similar topic ("I saw that your posted… you might like…").

- **Use Facebook's search engine:** Briefly vet the pages or groups you find to make sure they aren't snake-oil pages, and then prioritize those that have large or engaged followings, that regularly post third-party content, and that are actively posting. Beware, though: Facebook will flag your messages as spam if you send them to too many groups too quickly.

Facebook terms you need to know:

- **Newsfeed**: A never-ending, algorithmically sorted digest of posts (both organic and paid) from friends, acquaintances, brands, and more.

- **Pages**: The "home base" for brands.

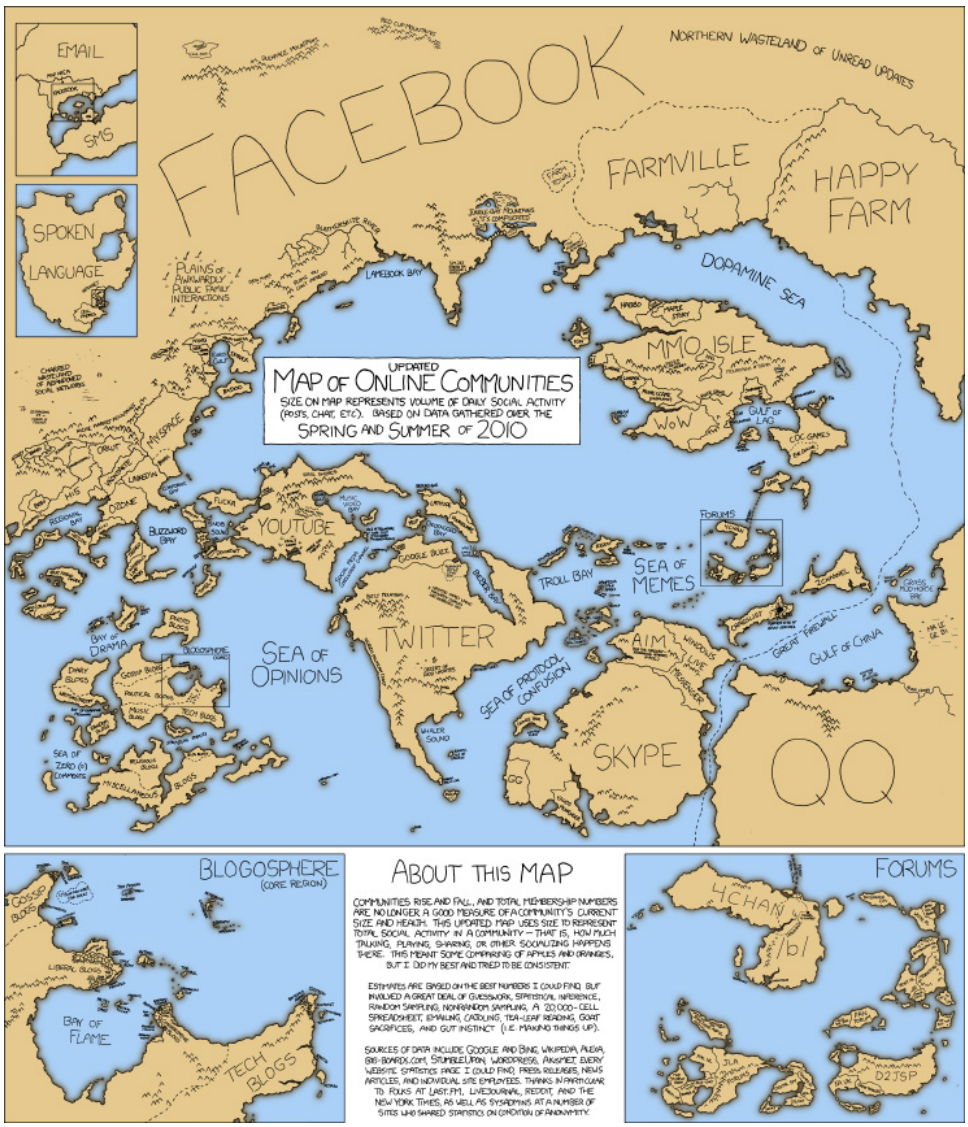
- **Groups**: Forum-like communities dedicated to specific topics. Publishers with adequate resourcing and strategic goals may consider launching their own. Some groups are also open to publishers sharing relevant content.

Other products within Facebook include Watch (the video player), Marketplace

(local classifieds) and Messenger (1:1 messaging, which also exists as a stand-alone mobile app).

Facebook was once a huge traffic driver to publishers, but a January 2018 **algorithm change**[33] to put a higher priority on "meaningful social interactions" led to **a dramatic drop in Facebook referrals**[34]. As a result, many news organizations no longer see as much success posting stories, although this decline was not universal.

A common sentiment is that Facebook is now pay-to-play, and you will have to **boost posts or otherwise use paid advertising**[35] to reach even your own followers.



2010 cartoon from xkcd.

Twitter

Quick and short, this “newsiest” of the social-media apps is a natural home for breaking news and live events. Twitter is populated with “power users” and active subcommunities, such as journalists, academics, and activists.

The main feed can be organized two ways: algorithmically (“Home”) and chronologically (“Latest”).

Twitter terms you need to know:

- **Lists:** Collection of accounts that can be followed in their own feed.
- **Moments:** Curated tweets, usually around a single topic.
- **“What’s happening”:** Sidebar with hashtags and keywords for buzzy topics.
- **TweetDeck:** Separate monitoring tool where you can see several different types of feeds simultaneously.
- **Hashtags:** Key words set off by the # symbol, which links to a feed of tweets with that keyword.

Hashtags are useful for amplifying the reach of a tweets, although you want to be discerning when using them — #don’t #hashtag #every #word.

URL: https://youtu.be/57dzaMaouXA

Be more judicious with your hashtags than Jimmy Fallon and Justin Timberlake.

There are tools for finding popular hashtags (**Sprout Social has a roundup**[36]), but if you're looking to gain traction in a specific niche, following chatty users in that space is a great way to discover them.

Likewise, following scientists and science writers can help with keeping a pulse on conversations in those fields. It's especially useful to go beyond the big names to follow scientists and science communicators who will have a boots-on-the-ground view of their fields.

A few hashtags that will help direct you to active voices:

- #**SciComm**
- #**AcademicTwitter**
- #**PhDChat**
- #**MedTwitter**
- #**ScienceIsForEveryone**
- #**UniqueScientists**
- #**BlackandSTEM**
- #**BlackAFinSTEM**
- #**DiversityinSTEM**
- #**LatinasInSTEM**
- #**LatinxandSTEM**
- #**DisabledAndSTEM**
- #**WomeninSTEM**

Two other Twitter accounts of note: **@Also_AScientist** and **@culturedish**, which can lead you to specific scientists, science communicators, and science journalists outside of the stereotypical image of "who a scientist is."

Instagram

Aesthetically pleasing and smoothly designed, Instagram (owned by Facebook) is an image-driven platform, usually with an aspirational or escapist quality to

the content. Well-composed photography mingles with beautiful illustrations and celebrity-sponsored content. The platform tends to attract a younger audience.

