STANDING UP FOR SCIENCE 3

PEER REVIEW

THE NUTS AND BOLTS

A guide for early career researchers

Peer review is the system used to assess the quality of scientific research before it is published. Researchers in the same field scrutinise research papers for validity, significance and originality to help editors assess whether research papers should be published in their journal.

INTRODUCTION

ANIN LUO & SHAUNI MCGREGOR Voice of Young Science Members

Peer review is the evaluation of research by other researchers in a scholarly field and is fundamental to all stages of the research process. It's used to review grant proposals for research funding and in the publication of scientific findings, and it's also an important consideration for policymakers, reporters and the public when weighing up research claims and debates about evidence.

The peer review process judges the validity, significance and originality of the work, rather than the person who has done it. This makes it the best system available to give authors feedback and select which research should be brought to wider attention.

It's especially important for us, as early career researchers, to get involved in peer review because it allows us to gain insight into the latest developments in our research area, play a greater role in the research community and develop critical thinking, judgement, writing and data presentation skills.

However, no system is perfect and the peer review process is no exception. It can be biased, there is little recognition available for reviewers and there is a lack of transparency about how peer review actually works. In Voice of Young Science (VoYS) workshops, early career researchers bring up this lack of transparency, and want to be involved in the peer review process but don't know where to start. They want to improve their understanding of what makes reliable research to know how to provide a good quality critique, and what is expected of them as reviewers.

This is a nuts and bolts guide that seeks to answer those questions. It is written by early career researchers for early career researchers, to open up the "black box" of peer review. It doesn't only seek to equip early career researchers with an understanding of peer review and how to participate, it also aims to encourage early career researchers to play an active role in public discussions about scientific reasoning, peer review and research quality and to bring the attitude of scrutinising evidence to everyday life. Good quality peer review is needed to maintain good quality information in society, and it is a useful process for not just the research community but all of us.

We've interviewed scientists, journal editors, grant bodies' representatives, patient group staff and journalists in the UK and around the world. We've asked them to explain peer review and provide the insights reviewers need to do it well. We've also asked them challenging questions about scientific fraud and plagiarism going undetected, issues of trust and bias and the years it can take to publish ground-breaking research.

With this guide, we hope that you will not only find out how peer review works and the challenges involved but also how to bring the peer review process to the public to weigh up evidence in everyday life.

THIS GUIDE WILL HELP EARLY CAREER RESEARCHERS UNDERSTAND:

1. How the peer review process works
2. Some of the limitations of peer review
3. The role of peer review in society.

CONTENTS

BEHIND THE SCENES

There are three key roles in peer review: the authors who write the papers, the reviewers who provide expert opinions and advice, and the editors who make the decisions.

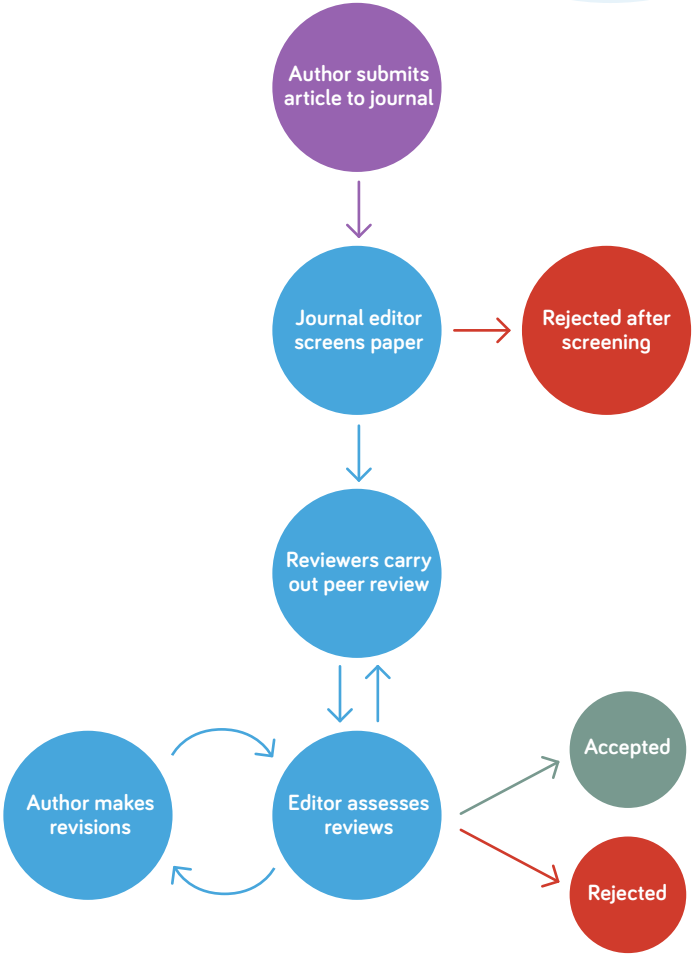


Figure 1: Diagram of a “typical” peer review process (there are many varieties)

WHAT IS PEER REVIEW?

