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How publishers can fight misinformation in and about science and medicine

Carl T. Bergstrom & Jevin D. West

Scientific and medical publishers have a major role in developing guidelines and policies to combat misinformation and disinformation.

Misinformation and disinformation about science and medicine have reached crisis proportions and cause harm on a massive scale[1]. This includes misinformation about science, such as when television personalities or social media accounts spread anti-vaccine propaganda or push ineffective dietary supplements, as well as misinformation in science, such as when claims appear in scholarly journals that are incautious, deceptive or even fraudulent[2].

The fight against misinformation and disinformation requires the use of every point of leverage available to the scientific and medical communities. Authors need to counter rather than contribute to misinformation[3]. Scientists must challenge questionable results. Newspapers and magazines must improve practices around health and science reporting. Press offices should dial back the hype. Members of the public need to receive adequate education to identify reliable evidence. In addition, scientific and medical publishers need to take an active role in tackling misinformation by countering the incentives that drive its creation and spread (Box 1).

Understand incentives

People create and spread misinformation and disinformation for a wide range of reasons. Designing safeguards is difficult without understanding motives, so publishers first and foremost need to consider the incentives of those who submit misleading or low-quality work. Sometimes, the motive is to create doubt about established science, promote a bogus therapy, advance a policy platform despite scientific evidence to the contrary or otherwise deceive readers. Sometimes, well-meaning researchers will make mistakes. Other times, the aim is simply to garner a publication. Each of these causes may require different safeguards.

Journals need to be attuned to the incentives that lead high-quality articles to be publicized and framed in misleading ways, as well as being attuned to their own incentives. Journals should focus on the subject areas most important to the communities they serve, not those areas that garner the highest citation rates or do best on social media.

Consider augmented peer review

Misinformation within the scientific literature can arise accidentally and organically, but substantial quantities of disinformation are deliberately injected into the scientific literature. The term 'agnotogenesis' describes efforts to stave off regulation by creating a perception of doubt around scientific findings[4], and such campaigns typically address questions already known to be politically contentious. For these controversial topics, publishers may receive a larger fraction of papers with conclusions driven by a pre-existing agenda rather than sincere scientific investigation. Moreover, disinformation that goes undetected in these domains is likely to cause disproportionate public harm.

Journals could consider broader public implications of the manuscripts they are handling, and augment peer review safeguards for papers that address potentially fraught topics. A paper associating vaccination with cognitive harm, for example, might go through a more stringent peer-review process than a paper that describes the mating rituals of a migratory seabird. This could include additional reviewers or asking reviewers to assess whether a paper is at risk of being misused or misinterpreted.

Avoid reputation-laundering

Publication in a scientific journal confers legitimacy. Yet journals sometimes publish opinion pieces, which are not peer reviewed and are sometimes accompanied by stronger disclaimers than are research papers, stressing that the opinions therein are those of the author alone. Journals have a duty to provide a forum for a diversity of scientific opinions, including minority ones. However, publishers need to be thoughtful about the motives behind some of the more controversial work that they publish, especially if it is not peer reviewed. Some opinion pieces can serve to launder the reputation of a special interest group pushing scientific disinformation. Purveyors of disinformation can also take advantage of peer review fraud. Perhaps because they often employ guest editors, special issues appear to be particularly vulnerable to scammers aiming to circumvent peer review[5].

BOX 1

Ten actions for publishers to combat misinformation

1. UNDERSTAND the incentives at play.
2. REVIEW responsible and proportionally where necessary.
3. AVOID reputation-laundering.
4. AUDIT citations.
5. ISSUE responsible press releases.
6. CONTEXTUALIZE before and after publication.
7. FACILITATE post-publication peer review.
8. RETRACT early, often and conspicuously.
9. ADAPT alongside the community.
10. PREPARE for generative AI.

Audit citations

Citations are not only the currency of promotions, impact factors and academic recommender systems; they are how background claims are justified in scientific writing. Yet many citations in scientific papers are used to justify claims that are not supported by the original references[6].