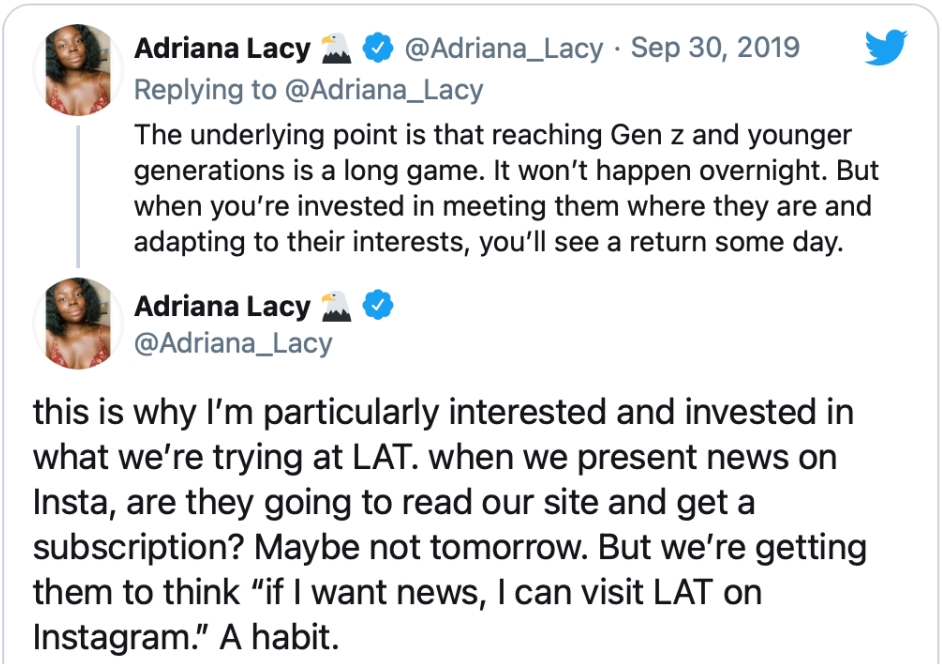
Instagram terms you need to know:

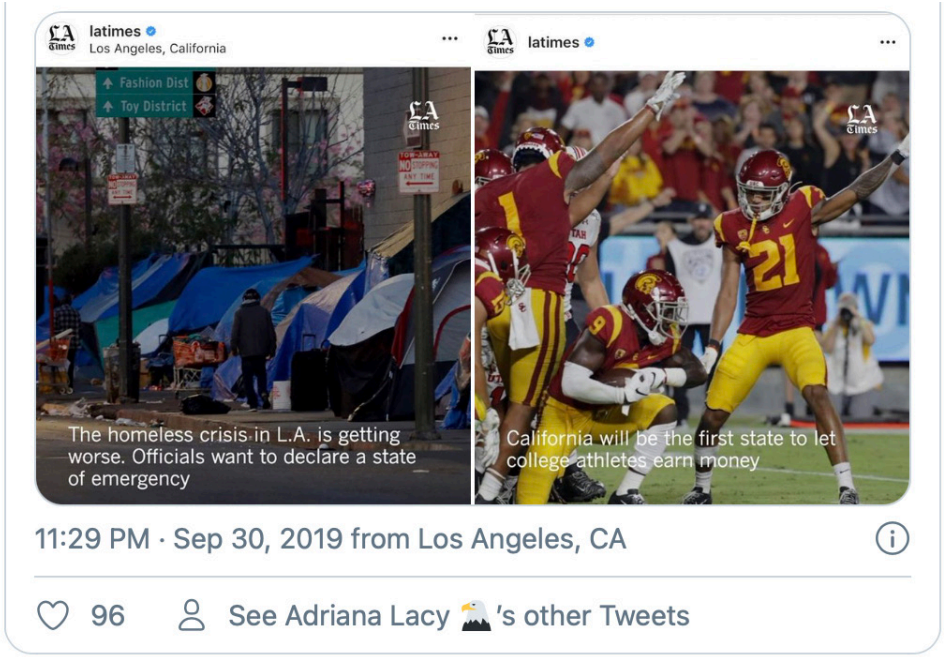
- **Feed:** Posts from accounts or hashtags that a user follows, sorted algorithmically.
- **Search & Explore:** Algorithmically surfaced posts and curated topics from accounts a user does not follow.
- **Stories:** Short videos or images, shot vertically, that expire after 24 hours
- **Live:** Vertically shot livestreamed videos that appear in the Stories section.
- **IGTV Watch:** Longer-form video.

Hashtags are a valuable tool for making Instagram posts more discoverable, as further described in **Hootsuite's guide to Instagram hashtags**[37].

Instagram is not generally a huge traffic driver — it's hard to link back from within the feed, and you need to either reach 10,0000 followers or get verified in order to link back through Stories.

However, for organizations that can regularly post engaging images, there is long-term brand-building potential with younger audiences. In a version of Social-media *Inception*, Adriana Lacy, of the *Los Angeles Times*, took to Twitter to **discuss using Instagram for habit formation**[38]:





At times, Instagram can veer from its escapist culture and see **content on political and social justice become much more widespread,**[39] such as when Black Lives Matter activists turned to the platform as an educational and organizing tool.

Reddit

The self-described "front page of the internet," Reddit hosts a collection of dedicated communities ("subreddits") dedicated to particular topics. Users comment on and "upvote" particular posts; highly engaged posts can end up on the front page of Reddit, causing traffic spikes. Many subreddits also host "Ask Me Anything" (AMA) sessions.

There are many communities dedicated to science, including: **r/science**[40] (large community dedicated to research published in the previous six months) and **r/everythingscience**[41] (smaller associated sub to r/science). There are also subreddits dedicated to specific disciplines, regions, hobbies and so on.

However, Reddit is a particularly *particular* culture, with various rules and standards of etiquette. The key is being an engaged participant; it is generally bad form to post links to your stories on Reddit. To that end, **always contact the moderators and ask for permission before posting on a subreddit.** Each one has its own rules and conventions. One subreddit told me that if I ever posted any any content from Knowable Magazine, then any link from our domain — no matter who posted it — would be banned.

LinkedIn

You know it as a site primarily for professional networking and recruiting. As such, it could be a good home for publishers with business or industry coverage.

Different types of profiles include Company Page (good for the main brand); Showcase Page (for a sub-brand or subsidiary); and personal profiles (for individuals).

Distribution mechanisms include:

- Posts that show up in the main feed;
- LinkedIn groups; and
- InMail (messaging program, could be used for paid campaigns).

Individual people's profiles can be influential, so consider building up "thought leaders" within your organization as part of your LinkedIn strategy.

Some publications have success with pitching the LinkedIn editors directly to get more highly featured. Given the nature of the platform, workplace and career stories may find a receptive home here.

Pinterest

Both a beautiful bookmarker and a powerful search platform, Pinterest is beloved by moms, do-it-yourselfers, and hobbyists of all sorts.

"Pinboards" are used to save and discover content from around the web. Users will "pin" a link to their own boards. There is a powerful search function for serving up other pins. Users can also follow other boards, which show up on the algorithmically populated feed.

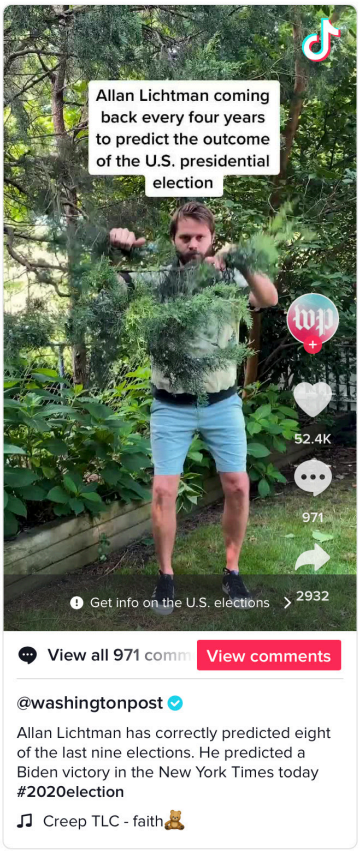
Classic content examples include DIY projects, design, cooking, and wedding planning. But anything people are passionate about or have hobbies around is fodder for Pinboards. That can include a lot of science material.

You may want to consider including "pinnable" content, such as infographics that can be pinned directly from your site. See Hubspot's **guide to optimizing pins**[42].

If educators or science teachers are part of your core audience, Pinterest could be an effective tool for reaching them. A 2018 survey found that **73 percent of educators reported using the platform**[43].

You might consider maintaining a pinboard yourself, with keyword-rich pins that can seed others' boards.

TikTok



The new kid on the block, this app features vertically shot videos that are often meme-y and addictive. Think dancers, lip-syncing, and a brand of comedy specific to Gen Z.

Few publishers are on here. One that is: ***The Washington Post***[44], which uses the platform to provide a humanizing look into its newsroom and encourage awareness among younger potential audiences.

Read more: "**How *The Washington Post* uses TikTok to engage with its audience**[45]," by Katie Pellico, *CNN Business*.

Snapchat

The original ephemeral-content app, Snapchat is known for short, vertically shot videos that disappear after 24 hours.