MEET THE EDITORS

To gain an insight into how peer review works, we asked editors from a variety of peer reviewed journals how they select reviewers, reduce potential bias and make decisions about which manuscripts to publish.

HOW DO YOU DECIDE WHICH PAPERS MAKE IT TO PEER REVIEW?

"I have a load of manuscripts coming to me each day — far more than I can publish. So I have to look at them and decide firstly, is this paper relevant to the journal I'm editing? (Is it groundbreaking etc?) I'm looking for the best papers, but I often know very little about the nitty gritty of the research area. It is the experts that I send the paper out to review to who know the subject area well and can help me make a judgement."

CHRIS SURRIDGE Chief Editor, Nature Plants

"When your paper is submitted, we first of all look through it briefly to check the format and length, the clarity of the discussion, research methods and overall fit with the journal. This is a fairly quick process — around two weeks or so. If it passes this 'desk review' procedure, we then send it out for full review to subject experts."

ROBERT BLACKBURN Editor in Chief, International Small Business Journal (ISBJ)

HOW DO YOU THEN SELECT REVIEWERS?

"If I know the field intimately, I will select people to review from my knowledge base. If I don't know the field, I select reviewers by searching 'PubMed' (a free online database of citations and abstracts) for authors of similar research or pick suitable authors from the bibliography of the paper. I don't think it makes sense to carefully and precisely select and invite only verifiable world leaders. Most luminaries are often too busy, and the process of selection becomes far too slow."

MICHAEL CURTIS Editor in Chief, Journal of Pharmacological and Toxicological Methods

HOW CAN I BE SELECTED AS A REVIEWER?

"The most important thing is to be visible : make sure you've an academic profile with your email address and expertise clearly available. You can also contact journals directly to volunteer as a reviewer. Publishers sometimes have minimum criteria for reviewers, but don't let these be a barrier to you — most journals will allow early career researchers to co-review alongside their supervisor or PI. "

ELEANOR-ROSE PAPAS Editorial Operations Manager, F1000Research

Once the reviews have been submitted, it's decision time. Peer review is not a democratic voting system. It is the editor who makes the final decision based on all the information available to them.

HOW DO YOU REACH THE FINAL DECISION ON A PAPER?

"To reach a decision on a paper, we take into consideration a combination of the reviewers' opinions and our editorial judgement. In addition to looking at the broader recommendations made by the reviewers, we think about the specific scientific points they raise in light of their areas of expertise, the feasibility of any requested revisions and the effects these revisions may ultimately have on the overall conceptual interest and quality of the paper. All of these considerations factor into our overall view of the appropriate next steps for the paper."

MARIE BAO Editor, former Editor of Developmental Cell and the current Associate Director of Research Programs at Harvard Medical School

Many journals have an editorial team with an editor-in-chief and a number of scientific editors who are assigned responsibility for the peer review of individual papers. Editors will often consult with each other before accepting a paper.

"We invite several reviewers in order to get a view which is independent from the editorial team. If the reviewer and the assigned editor agree that a paper should be rejected, we reject. But if there is reasonable support, then we start a confidential online discussion with additional editors. Usually it becomes clear very quickly whether a paper is going to be accepted or rejected, but if there is no clear consensus, then, as Editor-in-Chief, I make my own assessment and provide a recommendation to the handling editor."

PHILIP STEER Emeritus Editor, BJOG: An International Journal of Obstetrics and Gynaecology

WHAT ARE THE DIFFERENT TYPES OF PEER REVIEW?

DR IRENE HAMES (Research publication and peer review specialist, author of 'Peer Review and Manuscript Management in Scientific Journals') runs us through the different types of peer review.

SINGLE-BLIND REVIEW

The reviewers know who the authors are, but the authors do not know who the reviewers are. This is the most common system in science disciplines.

- ✓ This allows reviewers to provide honest, critical reviews and opinions without fear of reprisal from the authors.
- ✗ This lack of accountability can allow unscrupulous reviewers to submit unwarranted negative reviews, delay the review process and steal ideas.

DOUBLE-BLIND REVIEW

The reviewers do not know who the authors are, and the authors do not know who the reviewers are. This is the main form of peer review in the humanities and social sciences.

