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. Independent 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

JULIA WILSON
VoYS co-ordinator

Peer review now results in over 1.5 million scholarly articles published each year and is fundamental to the integration of new research findings in hundreds of fields of inquiry. For scientific knowledge to progress scientists need to share their research findings with other scientists and this is done through publishing in peer reviewed scientific journals. Peer review is also the tool used for reviewing grant proposals for research funding.

Peer review provides a system to select which research should be brought to the attention of other researchers. It also gives authors feedback to improve the quality of their research papers before publication. The peer review system judges the validity, significance and originality of the work, rather than who has done it. Because it indicates that research has been scrutinised by independent experts in the field, peer review is also an important consideration for policy makers, reporters and the public when weighing up research claims and debates about science.

Peer reviewing is particularly important for early career researchers because it allows them to gain insights into other developments in their research area and play a greater role in their research community. Reviewers develop their own research, writing and data presentation skills, and their ability to look at their own work objectively.

However, there has been growing talk of "a crisis in peer review" – with concerns raised about the global expansion of scholarly research, and to particular incidents of flawed papers making it into print, leaked email exchanges showing researchers trying to influence the process; as well as the mounting pressures on researchers to get grants and publish papers, leaving little time to review papers.

In Voice of Young Science (VoYS) workshops, early career researchers raised questions about how to get involved in reviewing, how to be sure of doing a good job and what to expect as authors and reviewers.

This is a nuts and bolts guide to peer review for early career researchers written by members of the VoYS network[1]. Using a collection of concerns raised by their peers, the VoYS writing team set off to interview scientists, journal editors, grant bodies' representatives, patient group workers and journalists in the UK and around the world to find out how peer review works, the challenges for peer review and how to get involved.

We have not avoided criticisms of the peer review process in this guide but rather entered into the debate, asking journal editors and reviewers some challenging questions about scientific fraud and plagiarism going undetected; issues of trust and bias; ground-breaking research taking years to publish and the system benefiting a closed group of scientists.

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

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[1]Voice of Young Science (VoYS) is a network of early career researchers who stand up for science in public debates about science. Further information at www.senseaboutscience.org/pages/voys.html.

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.