Snapchat remains **popular among teenage users**[46], but publishers have not gotten traction. Those who partner with the platform can produce original programming available on the "Discover" tab. But if you are a "user," it is difficult for potential users to find and follow you. If you seek to build a younger audience with ephemeral content, Instagram may be a better bet.

Products include:

Messaging: 1:1 or group messages (consecutive days of 1:1 messaging can lead to a **coveted Snapstreak**[47]);

- **Stories:** Ephemeral broadcast content; and
- **Snap Originals:** Professionally produced shows specifically for Snapchat.

Tumblr

Once a mainstay of every nerd's content diet, Tumblr is a microblogging site featuring a smorgasbord of images, diaries and fan fiction. It's also a site in decline.

Tumblr used to have devoted science communities. But usage in general has fallen in recent years, particularly after **an explicit-content ban was put in place**[48], so it has become uncommon for publishers to devote energies there.

Google/SEO

The “university” in your pocket that can settle a spirited debate with a few keywords or send you down rabbit holes for hours on end.

Although this is not a “social-media platform” per se (RIP, Google Plus), Google and other search engines **remain an important traffic source for publishers**[49]. Besides the standard search-engine result page (SERP), your content can show up on a number of Google products, including Google News. **The Google News Initiative provides an overview of their offerings**[50].

Search-engine optimization is a complex endeavor. **Here are a few tips to get you started:**

- **Think like a “searcher”:** Put yourself in the shoes of a potential reader. What words would people use in a Google search if they wanted to find the information in your story?

- **Research keywords**: If you’re publishing about a recurring event, **Google Trends**[51] can provide insight into what people searched for during the previous occurrence. (Example: **the Nobel Prize**[52].) For other topics, you can use Google’s **Keyword Planner**[53].

- **Craft headlines with search in mind:** Include a keyword in the headline, the earlier the better. Many content-management systems will allow you to write a separate “SEO” headline if you want separate versions for search and for your site. But note that your onsite headline will also be a signal to Google about what the story is about.

- **Skip the “keywords” box:** If you use that to help your readers navigate your website, by all means continue, but keep in mind that it’s not going to help you rank higher on search — **Google has not used that metatag in more than a decade**[54].

- **Use alt text on images:** Besides making your site more accessible to vision-impaired audiences, alt text will help Google’s bots better understand visual-rich content on your site. (Read more about **best practices for writing good alt text**[55].)

- **Link back to your previous coverage on a topic**: Build search authority by internally linking, and be sure put the hyperlink on a keyword. (Read more about **anchor text**[56].)

Further reading:

- **Trisolute News Dashboard**, an SEO tool for news publishers, has an extensive explainer on **Google News optimization and news SEO for digital publishers**[57].
- **Backlinko** reviews the **more than 200 factors that contribute to search**[58].
- **Stay up to date** with product updates: **Search Engine Land**[59] covers trends and updates.

Finding Your Social-Media Voice

Embracing humor and being conversational are considered good practices. But how will that work for your publication? Brandon Echter, audience-engagement editor at Snopes.com, specializes in honing social-media voice. The following conversation with him has been edited and condensed for clarity.

What's the connection between the content and the social-media voice?

Content 100-percent informs your voice. While people do contain multitudes and oftentimes do switch between "Here is my serious voice" and "Here's me joking around," if your content is more serious or more jokey, that's going to inform who you are on social media, because that sets the tone.

How do you come up with a brand role or a social-media persona?

We answer a bunch of questions: If this publication was a person, what would that fictional person be? Where would they hang out? What would they like to do?

Who should be involved in developing the brand voice?

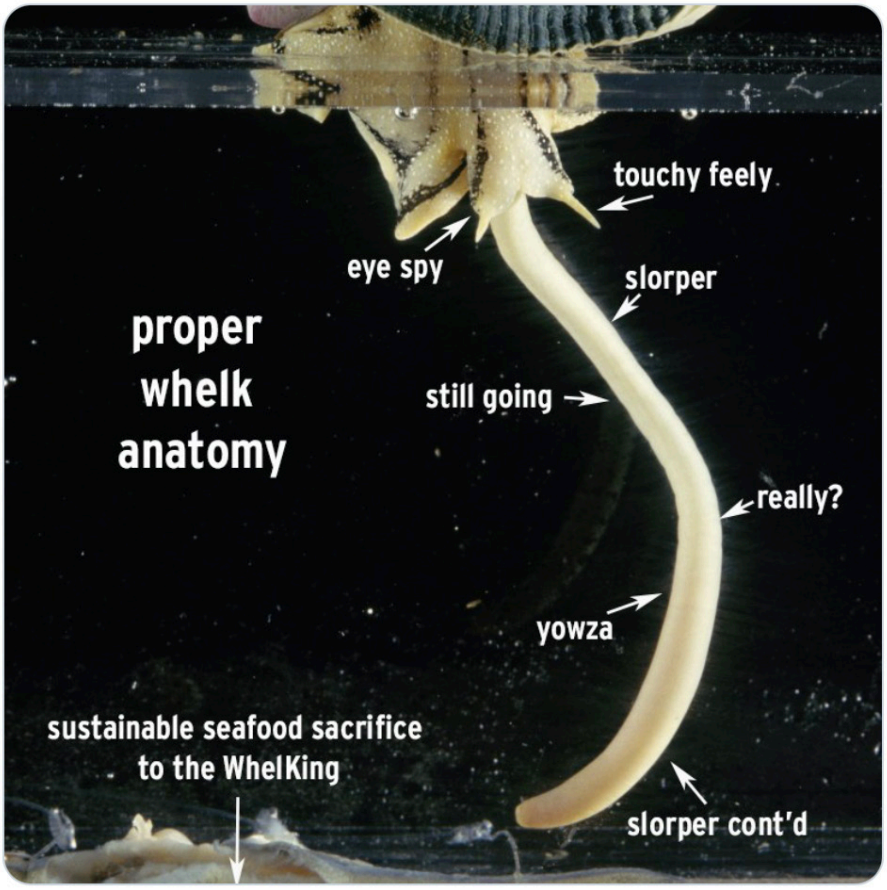
Brand role is very much a collective, and you do need to have everybody's input there. That persona will probably be somewhere in between all of those people's ideas of what the brand is. It is really helpful to do activities like this as a group — but individually. Everyone writes their own answers to the questions, and then you all combine and see where this person is.

Do you have any examples of places that you think have a real well-developed voice?

The Monterey Bay Aquarium (**@MontereyAq**) has this really wonderful "look-at-this, internet-native voice."

Monterey Bay Aquarium
@MontereyAq

whelk, another animal unscienced
#UnscienceAnAnimal



6:30 PM · Jan 30, 2019

1.6K 471 people are Tweeting about this

On the more serious side, ProPublica (@propublica) has done a really good job of using things like Twitter threads to tell narratives and speak from its own serious, storytelling voice.

ProPublica
@propublica

1/ Hold on. We have some emails to share.

4:47 PM · Jul 13, 2017

5.9K 3.9K people are Tweeting about this

Watch More: Be Human — Breathing Life Into Your Social Media[60]: A talk Echter gave for The Communications Network:

URL: https://youtu.be/quQywpoEDvo

Collaborating on Social Media

Social media, in its best iteration, requires a collaborative effort.

Reporters and editors are the experts on their stories and beats. They can identify important takeaways, flag nuances, and spot errors when it comes to packaging and promoting stories. But, they may be unfamiliar or uncomfortable with social-media norms, lingo, best practices, or even having that sort of public presence.

Meanwhile, social-media editors are well-versed in the nuances of discourse on those platforms but don't necessarily have a firm grasp of the nuances of every story.

So here are some tips for how newsroom colleagues can collaborate:

- **Ask (and answer) the "dumb" questions.** Writing for social often involves summarizing, paraphrasing, or drafting new copy that does not show up in the original story. Run new language — even small changes — past the original reporters or the editor if they didn't write it, to make sure it is accurate.

- **Bring audience in early.** Include the social-media or audience editors in editorial and pitch meetings, so they can know what stories are in the queue,

gain insight into how the editorial team thinks about them, and jump-start any engagement or promotion planning (e.g. researching keywords for SEO or putting out calls on social media for sources).

- **Set up collaborative communication channels**. A popular approach is using a designated Slack channel for workshopping headlines and social media posts.