- ✓ Reduces possible bias resulting from knowing who the authors are or where they come from; work is assessed on its own merits.
- ✗ Involves some effort to make sure manuscripts are anonymised, reviewers can often guess who the authors are (particularly if the authors have cited many of their own papers), information important for a complete critical appraisal is missing.

OPEN REVIEW

At its most basic, reviewers know who the authors are and the authors know who the reviewers are. It can also mean inclusion of the reviewers' names and/or reports alongside the published paper, comments from others [subject community or wider public] at pre-publication stage, or various combinations and elaborations of these.

✓ Greater accountability and reduced opportunity for bias or inappropriate actions. Reviewers can be given public credit for their work. Increased transparency helps readers assess peer review quality.

✗ Potential reviewers may be more likely to decline to review. Revealing reviewer identity may lead to animosity from authors, damaged relationships and repercussions for job prospects, promotion and grant funding.

DO YOU THINK KNOWING THE NAME OF THE AUTHOR AFFECTS THE REVIEWER'S DECISION?

"It is probably impossible to ignore the effect of the author's name, whether they be an unknown or a big-shot scientist. By acknowledging that potential impact, you can mitigate the most disturbing effects. Remember that your job as a reviewer is to judge the work, not the scientist."

STEPHEN CURRY Professor of Structural Biology, Imperial College London

IS THE DOUBLE-BLIND SYSTEM EFFECTIVE?

"Double-blind peer review can work effectively for some editors and journals. For others, however, it doesn't. It's been shown that reviewers can often – in around half of cases – identify who the authors are, and the internet and online searching have increased the chances of this happening, especially with the increasing adoption of preprints. This is causing some journals in disciplines where double-blind review has been the norm to move to single-blind review. There are also concerns that some potential competing interests of authors and other factors that might be important in assessing work are not available in double-blind review."

DR IRENE HAMES Research publication and peer review specialist, author of 'Peer Review and Manuscript Management in Scientific Journals'

HOW DOES PEER REVIEW VARY FROM JOURNAL TO JOURNAL?

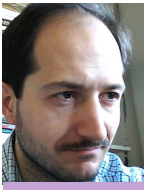
Peer review is not a one-size-fits-all system; there are variations across journals and research fields.

Acceptance rates at journals vary widely with some only accepting a small percentage of papers submitted. These journals tend to have extremely stringent requirements for publication. For example, journals with a wide scope that receive a very high number of submissions, such as Science or Nature, will reject many good quality research papers, if the editor feels the research is not ground-breaking enough. Others, such as PLOS ONE, Scientific Reports and Peer J, use a peer review process that judges solely on the scientific and methodological validity. These journals will publish all papers that meet the necessary standards of scientific rigour. There are also smaller, more specialist journals which do not receive many submissions, so the competition to publish is not as high. The average acceptance rate for journals is normally between 30 - 60% [1].

Some peer reviewed journals are tracked on Clarivate's Web of Science citation database, which annually publishes Journal Citation Reports (JCR) that features an impact factor for each journal. This is calculated annually and is a measure of the number of times the "average article" in a journal has been cited in a particular year. Journals with high impact factors often receive more submissions, and thus have higher rejection rates.

Peer review also varies widely depending on the research field in terms of what reviewers are looking out for and the time the process takes. In mathematics, peer review can take years, whereas in biomedical subjects it can take just weeks. You'll get more of a feel for how peer review works in your field through conversations with your colleagues and your own experiences in the peer review system.

We asked Tommaso Dorigo, an experimental particle physicist who collaborates with scientists at CERN, to describe the process in his field:



"In my opinion, in experimental High-Energy Physics (HEP), most scientific papers could well do without external review. HEP collaborations count dozens, and in a few cases thousands, of collaborators. Each of them is responsible for what gets published and is entitled to take part in the review process before a paper is sent to a peer reviewed scientific journal. So a powerful internal screening blocks anything that is even remotely questionable before it reaches a journal."

TOMMASO DORIGO Experimental particle physicist, University of Padova

[1] Sugimoto et al. (2013) Journal acceptance rates: A cross disciplinary analysis or variability and relationships with journal measures. Journal of Infometrics. 7(4) pp. 897-906

IS PEER REVIEW JUST FOR PAPERS?

We often think of peer review as happening solely after results are collected and written up, but peer review can happen at multiple stages throughout the research process.

PEER REVIEWING GRANT APPLICATIONS

Peer review is also used to assess scientists´ applications for research funds. Funding bodies seek expert advice on a scientist's proposal to select which projects to fund.

"At Fight for Sight, peer review is an essential component of our assessment processes. It allows us to critically appraise the quality of research proposals by experts in the field. This mechanism reassures our supporters that their valuable donations are being invested to the highest quality eye research which will improve the lives of those affected by sight loss."