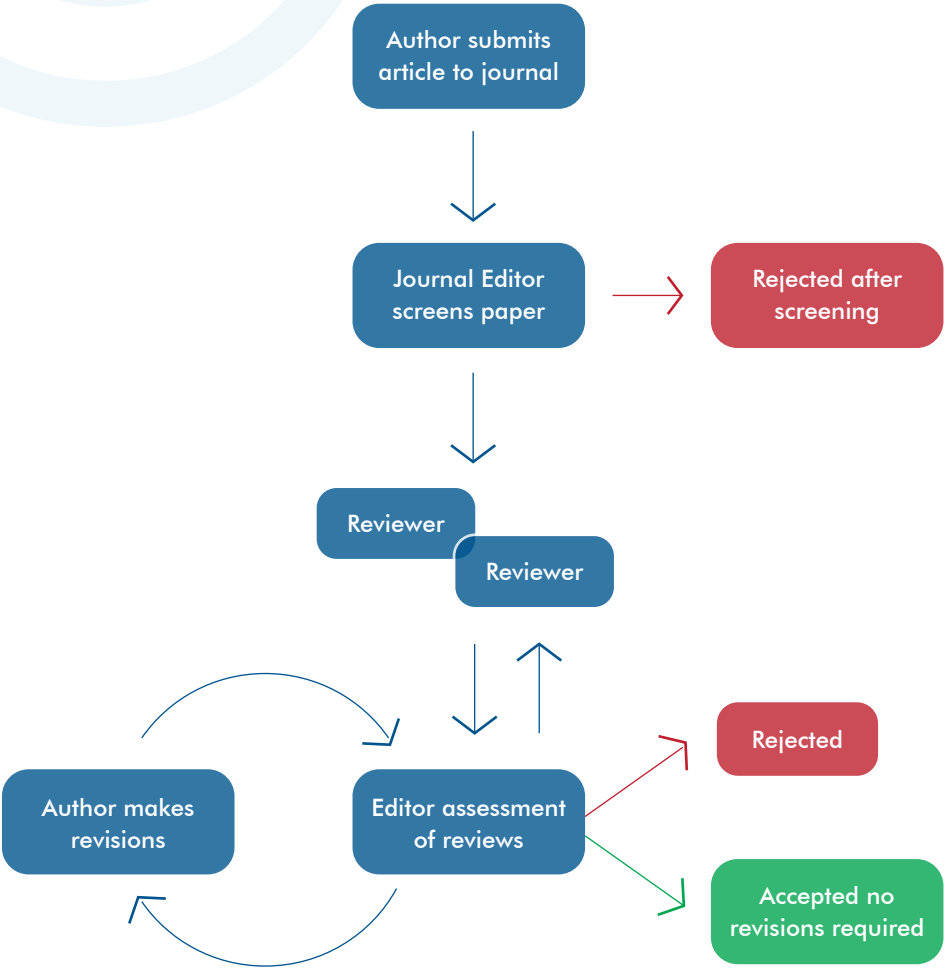

Figure 1: Diagram of a "typical" peer review process (there are many varieties)

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.

WHAT DO YOU DO WHEN A PAPER IS SUBMITTED?

"I have a whole 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 and Associate Publisher of *Nature Protocols*

"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 of the *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."

DR MICHAEL CURTIS
Editor-in-Chief of the *Journal of Pharmacological and Toxicological Methods*

"Finding subject reviewers is a careful procedure because it is voluntary and anonymous. We find these experts from our Editorial Board plus others - you may have cited somebody extensively and we may ask them, or we use our database of previously published authors and reviewers. The ISBJ also provides you with the opportunity to suggest possible reviewers - obviously not your friends or colleagues!"

ROBERT BLACKBURN
Editor-in-Chief of the *International Small Business Journal (ISBJ)*

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."

DR MARIE BAO
Associate Editor, *Developmental Cell*, Cell Press

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. These journals often hold discussions before accepting a paper.

HOW DO YOU OVERSEE THE PROCESS WITH YOUR EDITORIAL TEAM?

"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."

PROFESSOR PHILIP STEER
Editor-in-Chief, of *BJOG: An International Journal of Obstetrics and Gynaecology*

Enter the reviewers….

WHAT DO THEY HAVE TO SAY ABOUT THE BENEFITS OF 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."

DR STEPHEN KEEVIL
Medical Physicist, King's College London

90% review because they like playing their part as a member of the academic community[2]

85% just enjoy seeing other papers and being able to improve them[2]

Almost all researchers **91%** believe that their last paper was improved through the peer review process[2]

[2] Results from the 2009 Peer Review Survey: Sense About Science with support from Elsevier carried out one of the largest ever peer review surveys of over 4000 authors and reviewers: http://www.senseaboutscience.org/pages/peer-review-survey-2009.html

SOME TIPS FOR NEW REVIEWERS PLEASE!

"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."

STEPHEN CURRY
Professor of Structural Biology, Imperial College London

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 the manuscript).

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.

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. If you are unable to accept the invitation to review, suggestions of alternative reviewers are welcomed by editors.

WHAT CRITERIA DO YOU LOOK FOR?

"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."

PROFESSOR MIKE CLEMENS
Biochemistry & Molecular Biology, University of Sussex

QUESTIONS REVIEWERS ASK

Aside from assessing the title, abstract, English language of the article and references, reviewers assess the scientific quality of the work.

Does the paper fit the **standards and scope** of the journal it is being considered for?

Is the **research question** clear?

Was the **approach** appropriate?

Is 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 **develop novel concepts**?

Does it matter?

Are the **methods** described clearly enough for other researchers to **replicate**?

Are the methods of **statistical** analysis and level of significance appropriate?

Could **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?

Are the **conclusions** appropriate?