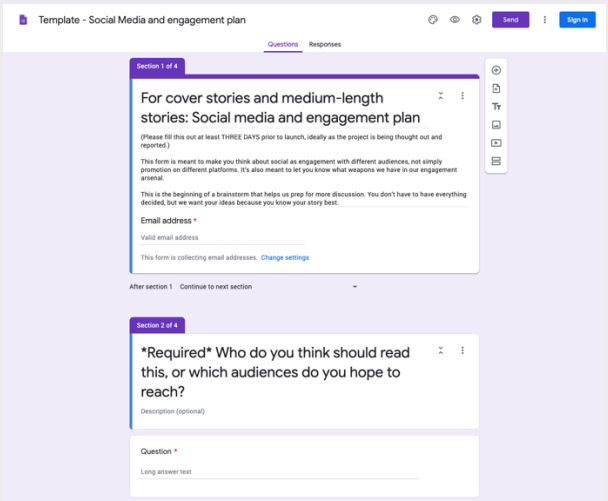
- **Find a work flow that works for *your* editorial team.** The structure and dynamics of your newsroom shape what you can expect from colleagues. (For example, staff writers might be expected to participate more than freelancers.) Don't be afraid to set up a process and then modify it as you learn.

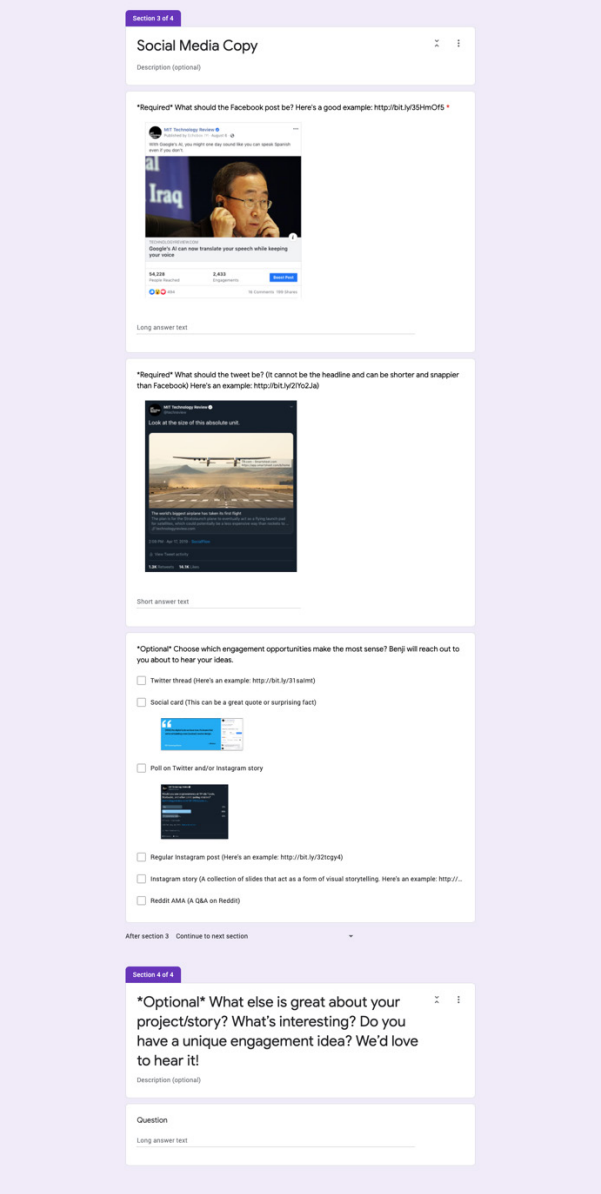
- **Test and retest.** Develop theories about what works best for your content, voice, and audience, and test those ideas. You might find social-media posts that pose questions do better than those that summarize the story. But don't assume it will always be that way. Keep testing your assumptions, and be prepared to modify your behavior based on the results.

- **Make it clear that everyone is on the same team.** Listen to and respect reporters' wishes. The last thing any journalist wants is a misleading social-media post tied to a bylined story, and the last thing a social-media manager wants is post "fake news."

Template — Social-Media and Engagement Plan

Created by Benji Rosen, of *MIT Technology Review*, and adapted from *The Arizona Republic*, the form pictured below helps reporters and editors plan for a social and audience engagement strategy for their big stories. The goal is to get reporters and editors thinking early and creatively, rather than resorting to the default actions at the end of the publishing process. Rosen recommends that newsrooms create similar forms for their staffs.





Case Study: STAT & Covid-19

Alexander Spinelli, social editor at STAT News, discusses how social media is a dynamic space that must be constantly monitored, and where newsrooms need to make adjustments as news developers. His reference point is the early days of what became known as Covid-19:

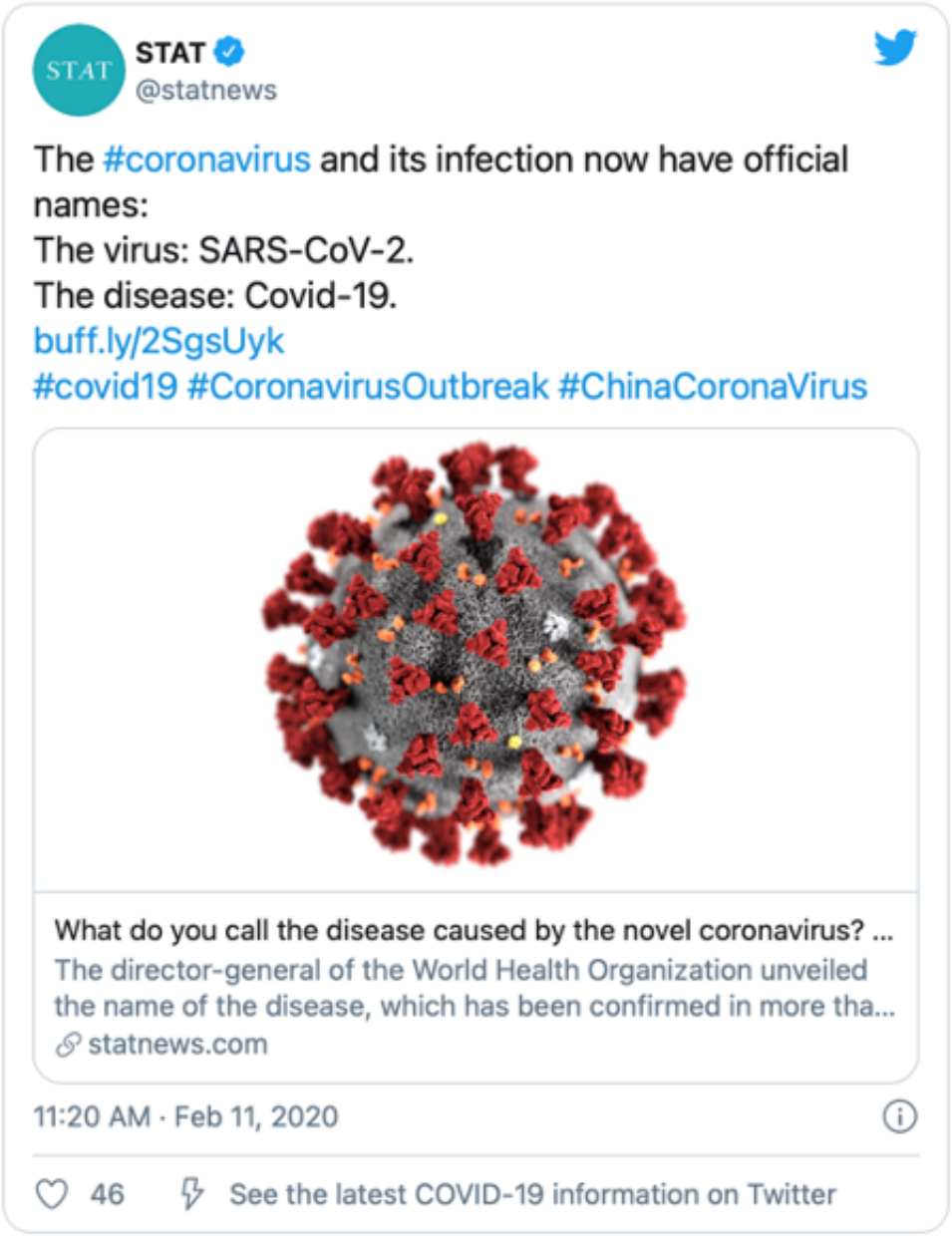
> *STAT started reporting on Corona back in December [of 2019], before it was Corona, before it was COVID-19: It was this mysterious pneumonia that was happening in Wuhan, China. And as the story progressed, different hashtags — different ways of phrasing — changed and evolved.*
>
> *In early posts, everything was #Wuhan, because that's what everyone was talking*

about. And then you realize, once this becomes a bigger, broader thing, your language changes, your approach changes.