Citations are rarely checked for accuracy, which could be remedied by citation auditing practices, such as checking that references in question have not been retracted and noting in the paper if any have been. Citations of a retracted work should always note the retraction, yet a recent study found that a large majority of citations of retracted COVID-19 papers failed to do so[7]. These steps could be readily automated. A more thorough process of citation review could be used to ensure that cited papers indeed say what the citing authors say they do and thereby reduce the spread of misinformation.

Provide responsible press releases

Journals need to be scrupulous and exacting when drafting press releases. University press releases often exaggerate or spin the findings of the papers they report on[8], and this can have a major impact on the quality of subsequent news coverage[9]. Journal press releases, too, sometimes exaggerate study results[10]. Press releases on biomedical research should always be clear about whether the paper offers correlational or causal evidence. They should report absolute as well as relative effect sizes. They need to note up front, in the title or first sentence, when results come from non-human model organisms. And they should clearly state the caveats and limitations described in the paper.

Provide context

An increasing number of publishers now ask authors to prepare a lay summary of their work to be published alongside the scientific paper. Not only does this practice contribute to the public understanding of science, it offers a valuable opportunity to head off misunderstandings and misrepresentations of a study's findings.

Publishers can provide context after publication as well, when papers are misrepresented or their claims are taken out of context. *The New England Journal of Medicine* has taken this route a number of times, with a prominent note of clarification for a paper that has been incorrectly cited hundreds of times as evidence that opioids are not addictive; for a recent article about the use of masks in hospital settings, the journal published a clarifying letter from the authors and added a context box above the online page for the original article.

Enable post-publication peer review

The journal peer review process plays an important role in screening out low-quality information, but reviewers are not infallible. Peer review in its broad sense is an ongoing process that begins when researchers first discuss nascent ideas with colleagues and that continues long after a manuscript is published. Publishers need to facilitate the process of post-publication peer review.

The published paper is the version of record, with the official DOI, and so is the optimal location for post-publication discussion. Such conversations are currently often relegated to third-party sites such as pubpeer.com, but it would be preferable for publishers to allow signed and moderated responses from the community to appear on the journal websites alongside the articles themselves. Where comments are critical, the journal should solicit responses from the article's authors and facilitate ongoing discussions. Several publishers have already implemented such features. Note that a successful program of this sort may not result in active discussion of every paper that is published. Even when the majority of articles receive no comments, a journal may provide substantial value by allowing the community to respond to a small number of problematic articles.

Retract early, often and conspicuously

Hampered by legal threats and grappling with reputational incentives, journals can be notoriously slow to retract articles even when facing overwhelming evidence of misconduct. In the short term, publishers should strive to retract quickly and liberally. In the long term, the entire retraction system in science probably needs an overhaul toward some system that allows unreliable papers to be marked as such with minimal negative connotations. Right now, retraction is too often seen as an act of censure against authors and an embarrassment to journals[11]. While those judgments persist, it will be difficult to overcome the incentives that inhibit retraction.

Conduct rigorous statistical review

Far too many published papers draw unsubstantiated conclusions from flawed statistical analyses[12]. Although the primary responsibility for statistical analysis lies with authors, the peer review system could be improved to include statistical review when appropriate.

Adapt alongside the community

Scientists will continually create a host of new mechanisms, including new publication models, to address concerns about the reliability of reported scientific findings. For example, the registered reports publishing model is intended to ameliorate problems of *P*-hacking and publication bias. These articles undergo journal peer review before the research is conducted, and their acceptance or rejection is based on the quality of the research plan rather than the happenstance of the experimental results. Publishers should engage metascience researchers and be willing to experiment with new approaches that improve scientific publishing.

Prepare for generative AI

Large language models (LLMs) and other forms of generative artificial intelligence are able to produce documents that appear to be scientific papers, with minimal human input. General-purpose LLMs such as OpenAI's ChatGPT can be instructed to write in the form of a scientific

paper. Other LLMs are specifically designed to do so. Meta's Galactica was trained on a corpus of scientific literature and specializes in scientific, writing including LaTeX-based equation typesetting. Although intense criticism drove Meta to remove the public demo after only three days, the system remains available for research use and stands as a harbinger of things to come. Google's BioGPT attempts to create content based on the biomedical literature.

Although documents produced by these systems appear superficially plausible, they frequently make incorrect claims about background research, describe experiments that were never conducted, present fabricated data, cite papers that don't exist and draw conclusions that are unsupported even by their own confabulations.