NEIL MEEMADUMA, Research Manager, Fight for Sight

Dr Liz Philpots thinks early career researchers should get involved in peer reviewing grant applications as well as journal papers:

"If it's your area, put yourself forward for peer reviewing grant applications – and say [to your supervisor] 'I'd like to do this one'. That's the only way to get experience."

DR LIZ PHILPOTS Head of Research and Impact, Association of Medical Research Charities

REGISTERED REPORTS: PEER REVIEWING RESEARCH BEFORE THE RESULTS

Registered reports is an approach to peer review where the research methods and analyses are pre-registered and peer reviewed before the research is conducted. If research passes this stage of peer review, the journal will normally accept it for publication provisionally before the research has taken place. This ensures that the scientific reasoning and methods are sound before the research is carried out and avoids 'negative publication bias' (where negative studies are less often published resulting in a bias towards studies with positive results). Once the results have been collected, the research is resubmitted for peer review before the final paper is published.

BEING A REVIEWER

The benefits of reviewing are diverse: from improving your critical thinking, giving and receiving feedback and gaining insights to improve your future publications. Reviewing is an essential skill to develop as a researcher.

WHY DO YOU REVIEW?

"Partly because it is an accepted part of membership in the academic community. But also, it is always interesting to see the latest work in my particular specialist areas and be able to comment on it and hopefully sometimes improve it prior to publication; to act as a gatekeeper for quality in an area of science that I know about and care about."

STEPHEN KEEVIL Professor of Medical Physics, King's College London

40.8%	It's part of my job as a researcher
35.1%	Do my fair share/reciprocate for reviews of my work
32.9%	Keep up-to-date with the latest research trends in my field
32.9%	Ensure the quality and integrity of research published in my field
17.5%	Voluntary service to my field/research community
13.9%	Develop personal reputation and career progression
13.5%	Improve my own writing skills
11.9%	Build relationships with journals/editors

Results from Publons' 2018 Global Reviewer Survey of approximately 12,000 reviewers. Available at: https://publons.com/community/gspr

I'VE JUST BEEN ASKED TO REVIEW A PAPER. NOW WHAT?

When accepting the invitation to review, you are agreeing to provide a fair, robust and timely critique that is useful for the authors in improving their manuscript (whether or not the journal accepts it).

Before you accept to review a paper, ensure you can submit within the time frame, because slow review times are a source of frustration for authors. Many journals record how long a reviewer has taken to submit a review. If they are frequently very slow, editors will take this into account and avoid inviting the reviewer again. Some journals also rank your review once it is submitted, so if you do a good job, you are likely to be invited again.

If, after agreeing to review, you find that you will not be able to complete the review in the agreed time frame, contact the journal and let them know.

A colleague or supervisor may have asked you to review a paper for them. If you choose to do so, make sure to let the editor know so that you can be properly credited for the work. Remember that reviews should be carried out in confidence, and a colleague shouldn't be sharing a paper with you without the editor's permission.

If you have any conflicts of interest – for example, you work closely with the author or are in direct competition – you must declare these to the editor. These won't necessarily preclude you from reviewing, they just need to be transparent and borne in mind by the editor. If you are unable to accept the invitation to review, suggestions of alternative reviewers are welcomed by editors.

WHAT ARE YOUR TIPS FOR NEW REVIEWERS?

"When reviewing, try to remember that you are an author too and be professional and constructive in your approach. That can be hard but don't let your inner nitpicker get the upper hand. Leave 24 hours between reading the manuscript and writing your review, to allow time for your reasonable self to rise to the fore."

PROF STEPHEN CURRY Professor of Structural Biology, Imperial College London

WHAT QUESTIONS SHOULD I ASK WHEN REVIEWING?

- Is the research question clear?
- Was the approach appropriate?
- Are the study design, methods and analysis appropriate to the question being studied?
- Is the study innovative or original?
- Does the study challenge existing paradigms or add to existing knowledge?
- Does it matter?
- Are the methods described clearly enough for other researchers to replicate?
- Are the statistical analyses and level of uncertainty in the data treated appropriately?
- Could the presentation of the results be improved and do they answer the question?
- If humans, human tissues or animals are involved, was ethics approval gained and was the study ethical?
- Does the discussion take into account the limitations of the study?
- Are the conclusions appropriate?

What is expected of you as a reviewer will vary from journal to journal, and many journals will ask you to answer several questions on an online form. If you are unsure of what to include in your review, make sure to contact the editorial office and they should be able to advise you.

WHAT CRITERIA DO YOU LOOK FOR IN A PAPER?