You want to make sure that you as a news organization have a sense of accountability; you don't want to perpetuate any kind of stereotype. And that can all come down to how you're hashtagging something and how you're talking about it in a post.That all happened [while] I was learning about how the situation was progressing, but also as my experts — my reporters and editors — were directing me and steering me: 'Let's not use this language anymore. Let's make sure that we're talking about it like this. Let's steer the narrative that way.'

The evolution of the terminology around the virus was reflected in STAT's social-media accounts:

Posted Jan. 24, 2020.



By Feb. 11, the terminology evolved, and so did STAT's social media phrasing.

Developing a Plan in Case of Trolling

One of the dangers of engaging in social media as a journalist is the risk of being trolled, doxxed, threatened, or harassed — especially if you're a woman or a person of color.

PEN America's **Online Harassment Field Manual**[61] provides strategies for journalists and colleagues, including **steps for tightening cybersecurity**[62], **tips for dealing with harassing messages**[63], and **best practices for employers and HR departments**[64].

One relevant nugget for headline and social-media editors: When a headline is inflammatory or divisive, the writers will bear the brunt of the criticism or harassment online, so inviting their input may reduce the risk of abuse directed at them.

Key tips include:

- **Screenshot, archive, and/or print the message** in case they are deleted and you need to show proof.
- **Reach out to your colleagues** if you see them being targeted online.
- **Use a password manager** and multifactor authentication. One of the best tools is 1Password, which makes its service **free for journalists**[65].

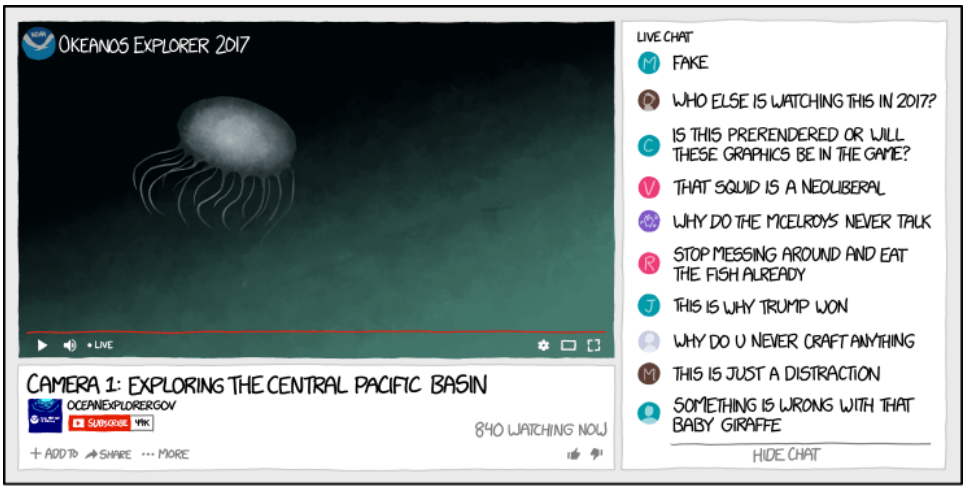
Read the entire field manual for a complete list of tips and best practices.

Interactive and Real-Time Engagement

There are a number of ways you can engage with your audience in real time. You can provide a mediation layer between researchers and the audience, or provide insights into how the journalists reported on a science story:

- **Tweet chats:** Interview or conversation, usually between two or more Twitter accounts and organized with a specific hashtag. The "interviewer" account will tweet a question, and the "interviewee" will reply to that tweet with an answer. (Another live "text" event is the Reddit AMA — see below.) Example: In **#STATMadnessChats**[66], "contestants" in the **annual STAT Madness bracket**[67] converse with **@statnews**[68] through their institutional Twitter handles to discuss their research innovations.
- **Livestreams:** Many social-media platforms include a "livestream" product, which can either be a live broadcast or the debut of a produced work. These include **YouTube Live**[69], **Facebook Live**[70], and **Instagram Live**[71]. Reporters, editors, and even sources can interact with viewers in real time, either by responding in the comment section or by "on air" callouts. Example: *Nova,* on PBS, premieres documentaries (such as ***Polar Extremes***[72]) on Facebook Live, and the brand account, producers, and researchers will chime in during the airing with plugs for related videos and behind-the-scenes tidbits.
- **Virtual events:** Panels, webinars, and lectures are broadcast virtually (say, via Zoom). These often include some sort of presentation or structured

discussion, followed by Q&As with the audience. Example: Spectrum, a website on autism research, hosts webinars for researchers across different disciplines. As the Covid-19 pandemic hit, Spectrum hosted a discussion with researchers on **how institutional shutdowns were affecting their work**[73].



From xkcd.com

A few tips:

- **Start to schedule well in advance.** Academics typically have busy schedules, and you may need time to wrangle all parties, especially if you want to feature multiple scientists.
- **Vet your speakers beforehand.** Your editors and reporters can be a good resource for flagging which scientists communicate well on the fly.
- **Set expectations about how general your audience will be.** This will help researchers know how deep into the weeds they can go.
- **Promote beforehand.** Create a Facebook event; lean on your panelists and their institutions' marketing teams to promote the event; work with movers and shakers in the field
- **Make sure the technology works!** Test it out beforehand.

> ***"It feels special when you're an audience member, and you put in a question, and somebody actually reads it and you get an answer.***
>
> *Chelsey Coombs, engagement editor, Spectrum*

Reddit AMAs

AMAs, or "**Ask Me Anything**[74]" sessions, take place on a subreddit — a community on Reddit dedicated to a particular topic, and can last anywhere from 60

minutes to 24 hours. Benji Rosen, of *MIT Technology Review*, explains how they coordinate these sessions within their specialties. (Q&A edited and condensed for clarity):

Why do an AMA?

Often it points back to reporting that we've done, so it's a little payoff. But mostly it's just a way for us to follow the conversation on the subreddit, to get a pulse about what people are curious about.

How hands-on are you with the sources?

Many of our sources have never done this, and they don't know what it is. So I'm coaching them on best practices and what to expect, and then just following the conversation for them and alerting them to what's being talked about and what comments I think are the best, just to streamline the process to make it a little bit easier on them.

And what are some of those best practices?

Don't kill yourself. Don't go in there thinking that you have to chat with users for 10 or 12 hours — just check in two or three times over the course of the chat. Maybe answer like five or six questions per time. Have it be thoughtful, show people how to follow you elsewhere or get in touch with us to continue the conversation. People [the potential sources] balk when they hear it's a 24-hour chat,* but once they realize that it's like an intermittent chat, where you can check in and check out, it makes it a lot more manageable.

Here is an example of an AMA that was hosted by *MIT Technology Review* to discuss its **Covid Tracing Tracker**[75].

> A flood of coronavirus apps are tracking all of us. We're the MIT Technology Review team helping you keep track of them. Ask us anything!
>
> Technologists everywhere have been rushing to build apps, services, and systems for contact tracing: identifying and notifying all those who come in contact with a covid-19 carrier. Some are lightweight and temporary, while others are pervasive and invasive: China's system, for example, sucks up data including citizens' identity, location, and even online payment history so that local police can watch for those who break quarantine rules.
>
> Opinions differ on whether these apps are just a technocratic daydream or—if done correctly—a potentially useful supplement to manual tracing. But the reality is that these services are already rolling out, and many more are likely to come in the next few months.

Despite the avalanche of services, however, we know very little about them or how they could affect society. How many people will download and use them, and how widely used do they have to be in order to succeed? What data will they collect, and who is it shared with? How will that information be used in the future? Are there policies in place to prevent abuse?