If the science is sound but the language is poor, some reviewers may suggest edits, whereas others might flag up to the editor that the paper needs an English language edit. If the language is so poor it is difficult to assess the science you might recommend the author improves the language and resubmit. There are English rewriting services available.

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

"When it comes to clinical trials and epidemiology papers, statistical literacy is an important issue."

DR STEPHEN KEEVIL
Medical Physicist, King's College London

IS THERE ANY TRAINING?

"Most journals provide online guidelines for reviewers but in my experience little other training is available. The skills are largely learned from colleagues and mentors in the reviewer's own department."

PROFESSOR MIKE CLEMENS
Biochemistry & Molecular Biology, University of Sussex

"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."

DR DEIRDRE HOLLINGSWORTH
Epidemiologist, Imperial College London

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.

Research groups and medical departments often hold their own 'journal club' where they discuss a recent paper. This allows the group to keep up-to-date with scientific developments and develop skills to critically appraise research papers that will be useful when reviewing.

Some journals (eg. the *EMBO Journal, BMJ Open*) publish reviewers' reports alongside papers which can be useful for inexperienced reviewers to look at.

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 and opinion 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. It can sometimes take a few attempts to gain a sense of what the acceptance threshold is for a particular journal as each journal is different.

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.

IS ANYTHING BEING DONE TO PREVENT "WASTAGE" OF REVIEWS?

"Cascading peer review (a.k.a. 'waterfall peer review') is when a paper that has been rejected after peer review, is passed to another journal along with the reviewers' reports. The peer review process at the second journal can be kept relatively short because the Editor considers the reports from an earlier round of peer review, along with any new reviews. Variations on this process exist, according to the type of journal - but essentially reviews can "cascade" down through various journals."

DAN MORGAN
Executive Publisher of *Psychology & Cognitive Science*

HOW THE VITAE RESEARCHER DEVELOPMENT FRAMEWORK CAN HELP YOU WITH PEER REVIEW

vitae
realising the potential of researchers

Being a successful researcher involves developing many skills including reviewing the work of others as part of the peer review process. This skill will help you in many employment destinations, not just research.

The Vitae Researcher Development Framework (www.vitae.ac.uk/rdfresearcher) is a guide to identify your strengths and priorities for professional and career development. It sets out the knowledge, behaviors and attributes of successful researchers and assists you in achieving higher levels of development.

The Framework is made up of four domains, which encompass

- knowledge and intellectual abilities
- personal effectiveness
- research governance and organisation
- engagement, influence and impact

These are further broken down into a number of characteristics, which you would be developing through peer review including:

- reputation and esteem
- collegiality
- publication
- knowledge base
- critical thinking and analysis
- networking and responsiveness to opportunities
- reputation and esteem
- time management skills
- continued professional development

"As a researcher it's easy to get stuck into only thinking about the knowledge and skills that are specific to your research field. The Researcher Development Framework emphasises broadening your horizons and identifying strengths and skills, such as those involved in peer reviewing, that will help you become a better researcher."

DR DANIEL WEEKES
Research Associate, Kings College, University of London

WHAT ARE THE DIFFERENT TYPES OF PEER REVIEW?

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, very general and high impact factor journals 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* (published by the Public Library of Science), use a peer review process that does not judge significance or originality, but 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 and so the competition to publish is not as high. The average acceptance rate for journals is 50%.

Some peer reviewed journals are tracked by Thomson Reuters and awarded an impact factor, calculated annually. Impact factor is a measure of the number of times the "average article" in a journal has been cited in a particular year.

Peer review 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).

In some fields, like physics, it is more common to put research online in a subject repository (such as ArXiv) before it is submitted to a journal. This allows the research to be circulated and commented on before it is subject to peer review – whereas within medicine there are ethical concerns about research being accessed before it has been peer reviewed.

We asked Tommaso Dorigo experimental particle physicist 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 at CERN

WHAT ARE THE DIFFERENT TYPES OF PEER REVIEW?

DR IRENE HAMES (Editorial Consultant and 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. The most common system in science disciplines.