"For me it is the originality of the work, the importance of the questions addressed, the appropriateness of the techniques used, the quality of the data and the reliability and significance of the conclusions that are the most important criteria."

MIKE CLEMENS Visiting Professorial Fellow in Biochemistry, University of Sussex

HOW CAN I LEARN TO REVIEW WELL?

"When I started reviewing I had no formal training, but I did get invaluable guidance from senior staff. Now there are also training days and web courses which give advice on the structure and content of a review, and, importantly, the expectations of the editor."

DEIRDRE HOLLINGSWORTH Senior Group Leader, Oxford Big Data Institute

Most experienced peer reviewers have 'learnt on the job'. If you are reviewing for the first time, it is a good idea to ask an experienced reviewer with an analytical approach to be your mentor.

Many organisations, including Elsevier, Springer Nature, Wiley, Taylor & Francis, PLOS, F1000 Research, Cambridge University Press and Oxford University Press, offer free online resources for new reviewers that can help you get to grips with the peer review process. We have included a section at the back of this guide

Once a decision has been made, journals often let reviewers know whether they accepted or rejected the paper and send them a copy of the other review(s). This allows you to see the assessments of other experts and whether there is anything you have missed in your own review. It can also help you judge whether you were too stringent for the journal or too lenient.

Some journals (e.g. EMBO Journal, BMJ Open, PLOS journals, eLife, PeerJ and F1000 Research) publish reviewers' reports alongside papers either as an option or by default, which can be extremely useful as it allows scrutiny of the peer review process itself.

To be a good reviewer, it's also important to have an understanding of the ethics of scientific publication. It's possible that you may find yourself having to flag up an ethical concern to the editor, such as conflicts of interest, plagiarism or ethical oversight by the authors. The Committee on Publications Ethics (COPE) is an international forum who discuss all aspects of publication ethics. They have developed a series of flowcharts outlining the best practice steps for handing various ethical issues you might come across as a peer reviewer. These are the flowcharts that editors will rely on to handle an ethics issue during the peer review process.

You can find these, and a full list of other useful resources for peer reviewing, at the back of this guide.

DO I NEED TO GET UP TO SCRATCH WITH MY STATS?

"The editor will not expect you to comment beyond your areas of expertise, so if you are not overly confident in your stats, you should provide comments as a subject specialist and inform the journal that they will need someone else to review the statistics."

DR ELISA DE RANIERI Editor in Chief, Nature Communications

A growing number of journals are now employing statistical experts to perform specialised statistical reviews. This supplements the normal peer review process, and ensures that the underlying statistics of the research must stand up to the same level of scrutiny as the rest of the research, even when statistics is not an invited peer reviewer's strength.

TRANSFERABLE PEER REVIEW: PREVENTING "WASTAGE" OF REVIEWS

Papers can go through several rounds of peer review. When a paper is rejected, the author will, in most cases, submit it to another journal. The new journal editor will then send the paper out to new reviewers. There is concern amongst the scientific community that this leads to "wastage" of reviews as previous reviews are not always taken into consideration.

"Transferable peer review (a.k.a. "waterfall", "cascading" or "streamlined" peer review) is when previous reviewer's reports for a rejected paper are used again when the paper is submitted to another journal. The peer review process at the second journal can often be kept relatively short because the editors consider the reports from the earlier round of peer review. However, they usually reserve the right to invite new reviews. Variations on this process exist, according to the type of journal or publisher. EMBO and ASAPbio have announced Review Commons, a journal-independent reviewing service enabling authors to receive reviews prior to submission to a journal, which they can post on a preprint and/or send along with their submission to a Review Commons partner journals."

DAN MORGAN Director of Community Relations, Public Library of Science (PLOS)

SHOULD REVIEWERS BE REWARDED?

"Based on the 2019 peer review survey results it is clear that reviewers would like to be rewarded. The question is, how? In the survey the majority indicated that they would like to receive payment in kind for their reviews. Somewhat surprisingly few supported direct payment (28%). Many worried about the potential for bias that payment would introduce, marking a shift in mindset since the 2009 survey, where 41% of researchers supported financial reward for reviews. Journals reward reviewers with certificates, providing accreditation (CME/CPD points) or publishing an acknowledgement."

ADRIAN MULLIGAN Deputy Director, Research & Academic Relations, Elsevier

Many journals provide recognition to reviewers by publishing their names in an annual thank you list. Also, online initiatives, such as ORCiD, Publons and Elsevier's Reviewer Recognition platform, allow reviewers to keep a public record of the quantity and quality of their reviews. However, the recent Quality, Trust and Peer Review survey makes it clear that the many hours of important work peer reviewers contribute need to be recognised more formally, especially by employers.

https://senseaboutscience.org/activities/peer-review-survey-2019/

PEER REVIEW: THE WARTS AND ALL

Peer review is not a perfect system. It relies heavily on trust and, as scientists are human like the rest of us, there will always be cases of misconduct.