At MIT Technology Review, we started asking these questions and found that there were not always clear answers.

So to help monitor this fast-evolving situation, we've gathered the information into a single place for the first time with our Covid Tracing Tracker—a database to capture details of every significant automated contact tracing effort around the world.

We've been working with a range of experts to understand what we need to look at, pulling sources including government documents, announcements, and media reports, as well as talking directly to those who are making these apps to understand the technologies and policies involved.

Ask us anything about your country's automated contact tracing app, contact tracing more broadly, data privacy, or how you can participate in this project.

We're Bobbie Johnson, an editor and lead on the project, Tate Ryan-Mosley, Tech Review's research manager, and Patrick Howell O'Neill, its cybersecurity and privacy reporter. Ask us anything!

Proof: https://twitter.com/techreview/status/1261417679484620800

r/IAmA • techreview • 5m ago
7905 points • 445 comments

*Not every AMA runs on this 24-hour timetable, and your approach to prepping sources may need to be different. Social Media Examiner recommends prepping for a one-hour AMA **by brainstorming potential questions**[76] so you are ready to go.

Measuring Success

Analytics

Web metrics and social-media data can be powerful tools for assessing what's resonating with your audience – or they can be a confusing and potentially mis-leading jumble of numbers.

Analytics are not intended to replace editorial judgment. Rather, they should help guide decisions when you are faced with limited resources or several equally good choices. Here are some ways to make use of metrics:

1. **Identify what's important.** Deciding what numbers you want to look at will depend on broader strategic goals – editorial, audience, business. Your publication might be interested in which types of stories drive subscriptions, which ones attract repeat users, or what stories get the most organic social-media play. Focus on those figures, rather than "vanity" metrics, like what stories drove the most clicks. Clicks are nice, but subscriptions pay the bills. For more, read about **vanity metrics and how to identify them**[77] in Tableau.

2. **Stakeholder buy-in is crucial.** Lots of people can have a role to play in understanding and making use of the analytics. As an editor, make sure that you understand what insights and conclusions you can and cannot draw from the numbers, and that everyone agrees on those guidelines.

3. **Look for simple nuggets first.** Analytics are easier when you break them down into manageable chunks that can be built up into a knowledge corpus. For example, you might ask simple questions like:

    - What is the best time of day for our Facebook posts?
    - What hashtags correlate with the biggest reach?
    - What headline format (or length) drives the highest click-through rate?
    - Are there any evergreen stories that consistently drive SEO traffic? (And do they have links back to newer, relevant stories?)

4. **Set up simple systems.** It is easy to set up small-scale processes — like having someone hand-post Twitter messages — and hard to maintain them. Automate whenever possible, and try to find ways to make recurring reports simple to put together and send.

5. **Be mindful of morale.** Not all metrics will show happy news. Some stories don't resonate, some strategies don't work. You don't want to obfuscate or hold back on sharing an unpopular stat. Rather, develop good bedside manner. To that end:

    - **Don't lay blame.** It's not about someone doing something wrong, it's about the lesson that can be learned.
    - **Highlight and learn** from success stories; don't focus on the failures. That's not to say failures should be ignored; indeed, interrogate them and learn

lessons from them. But share the success stories and explain why they are successful. People will naturally work to replicate what works and is praised.

Here are three case studies that demonstrate how those concepts can be put into practice:

Case Study 1: Using Analytics When Assigning Stories at *Science News*

Understanding your audience's interests can help you figure out the best way to use your resources. Mike Denison, audience-engagement editor at *Science News*, explains:

> *I noted in a quarterly report that we covered a lot of spacecraft launches, and those did nothing for us. Low traffic, low engaged time, wasn't exactly inspiring a ton of reader feedback. [Those are] really quick-turnaround, high-pressure stories. It's a good bit of work and planning for not very much reward. Pretty soon after that meeting, our assignment editor [said], let's not bother writing up launches, just tweet about it and let the brand account retweet you. Let's focus our energy elsewhere, unless it's a really big deal. I think that was a good [example of] using analytics to stop doing something. It wasn't like our astronomy writer suddenly had nothing to cover anymore. They just had a little bit more bandwidth for bigger stories that would resonate more with readers.*

Case Study 2: Using User-Generated Content to Engage Audiences: #AgarArt

How can art (and audience participation) engage people in science? Chaseedaw Giles, creator of the American Society for Microbiology's **annual #AgarArt contest**[78], explains how beautiful images made of microbes and concocted in petri dishes capture the public's attention:

> *The goal was to communicate science to the public and bring more awareness to the field of microbiology. It really got the public into microbiology because it was art. It showed how microbes can be really beautiful. Even though they're germs, they can be really beautiful.*
>
> *To roll it out, we created a web page on our site to announce the contest and sent out a press release to our members. We used our social-media platforms (Facebook, Twitter, Instagram) to promote the contest, and we created an "agar art" art gallery at our annual meeting, where we display current and past contest winners' submissions.*
>
> *[Advice for someone who wants to launch a project like this]: If you manage a social-media channel, look for trends in the content that you share. What seems to get people the most*

engaged? Once you find that, explore it. Even if you don't manage social media, search for the content you are trying to promote on social media. Is there a niche that needs to be filled? Is there content already there, but it's not organized in a way that people can easily access it? That's what we did with agar art. The content was there, and people really liked it, but it wasn't organized in one place, and didn't have any cohesive branding tying it all together. That's when I decided to turn it into an art contest that went global.

One of the entries in the 2019 #AgarArt contest.

Case Study 3: Catching Misuse of Older Stories at *The Scientist*

Content can take on a life of its own — and sometimes be misused. Paying close attention to your analytics can uncover these potential and unintentional bouts of misinformation. Shawna Williams, a senior editor at *The Scientist*, explains how archival content can take on new life:

> *One interesting case we've had recently is this article that we published in 2015, about a coronavirus that was* **made in the lab and sparked controversy at the time**[79]*. If you look at our homepage, it's been on the right trending columns since January [2020]. And we know that this is up there because people are spreading it around and saying, look, this virus [SARS-CoV-2] was made in a lab — either it escaped accidentally, or it was a bio weapon that was made on purpose. And that is, as far as we know [in April 2020], not the case at all.*
>
> *We did end up doing a story on "***Is there any evidence that this virus originated in the lab?**[80]*", and we put a link to it at the top of that article. But, of course, the social-media preview doesn't indicate that, and also doesn't indicate that this is an article from 2015.*
>
> *There's nothing wrong with the [original] article. It's completely accurate. But five years later, it's being used in a way that we never anticipated.*

Lisa Winter, social-media editor at *The Scientist*, describes how they came to realize the story was being misused:

> *[The news director] Kerry Grens keeps a pretty close eye on the Google Analytics. And at first it was just like, oh, that's weird. The story is getting picked up. And then the emails started coming in from all of these wild conspiracy theorists, and it was getting posted on these blogs — with Google Analytics, you can see the source of where the link was clicked. And it was really kind of wild. And it was a debate: Do we even need to say this? Because we can't go following up every single article that might get posted someplace that we don't agree with, and we can't make a statement on every single story. But that one just got so huge, so fast, that it required a little clarification.*

Read more: In addition to writing a new story, *The Scientist*'s editor in chief wrote about the experience in "**Going Viral for the Wrong Reasons**[81]."

Comment Sections

Opinions vary widely when it comes to comment sections. Should you heavily moderate, or treat them like a public square? Should you jump in to address misinformation, or rely on other readers to correct them? Will they offer valuable insight, or abuse one another (and you)?

A few considerations:

- **Define the purpose of the comment section:** Cultivate a community? Foster direct relationships with readers?
- **Develop a clear commenting policy:** This will give you something to point to if you need to delete posts or ban a user.
- **Realistically evaluate your bandwidth:** Comment moderation can be time-consuming, especially if you have high volume.

The Coral Project **has compiled numerous guides and resources**[82] for moderation and creating community, including a **step-by-step guide for creating your community**[83], from **defining strategy**[84] to **sustaining community culture**[85]. (There is also a **printable workbook version**[86].)

The section on **codes of conduct**[87] provides a robust set of questions for you to consider while developing your community guidelines, along with examples and a recommended structure for writing out the policy.