- ✓ This allows reviewers to provide honest, critical reviews and opinions without fear of reprisal from the authors.
- ✗ Lack of accountability, allows 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. Main form of peer review used in the humanities and social sciences.

- ✓ Reduces possible bias resulting from knowing who the authors are or where they come from, work assessed on its own merits.
- ✗ Involves some effort to make sure manuscripts are anonymized, 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 of these.

- Greater accountability and reduced opportunity for bias or inappropriate actions. Reviewers can be given public credit for their work.
- 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. 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
Editorial Consultant and author of Peer Review and Manuscript Management in Scientific Journals

PEER REVIEW FOR FUNDING 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 Diabetes UK we use peer review to ensure that the research we fund will help to improve the lives of people living with diabetes. It helps us know why an area of research is important and needs further investigation and it also helps identify reasons why a research proposal, that at first seems a good idea, might not be suitable for funding."

DR IAIN FRAME
Director of Research, Diabetes UK

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 at the Association of Medical Research Charities

SHOULD REVIEWERS BE REWARDED?

"Based on the 2009 peer review survey results it is clear that reviewers would like to be rewarded. The question is how should they be rewarded? In the survey most reviewers indicated that they would like to receive payment in kind for their reviews. Publishers are keen to do this in a sustainable way and there are currently a variety of initiatives in place on journals, including giving certificates to reviewers or providing accreditation (CME/CPD points). Elsevier provides reviewers free access to its Abstracting and Indexing service Scopus. Also popular among reviewers is receiving an 'Acknowledgement in the journal', something more and more journals are now doing."

ADRIAN MULLIGAN
Deputy Director, Research & Academic Relations, Elsevier

COULD JOURNALS REWARD REVIEWERS FINANCIALLY?

"I don't think so. This may encourage some people to review papers for which they are not really qualified. However some other form of recognition of the work involved, such as free online access to papers published in the journal for a year, might be appropriate."

PROFESSOR MIKE CLEMENS
Biochemistry & Molecular Biology, University of Sussex

Many journals provide recognition to reviewers by publishing their names in the journal as part of an annual list. Some journals send a certificate to congratulate and express their appreciation to their best reviewers, clinicians can claim CPD points for reviewing. However, journal editors have made the case that the many hours of important work peer reviewers contribute need to be recognised more formally by interview panels and research-assessment exercises.

PEER REVIEW 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
Environment and Science News Editor at the *Guardian*

"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
Straight Statistics

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

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

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

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."

DR MICHAEL CURTIS
Editor-in-Chief of the *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 - Economics Journals, Routledge Journals,
Taylor & Francis Group

Reviewers could potentially slow down the publication of a paper to enable them to get their paper out first. However, reviewers are given a deadline to submit their review. If they are very late then journals will invite an expedited review from a backup reviewer or consider the reviews they already have in-hand at an editors' meeting to minimize the delay for the authors.

One criticism of peer review 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 - Economics Journals, Routledge Journals,
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
CMS experiment at CERN

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."

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

We often hear about cases of fraud going undetected. But can peer review ever really 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 randomization; 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."

DR MICHAEL CURTIS
Editor-in-Chief of the *Journal of Pharmacological and Toxicological Methods*

CAN PEER REVIEW DETECT PLAGIARISM?

"Unfortunately, the peer review process often doesn't pick up plagiarism as this would require the reviewer to know about every research paper published on the subject area (and remember them!). However, journals use a plagiarism checker that produces a report highlighting the similarities with published papers. Reviewers can carry out their own similar check using etBlast, a free database where they can paste the abstract and see which papers are similar. This process is also useful to help reviewers see where the paper fits within published literature, as well as how novel a paper is."

ELIZABETH HAY
Managing Editor, *RCOG Journals*

The Committee on Publications Ethics (COPE) is an international forum for editors of peer reviewed journals who discuss all aspects of publication ethics. They have developed best practice flowcharts for editors on how to handle cases of research and publication misconduct including plagiarism and research fraud as well providing guidance on how editors can responsibly carry out peer review.

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 and try and repeat 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. In a sense, 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 in their calculations 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**.