SO IS PEER REVIEW EFFECTIVE?

“Bad papers sometimes make it through peer review and the system is not set up to catch outright fraud. However, it acts as a useful first barrier to junk science and journalists should treat information from non-peer reviewed sources accordingly.”

JAMES RANDERSON New Editor, POLITICO

"It's a good thing scientists are mostly honest, because peer review offers the greatest possible temptation to steal ideas, to show favour to former students, to boost favoured theories or to do down rivals. Honest they may be but they aren't saints, so we must expect all of these things to happen from time to time.”

NIGEL HAWKES Science jouranlists

“Regardless of its weaknesses, peer review is something the scientific world cannot do without.”

MAMMO MUCHIE Editor in Chief, African Journal of Science, Technology, Innovation and Development

BUT WHAT DO EDITORS THINK? DO WE TRUST REVIEWS TOO MUCH?

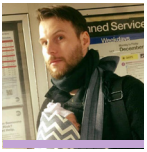
“Perhaps we do. It is easy to find plausible reasons to reject a paper, especially at the highly competitive end of the market. If a reviewer has a vested interest or a conflict of interest, this is rarely disclosed. Indeed, any 'expert' in the field must be a rival by definition and conflicted by definition. Yet we trust their judgements.”

MICHAEL CURTIS Editor in Chief, Journal of Pharmacological and Toxicological Methods

CAN WE PREVENT REVIEWER BIAS?

"Reviewers are trusted to deliver an opinion but the editor knows this to be subjective and so will carefully consider this when making a final decision on a paper. And journals rarely accept papers based on only one review."

COLLETTE TEASDALE Development Editor, Taylor & Francis Group



"There are concerns about diversity and inclusion of the reviewer community, there is now more awareness by journals of the need to increase the gender and geographical diversity of their reviewers and journal editorial boards."

TAYLOR DIETRICH Author Services Manager, Cambridge University Press

One criticism of peer review is that reviewers could potentially slow down the publication of a paper to enable them to get their paper out first. Another is that it "shuts down new ideas" as research that goes against the status quo may be rejected by reviewers.

We put this issue to the experts:

"Rather than shutting down new ideas, the process of peer review should mean that they are carefully considered and subject to close scrutiny before being released to a wider audience. Often the processes of peer review itself can specifically enhance a paper and the ideas it seeks to communicate."

COLLETTE TEASDALE Development Editor, Taylor & Francis Group

"Fundamental physics sometimes advances with the presentation of ideas which may sound crazy at first. This exposes the field to being hijacked by deranged minds with their own "theory of everything" in their pocket. It can be difficult for a reviewer to know whether a study is worthy of publication, and so there is a risk that reviewers decide on the basis of their personal biases and turn down good work or let crazy papers pass."

TOMMASO DORIGO Experimental Particle Physicist, University of Padova

New research that goes against current thinking might take longer to pass peer review but if it is scientifically sound, it will eventually be published.

"There have been numerous cases where highly original and controversial ideas have been blocked for years before they have been accepted, published and become popular."

MAMMO MUCHIE Editor of the African Journal of Science, Technology, Innovation and Development

CAN PEER REVIEW DETECT PLAGIARISM?

"Sometimes a reviewer will be able to spot that a paper is similar to another paper they have read, and the peer reviewer should always notify the journal office/editor if they suspect plagiarism. Unfortunately, the peer review process can't always pick up plagiarism as this is reliant on the reviewer to know about every research paper published on the subject area (and remember them!). However, many journals now use a plagiarism checker that produces a report highlighting the similarities with published papers and other online content, and editors then check whether any similarity found is warranted. Editors may seek expert opinion from the reviewer at this stage."

ELIZABETH HAY Head of Publishing, Royal College of Psychiatrists

CAN PEER REVIEW DETECT FRAUD?

"If a fraudster makes up data carefully, detection is very difficult. However, made up data often include impossible enumeration. It is astonishing how stupid fraudsters can be. I have seen: published photographs recoloured and relabelled as new data, blots that have been touched up, numerical data that defy the laws of mathematics, non-use of randomisation, an absence of blinding and wildly unequal group size. Underpowered studies with meaningless statistical analysis are also all too common. Mostly this is fraud by ignorance, but to present such works as meaningful experimental data is fraud nevertheless. It should be detected by peer review but it clearly escapes detection in many cases."