When two science-focused websites underwent a redesign, they took two approaches to comments, based on their experiences with their audiences, as described below:

Case Study 1: *Yale Environment 360*

Katherine Bagley, managing editor, keeps comments open because the audience does a good job of regulating itself.

> *Our readers are pretty good at moderating the communities. If somebody is being a jerk, our other readers will very quickly step in. Or if we get trolled — which happens a lot with environmental sites, especially on any climate-change-related posts — our readers will often jump in and defend. We will watch those things, but we'll jump in only under extreme circumstances.*
>
> *We have our writers monitor the comments section under their stories for a couple of days after stories are posted. Occasionally, if they see the need, or if they want to, they'll respond. And I think that generates some interest [and shows that] we're paying attention to what they're saying.*
>
> *We did a website redesign three years ago, and [whether or not to keep the comment section] was a really big discussion.*

We kept it open because [our audience] really leave[s] thoughtful, in-depth comments that generate discussion. We find snarky comments on social networks, but if people are coming to our stories and really commenting at the bottom of them — you have to click on a button to open it — we find that the comments really do generate good discussion.

I learn from them, too. And it's good for us to hear the different angles that people come away from a story with.

Case Study 2: *Science News*

Mike Denison, audience-engagement editor, describes how the amount of work required to monitor their comments, and the general low level of discourse, led them to end comments and refer readers to a feedback e-mail address.

Having a free-for-all open forum leads an organization to make a lot of really difficult decisions of either having a lot of comments present that are not in line with organizational mission or [sense of] decency — or you had to spend a lot of time moderating the comments or trying to create a discussion you'd look for.

We tried to "have our cake and eat it too" in that regard at Science News*, and it led to me deleting a lot of comments, to the point that serial commenters would start saying things like, "Shh, be careful, Mike's gonna delete all this." And that's not good for anybody.*

So, when we overhauled our website in 2019, we thought this was a natural point to kill the comment section. (And also, on a technical level, comment sections slow your page-load time.)

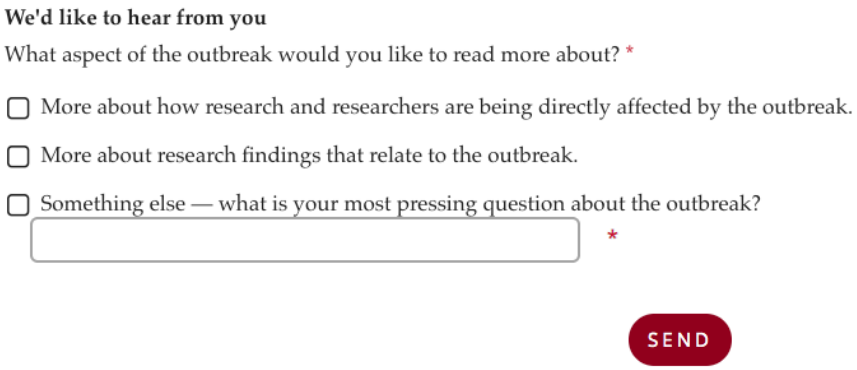
Where previously at the bottom of an article would be a comment section, [now there is] just a box, telling readers to email us at feedback@sciencenews.org. We set up different shifts for people who were going to monitor the feedback emails and respond to them where appropriate.

Polls and Calls for Feedback

Polls and call-outs embedded in your stories can provide fertile ground for collecting directed feedback and questions from your readers. How these are set up and deployed will vary on the basis of your goals.

At *Science Friday,* producers were working on **a local-climate-change project**[88] in which they solicited reader feedback. Doing so allowed them to hear from people all around the country. At *Nature*, producers use polls to get feedback on what to cover as well as ways to gauge reader interest. Here are three examples in which *Nature* used feedback forms to learn what readers wanted to see more of:

Steering Covid-19 Coverage


We'd like to hear from you

What aspect of the outbreak would you like to read more about? *

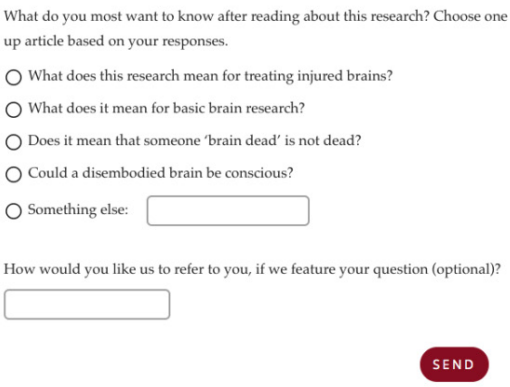
- [ ] More about how research and researchers are being directly affected by the outbreak.
- [ ] More about research findings that relate to the outbreak.
- [ ] Something else — what is your most pressing question about the outbreak? *

SEND

Nature's reader survey included in coverage of Covid-19. Printed with permission from Springer Nature. NatureMagazine, 2020.

- **Goal:** Guide coverage of Covid-19 so that resources could be used most effectively and wisely, and content would appeal to the target audience.
- **Approach:** Early on in the outbreak, *Nature* embedded a call-out in a few stories asking readers what they wanted to know more about — the impact of the outbreak on researchers, the research findings, or something else.
- **Outcome:** Based on reader responses, *Nature*'s editors focused on assigning stories covering continuing research.

Gathering Questions for Follow-Up Stories


What do you most want to know after reading about this research? Choose one option below – Nature's news team plans to write a follow-up article based on your responses.

- ○ What does this research mean for treating injured brains?
- ○ What does it mean for basic brain research?
- ○ Does it mean that someone 'brain dead' is not dead?
- ○ Could a disembodied brain be conscious?
- ○ Something else:

How would you like us to refer to you, if we feature your question (optional)?

SEND

Nature's reader survey included in a story about "brain death." Printed with permission from Springer Nature. NatureMagazine, 2020.

- **Goal:** They were covering a big story — "**Pig brains kept alive outside body for hours after death**[89]" — and knew that the initial article couldn't cover

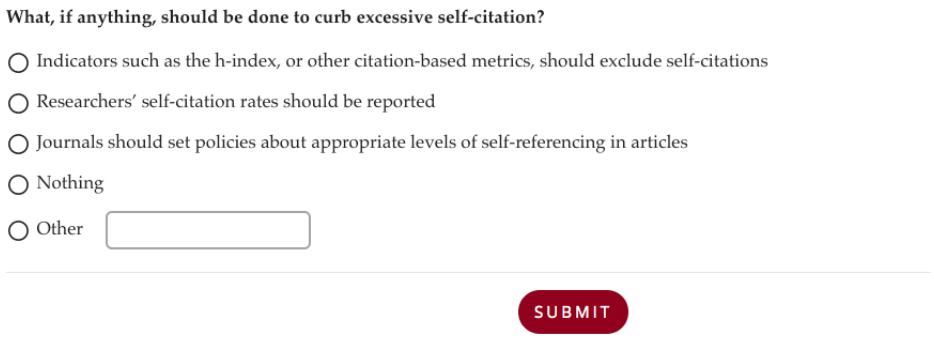
everything, so they wanted to discern what additional information their core audience of scientists wants to know about a major scientific development.

- **Approach:** They included a widget for responses, but placed it deliberately low on the page, so less-engaged (and theoretically more general) readers would be less likely to see it. The poll itself included prompts to guide respondents toward the types of questions *Nature* wanted to answer (e.g., "What does this mean for basic brain research?")

- **Outcome:** Manageable volume of relevant questions, and a resulting article[90].

> *"They don't need to be bells and whistles. Some of this is very basic stuff. It's just taking your more traditional journalistic approaches and applying them in a more digital way, or several magnitudes bigger.*
>
> *Anna Jay, chief editor, digital and engagement, Nature*

Checking Preconceived Notions



Nature's survey on reader's views on self-citation. Printed with permission from Springer Nature. NatureMagazine, 2020.

- **Goal:** Gauge their community's response to a news story that they anticipated would be popular both with the core audience of scientists and to a broader base.

- **Approach:** On the news story, "Hundreds of extreme self-citing scientists revealed in new database[91]," they included the above poll; the results were shown immediately, so readers could see the sentiments of their peers.