The capabilities of generative AI systems will only improve, with reviewers likely to find it difficult to distinguish a manuscript written by an AI about work that was never conducted from one written by humans about research that was actually carried out. Humans can also produce low-quality and fraudulent work, but the scale may be considerably greater with AI. Agents of chaos or unscrupulous researchers could create hundreds or thousands of AI-generated papers and submit them to scholarly journals, flooding the peer-review system. Even if 99% of these papers could be detected and rejected, the remaining 1% would erode the integrity of the literature. An academic researcher can be fired from their position if caught submitting fraudulent work — but what if that researcher never existed in the first place? This has implications for the credibility of science more generally.

Publishers need to start planning now for how they will handle generative AI as it becomes more prominent and more sophisticated. One possible, though painful, response would be to abandon the Mertonian norm of universalism[13] — the idea that scientific claims should be evaluated without reference to the identities of those making them. Instead, some sort of identification and reputation system may be needed, in which authors have to establish their identities as researchers for their manuscripts to be considered. Indeed, in an era of generative AI, journals may play an increasing role in validating the identities and qualifications of authors.

Accelerated communication

Over the past 20 years, the scale and structure of the information ecosystem have been transformed by developments in information technology and social media[14]. These developments have accelerated both communication within the scientific community[15] and public outreach around science, but have brought with them numerous unintended, unanticipated and uncontrolled consequences that accelerate the spread of scientific misinformation and disinformation. Many of the challenges that publishers face are not new, and the Committee on Public Ethics has spent the past quarter-century developing guidelines, now widely adopted by scholarly publishers, to address many of these specific issues.

Yet as the deluge of disinformation around the COVID-19 pandemic so clearly illustrates, present measures are insufficient. By proactively addressing both current misinformation threats and the prospect of those to come, scientific publishers have a major role to play in creating a healthier, more reliable information environment for the world.

Carl T. Bergstrom[1] ✉ **& Jevin D. West**[2]
[1]Department of Biology, University of Washington, Seattle, WA, USA.
[2]Center for an Informed Public, Information School, University of Washington, Seattle, WA, USA.
✉e-mail: cbergst@uw.edu

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References

1. US Department of Health and Human Services. https://www.hhs.gov/surgeongeneral/priorities/health-misinformation (2021).
2. West, J. D. et al. *Proc. Natl Acad. Sci.* **118**, e1912444117 (2021).
3. Bergstrom, C. T. *Nat. Med.* **28**, 2468 (2022).
4. Proctor, R. N. & Schiebinger, L. (eds.) *Agnotology: The Making and Unmaking of Ignorance* (Stanford Univ. Press, 2008).
5. Else, H. *Nature* **599**, 361–361 (2021).
6. Dumas-Mallet, E. et al. in *Integrity of Scientific Research: Fraud, Misconduct and Fake News in the Academic, Medical and Social Environment* (eds. Faintuch, J. & Faintuch, S.) 417–426 (Springer International Publishing, 2022).
7. Meyerowitz-Katz, G. et al. Preprint at *medRxiv* https://doi.org/10.1101/2022.06.30.22277084 (2022).
8. Yavchitz, A. et al. *PLoS Med.* **9**, e1001308 (2012).
9. Schwartz, L. M. et al. *Br. Med. J.* **344**, d8164 (2012).
10. Sumner, P. et al. *PLoS ONE* **11**, e0168217 (2016).
11. Gewin, V. *Nature* **507**, 389–391 (2014).
12. Brown, A. W., Kaiser, K. A. & Allison, D. B. *Proc. Natl Acad. Sci. USA* (2018).
13. Merton, R. K. *J. Leg. Polit. Sociol.* **1**, 115–126 (1942).
14. Bak-Coleman, J. B. et al. *Proc. Natl Acad. Sci.* **118**, e2025764118 (2021).
15. Bergstrom, C. T. *The New York Times* https://www.nytimes.com/2022/11/19/opinion/pandemic-twitter.html (19 November 2022).

Competing interests

C.T.B. has received honoraria from Novartis and served as a paid consultant for Color Health. J.D.W. is an advisor and board member for Consensus.app and co-founded and holds an equity stake in PatentVector.