MICHAEL CURTIS Editor in Chief, Journal of Pharmacological and Toxicological Methods

A SELF-CORRECTING PROCESS

If someone sets out to falsify data, there is sometimes no way of knowing this until the paper is published and others in the scientific community scrutinise the work. Publication of a peer reviewed paper is just the first step. Once a paper is published, findings and theories must go on to be re-tested and judged against other work in the same area. Some papers' conclusions will be disputed or superseded after further research is published. Long-term, peer review is a self-correcting process.

If a researcher discovers there is a mistake in their published paper, the online version of record cannot be altered in any way, but a correction (corrigendum) is published to appear alongside the paper online.

If other researchers disagree with aspects of a published paper or have identified flaws, they can write a letter to the journal editor. Some journals ask the authors to respond to the letter and publish the correspondences, which is a way of continuing the scientific debate. Some journals also have rapid response comments attached to papers online.

After publication, if a paper is found to be fraudulent or plagiarised, or researchers realise they made a mistake that invalidates the paper, the journal publishes a retraction which appears alongside the paper online. These can be tracked on Retraction Watch. If editors are concerned about the validity of a paper and there is an investigation underway, they will publish an expression of concern.

HOW IS PEER REVIEW CHANGING?

We've seen that peer review can suffer from problems with bias, fraud and a lack of transparency. Over the recent years, a number of new approaches to peer review have arisen to tackle these issues. These newer methods of peer review often seek to engage reviewers and authors more actively in the peer review process, both before and after publication.

Collaborative peer review – when two or more reviewers work together to review a paper and submit one unified report.

Preprint – a paper that is posted online, often in a repository like arXiv, before it has been through the formal peer review process. This can allow researchers to access papers quickly without having to wait for the sometimes lengthy peer review process. But it sometimes allows papers of an insufficient quality out into the public sphere.

Post-publication peer review - when a paper is scrutinised and reviewed by experts after it's published. This is where researchers share their thoughts on the quality and conclusions of other research papers. This is in contrast to pre-publication peer review, which is the conventional process where research is peer reviewed before it is published.

Transparent peer review – when the entire peer review process, including reviewers' reports, the authors' replies and the editorial decisions, are posted alongside the published article.

PEER REVIEW FOR THE PUBLIC

DOES PEER REVIEW MATTER TO THE PUBLIC?

It's easy to fall into the trap of thinking that peer review only matters to researchers. Why would such a technical process matter to the public? But, in an age where we're constantly presented with so much information, it's more important than ever to give people from all walks of life an understanding of research quality.

When we're constantly bombarded with conflicting claims, encouraging the public to ask 'But has it been peer reviewed?' is a powerful way to enable us to scrutinise the quality of the information we are presented with.

Just as a washing machine has to meet manufacturing standards, so peer review is a kind of quality mark for research. It tells you that the research has been conducted and presented to a standard that other researchers accept. At the same time, it is not saying that the research is perfect (nor that a washing machine will never break down).

"If patients have been diagnosed with a disorder and the medication doesn't seem to work immediately, they may search for an alternative on the internet where there are a host of claims for miracle drugs. It can be difficult to distinguish between claims that are backed by evidence and have been tested by researchers and those that are not. Understanding peer review gives patients a tool to weigh up these claims."

JANIS HICKEY, Director, British Thyroid Foundation

ENTER THE JOURNALISTS....

Most people hear about scientific research through announcements in the media, so it is the journalists who weigh up the status of research and decide what's worth reporting.

When writing about research claims, should journalists report the status and quality of research? For example, has the research been presented at a conference or is it published in a peer reviewed journal?

"I think it is important for science journalists to be as open as possible about the sources for their stories. I don't think it is necessary to state as a matter of course that a journal is peer reviewed (that is normally implicit), but I think it is often useful to say if a story is based on work from a non-peer-reviewed journal or work that has not been subjected to peer review."

JAMES RANDERSON News Editor, POLITICO

"Peer review is not a guarantee that the science is right, just that it seems to have been done properly. So whether I report the status of research or not depends on the content. If some distinguished cosmologist tells me — without benefit of peer review — that in their opinion the universe went through a phase that resembled custard before splashing into sticky globules that coalesced into galaxies, I might very well make a story out of it. Right or wrong, such a conjecture affects no one. On the other hand, if someone claimed a successful treatment for multiple sclerosis without benefit of a peer reviewed publication, I'd not touch it at all because it would be cruel to raise unfounded hopes."

TIM RADFORD Freelance journalist and founder of Climate News

"Many of my editors — and many of the people that I write for — don't understand the difference between research that has been peer reviewed and research that hasn't, so I tend not to include those terms in my writing. However I, personally, certainly do consider whether research has been peer reviewed or not when considering how much credibility to give to claims."