- **Outcome:** *Nature* published an editorial[92] based on the responses. It also included a static graphic of the interactive poll in the original article, to provide that information for future readers. (By including the static graphic, they pre-emptively prevented the interactive poll from breaking if they ever switch survey tools.)

Fostering Trust With the Transparency Project and Science News

The Transparency project[93] is a collaboration between *Science News* and News Co/Lab[94], a digital-media-literacy initiative at Arizona State University. The content consists of sidebars on stories covering controversial or politically charged topics, such as vaccine hesitation[95] and industry-funded studies[96]. Why did *Science News* report on this? What steps did editors take to be fair or avoid bias? What questions were *not* asked? At the end of the sidebar, readers are invited to take a quick survey about their perceptions of *Science News's* trustworthiness.

> ***"The idea was that if we showed readers that we'd done our homework, that would put to bed any potential ideas that we were acting maliciously or following some other ulterior financial motive or any other kind of ulterior motive.***

Mike Denison, Audience-Engagement Editor, Science News

If you do choose to embed feedback calls to action or polls, here are a few tips as well as pitfalls to avoid:

- **Think through why you're including a call-out.** Having a clear idea of what you want to get out of soliciting reader responses will help with making call-outs more precise and actionable.
- **Determine a timeline.** Set an end date. Or, if you leave a poll open indefinitely, make sure you have the resources to monitor it. (Bonus: If you're using a third-party tool, you're less likely to end up with broken widgets around your site.)
- **Be upfront about how responses may be used and tell readers what *they* will get from responding.** Will they immediately see answers from their peers? Will their responses help shape future coverage? If so, say so.
- **Place call-outs lower in a story, to filter for more-engaged readers.** Instead of gut reactions based on a headline, responses will come from those who made it through most or all of the story.
- **Put yourself in the shoes of someone trying to respond.** People will drop out if it's too onerous to complete.
- **Keep it in perspective.** Embedded polls on your site do not carry any

statistical weight as studies, so if you use them as fodder for stories, be sure to make that clear. Contextualize the results appropriately, as was done in this story: "**Two-thirds of researchers report 'pressure to cite' in *Nature* poll**[97]."

Figuring Out What Works for You

In a perfect world, you would have the staffing, the time, and the funds to excel in every audience channel — or, at least, to tailor every piece of content for the ones you choose to invest in.

I doubt anyone reading this believes they live in that world. The reality is there will be trade-offs. Your Twitter hashtags will get repurposed for Instagram; the images you created for Facebook will end up on LinkedIn.

My hope is that this is inspiring, not intimidating. These ideas should encourage you to test, experiment, and learn. Yes, an overwhelming volume of options and opportunities is out there, and yes, being on the front lines of online discourse — with all of its vitriol, fragmentation, algorithm changes, and misinformation — can be an exhausting endeavor.

But getting strong, well-reported, fact-based science journalism out to the public is a critical service, especially as science has become an even more immediate part of everyday lives in the form of a global pandemic and climate change.

And it shouldn't be all doom and gloom. Sharing science on social media can also be a joy — sharing the promise of a new breakthrough, the quirkiness of a charismatic fauna, and the wonder of the world we live in.

> ***"Our initial goal with engagement was just building up an audience at all. But now that we have a good-sized audience and it's growing nicely on its own, we're trying to focus more on engaging — letting them engage more deeply, hopefully, with our site, our content, our journalism, and our brand.***
>
> *Thomas Lin, editor in chief, Quanta Magazine*

Social-Media Checklist

1. Check that it's accurate.
2. Make it self-contained.
3. Skip the jargon.
4. Use good art.

5. Include relevant hashtags and handles.
6. Think about the human element.
7. Consider timing and context.
8. Check for typos.

I hope this leaves you eager to try a new idea or further refine a well-used skill. And also a bit of "belonging." For me, the greatest thing about talking with other science-engagement editors is that "Yes! Someone gets me!" sensation about the ups and downs of the job.

At the end of the day, "audience development" for a science publication looks like that for any other media outlet. Know your audience, constantly learn, and lead with unique, compelling, and accurate content.

(And make sure you have a version that's under 280 characters.)

Additional Reading and Resources

Industry Newsletters

- American Press Institute's "Need to Know" Newsletter
- Nieman Journalism Lab's newsletter
- Digiday newsletters

Communities

- Gather: A community for people working in engaged journalism and related fields. Offerings include a Slack group, virtual lightning chats, and a slew of cases studies and other resources.
- Social Media Managers Facebook Group: A group run by Social Media

Pro, an online social-media training company. Although it isn't journalism-focused, it's helpful for keeping a pulse on broader trends in social media.

- The Social Media Geek Out: Run by the consultant Matt Navarra (@MattNavarra), this group often includes posts about product updates on social-media platforms.

Twitter Lists

- Engagement @ sci pubs: A Twitter list maintained by me, including people who work in engagement and related positions, many of whom contributed insights to this chapter.

- ScienceWriters on Twitter: Lists journalists, press officers, and other science communicators, maintained by the National Association of Science Writers (@ScienceWriters).

People to Follow on Twitter

- Matt Navarra (@MattNavarra): Social-media consultant, founder of the Facebook group "The Social Media Geek Out"

- Taylor Lorenz (@TaylorLorenz): Follow to find out what the kids are up to.

- Gretchen McCulloch (@GretchenAMcC): Internet linguist and author of the book *Because Internet*, she explains the ways people use language in a digital context

- Amy Webb (@amywebb): Futurist and author of ***The Signals Are Talking***, who urges companies (including media) to look farther into the future.

Pew Research

- "How Americans Get Science News and Information" (September 2017): Report indicates that 54 percent of Americans get science news from general news outlets, but that they don't consider those sources the most accurate. More-trusted sources include museums, documentaries, and science magazines. Respondents reported a low level of trust for the science news they see on social media.

- "The Science People See on Social Media" (March 2018): An analysis of

science-related Facebook pages, including those run by organizations with a presence on multiple channels (largely media outlets) and "Facebook primary" pages like IFLScience. Take it with a grain of salt, as the data were collected before the **big algorithm change in 2018**.

- "**Sizing Up Twitter Users**"(April 2019): A few nuggets: 80 percent of tweets come from the top 10-percent-most-active tweeters. Active users are mostly women and focus on politics. Users tend to be younger, more educated, and more likely to be Democrats than the overall U.S. adult population.

Ensuring Inclusion

- **How Black Twitter and other social-media communities interact with mainstream news**. A Knight Foundation report analyzes tweets from three communities on Twitter — categorized as Black Twitter, Feminist Twitter and Asian American Twitter — and includes interviews with journalists and activists connected to those spaces. A few hashtags were STEM-related, such as **#ilooklikeanengineer** and **#distractinglysexy**. The report examines concerns and criticisms that members of these online communities have regarding the media, and offers potential ways that journalists can think about better engaging in these online spaces.

- "**How to Be an Ally in the Newsroom**": One specific piece of advice that is applicable in the audience-engagement role in any newsroom is to analyze your Twitter feed and see who you (or the account) are following and amplifying.

Audience Engagement

- "**How do audiences really 'engage' with news?**" A commentary from 2019 probing what the term "audience engagement" even means, and the uncertainty about what the benefits are.

- "**The business case for listening to your audience is still murky (but early results are promising)**". Will audience engagement actually improve the bottom line? A 2019 report (covered by Christine Schmidt for Nieman Lab) examines the impact of three dozen newsroom experiments, where the answer was unclear.

Limitations of Web Metrics

- "**It's 2015 — You'd Think We'd Have Figured Out How To Measure Web Traffic By Now**": It's no longer 2015, of course, but that doesn't make this feature by Sam Dean for FiveThirtyEight any less insightful.

- "**How Much of the Internet Is Fake? Turns Out, a Lot of It, Actually.**": A rundown of the types of bots and "fake" traffic, by Max Read, in *New York Magazine,* 2018.

Mental Health

- "**Managing Your Mental Health While Managing a Newsroom's Social Media**": Interviews with social-media managers about staying sane while staying connected, by Chaseedaw Giles for Kaiser Health News.

Watch

- ***Behind the Curve***: A Netflix documentary about flat earth believers. It provides insight into the thinking of people who distrust established science, the relationship of that thinking to conspiracy theories, and how it has spread.

About the Author

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Endnotes

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13 About This Book

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