Pre-publication peer review is the conventional process of papers being sent out for peer review before they are published in a journal.

Post-publication peer review is when a paper is scrutinised, replicated and commented on by experts after it is published. New web technologies allow readers to rate papers, and add comments and notes to online articles for readers to see.

The internet has created novel ways of reviewing research both pre and post peer review. Some researchers have started to use blogs, wikis and other Web 2.0 technologies to communicate their own research to other scientists in the field as well as share their thoughts on the quality and conclusions of other research papers.

DOES PEER REVIEW MATTER TO THE PUBLIC?

Peer review is not only relevant to scientists. Sense About Science has worked with the public to promote an understanding of peer review, encouraging the question 'has it been peer reviewed?' to help the process of weighing up conflicting scientific claims. Understanding that published research has been scrutinised by other experts in the field can help people understand why a claim that is backed up by a peer reviewed paper is likely to be more reliable than someone's opinion which has undergone no such scrutiny.

"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
Environment and Science News Editor at *the Guardian*

"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 his 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

"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

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 and 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[3] of over 4000 researchers, most (84%) believed that without peer review there would be no control in scientific communication

[3] Results from the 2009 Peer Review Survey: Sense About Science, with support from Elsevier carried out one of the largest ever peer review surveys of over 4000 authors and reviewers: http://www.senseaboutscience.org/pages/peer-review-survey-2009.html

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

"One of the reasons I like to review papers is that it makes me feel like an important part of the academic community, and that my opinion about what is (or isn't) good science actually matters."

JAMIE MCCLELLAND
VoYS

"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."

DR DEIRDRE HOLLINGSWORTH
Epidemiologist, Imperial College London

"Peer review is important because it helps people make decisions about what to believe, what to treat with scepticism and what to trust. When research work has been scrutinised and critically assessed by experts before publication it helps prevent the release of work that is unsound, inadequate or has been wrongly interpreted. Its role is to ensure the scholarly record is as sound as possible. It isn't, however, a guarantor of absolute truth – it does sometimes go wrong and there are shortcomings - but it is considered by many to be crucial to the reputation and reliability of scientific research."

DR IRENE HAMES
Editorial Consultant and author of Peer Review and Manuscript Management in Scientific Journals

4. FURTHER INFORMATION

SENSE ABOUT SCIENCE PUBLICATIONS:

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

I Don't Know What To Believe

Peer review Survey 2009 Final Results

Peer review and the Acceptance of New Scientific Ideas

Peer review Education Resource http://www.senseaboutscience.net/

OTHER GUIDES TO PEER REVIEW:

Peer review: a guide for researchers Research Information Network
http://www.rin.ac.uk/our-work/communicating-and-disseminating-research/peer-review-guide-researchers

Anthony M. Vintzileos, MD, Cande V. Ananth, PhD, MPH 2010 The Art of Peer-Reviewing an Original Research Paper; Important Tips and Guidelines *J Ultrasound Med 2010; 29:513–518*

BMJ training materials for reviewers:
http://www.bmj.com/about-bmj/resources-reviewers/training-materials

USEFUL RESOURCES FOR REVIEWING

To find published papers with similar abstracts: etBlast: http://etest.vbi.vt.edu/etblast3/
Clinical Trials registration information (all clinical trials should be registered before the first patient is enrolled): http://www.icmje.org/faq_clinical.html
The Declaration of Helsinki; international ethical principles for medical research
http://www.wma.net/en/30publications/10policies/b3/
Committee on Publication Ethics: http://publicationethics.org/
Guidelines for research to be published in a biomedical journal, flowcharts and checklists for e.g. systematic reviews, meta-analyses observational studies, and randomized controlled trials: http://www.equator-network.org/
International prospective register of systematic reviews:
http://www.crd.york.ac.uk/prospero/

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Join VoYS!

The Voice of Young Science network consists of hundreds of early career researchers who want to stand up for science in public discussions. VoYS members tackle misconceptions, challenge pseudoscience and respond to misinformation in all kinds of media.

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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