CLAIRE COLEMAN Freelance journalist who often writes about beauty treatments for the Daily Mail

PEER REVIEW MATTERS TO EVERYONE

Peer review may have its limitations, but it is also a remarkable process which relies on the trust and co-operation of the scientific community. It acts as a quality control, ensuring that published research is valid, significant and original. The process is essential for the dissemination and advancement of scientific knowledge. Without peer review, how would we weigh up claims and know what to believe?

In a survey of over 3000 researchers[3], most (85%) believed that without peer review there would be no control in scientific communication.

"Peer review is the last, great, closed part of the research lifecycle. Data on peer review needs to become a core component of the research record. Bringing transparency, recognition and training to peer review will result in better reviewers and a faster, more trusted research process. This will only be possible with collaboration across the wider ecosystem of researchers, publishers, funders and research institutions."

ANDREW PRESTON Managing Director, Publons

[3] Results from the 2019 Quality trust and peer review survey: Sense about Science, with support from Elsevier, carried out a surveys of over 3000 authors and reviewers: https://senseaboutscience.org/wp-content/uploads/2019/09/Quality-trust-peer-review.pdf

Reviewing is a role that is integral to the scientific community, so it is important that early career researchers get involved in the process early on.

"As an early career academic, being involved in peer review offers me a unique opportunity to get involved in relevant discussions that allow me to update my repertoire of knowledge in new and exciting ways."

ETIENO ENANG PhD Candidate and Research Assistant, University of Strathclyde

"Reviewing for journals is my chance to stop bad science being published and improve the quality of good science papers which deserve to get published!"

MARGARET HESLIN VoYS

"If the results in a paper have important consequences for the public, it is essential that the work is reviewed by peers to check that the conclusions are reliable."

DEIRDRE HOLLINGSWORTH Senior Group Leader, Oxford Big Data Institute

"Well managed and good quality peer review is important – critical assessment by appropriate experts helps readers know what to trust and what to treat with scepticism. But the quality of peer review is very variable, sometimes it's flawed and inadequate, so just being labelled 'peer reviewed' can no longer be taken as an indicator of soundness. Increasing transparency about the peer review process itself and being able to see the peer review reports and editorial correspondence can help instil confidence that a piece of work has been appropriately and adequately assessed."

IRENE HAMES Research publication and peer review specialist, author of 'Peer Review and Manuscript Management in Scientific Journals'

FURTHER RESOURCES

SENSE ABOUT SCIENCE PUBLICATIONS:

All are available as free downloads from **www.senseaboutscience.org**

I Don't Know What To Believe

Quality, trust and peer review: researchers' perspective 10 years on

Peer Review and the Acceptance of New Scientific Ideas

HOW TO REVIEW

Elsevier Researcher Academy: Certified Peer Reviewer Course https://researcheracademy.elsevier.com/navigating-peer-review/certified-peer-reviewer-course

PLOS Reviewer Centre: http://reviewers.plos.org/

Publons Academy: https://publons.com/community/academy/

Nature Masterclasses: Focus on Peer Review https://masterclasses.nature.com/focus-on-peer-review-online-course/16605550

Wiley: How to Perform a Peer Review: https://authorservices.wiley.com/Reviewers/journal-reviewers/how-to-perform-a-peer-review/index.html

SAGE Journals: Reviewers Guide: https://us.sagepub.com/en-us/nam/how-to-review-articles

GET RECOGNITION FOR YOUR REVIEWS

Publons: https://publons.com/about/home/

ORCID: https://orcid.org/

ETHICS IN PEER REVIEW

Committee on Publication Ethics

Ethical Guidelines for Peer Reviewers: http://publicationethics.org/

What to consider when asked to peer review a manuscript: https://publicationethics.org/files/What-to-consider-when-asked-to-PR.pdf

CAREER DEVELOPMENT

Vitae researcher development framework: https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae.pdf/view

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Join VoYS!

VoYS is a unique and dynamic network of early career researchers across Europe committed to playing an active role in public discussions about science. By responding to public misconceptions about science and evidence and engaging with the media, policymakers and the public, this active community of 3000+ researchers is changing the way the public and the media view science and scientists.

VoYS members also encourage other early career researchers to get involved, sending the message that it is important for scientists to stand up for science in public discussion and that you don't need to wait until the end of your career to do so.

This guide is the third in the 'Standing up for Science' series of VoYS publications:
Standing up for Science 1: A guide to the media for early career researchers
Standing up for Science 2: The nuts and bolts

Further information about VoYS and their publications can be found here:
www.senseaboutscience.org/pages/voys.html

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