

Peer review in scientific publications: benefits, critiques, & a survival guide

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ABSTRACT

Peer review has been defined as a process of subjecting an author's **scholarly** work, research or **ideas** to the scrutiny of others who are **experts** in the same field. It functions to encourage **authors** to meet the accepted high standards of their discipline and to control the dissemination of research data to ensure that unwarranted claims, unacceptable interpretations or personal views are not published without prior expert review. Despite its wide-spread use by most journals, the peer review process has also been widely criticised due to the slowness of the process to publish new findings and due to perceived bias by the editors and/or reviewers. Within the scientific community, peer review has become an essential component of the academic writing process. It helps ensure that papers published in scientific journals answer meaningful research questions and draw accurate conclusions based on professionally executed experimentation. Submission of low quality manuscripts has become increasingly prevalent, and peer review acts as a filter to prevent this work from reaching the scientific community. The major advantage of a peer review process is that peer-reviewed articles provide a trusted form of scientific communication. Since scientific knowledge is cumulative and builds on itself, this trust is particularly important. Despite the positive impacts of peer review, critics argue that the peer review process stifles innovation in experimentation,

and acts as a poor screen against plagiarism. Despite its downfalls, there has not yet been a foolproof system developed to take the place of peer review, however, researchers have been looking into electronic means of improving the peer review process. Unfortunately, the recent explosion in online only/electronic journals has led to mass publication of a large number of scientific articles with little or no peer review. This poses significant risk to advances in scientific knowledge and its future potential. The current article summarizes the peer review process, highlights the pros and cons associated with different types of peer review, and describes new methods for improving peer review.

WHAT IS PEER REVIEW AND WHAT IS ITS PURPOSE?

Peer Review is defined as “a process of subjecting an author’s scholarly work, research or ideas to the scrutiny of others who are experts in the same field” (1). Peer review is intended to serve two primary purposes. Firstly, it acts as a filter to ensure that only high quality research is published, especially in reputable journals, by determining the validity, significance and originality of the study. Secondly, peer review is intended to improve the quality of manuscripts that are deemed suitable for publication. Peer reviewers provide suggestions to authors on how to improve the quality of their manuscripts, and also identify any errors that need correcting before publication.

HISTORY OF PEER REVIEW

The concept of peer review was developed long before the scholarly journal. In fact, the peer review process is thought to have been used as a method of evaluating written work since ancient Greece (2). The peer review process was first described by a physician named Ishaq bin Ali al-Rahwi of Syria, who lived from 854-931

CE, in his book *Ethics of the Physician* (2). There, he stated that physicians must take notes describing the state of their patients’ medical conditions upon each visit. Following treatment, the notes were scrutinized by a local medical council to determine whether the physician had met the required standards of medical care. If the medical council deemed that the appropriate standards were not met, the physician in question could receive a lawsuit from the mal-treated patient (2).

The invention of the printing press in 1453 allowed written documents to be distributed to the general public (3). At this time, it became more important to regulate the quality of the written material that became publicly available, and editing by peers increased in prevalence. In 1620, Francis Bacon wrote the work *Novum Organum*, where he described what eventually became known as the first universal method for generating and assessing new science (3). His work was instrumental in shaping the Scientific Method (3). In 1665, the French *Journal des sçavans* and the English *Philosophical Transactions of the Royal Society* were the first scientific journals to systematically publish research results (4). *Philosophical Transactions of the Royal Society* is thought to be the first journal to formalize the peer review process in 1665 (5), however, it is important to note that peer review was initially introduced to help editors decide which manuscripts to publish in their journals, and at that time it did not serve to ensure the validity of the research (6). It did not take long for the peer review process to evolve, and shortly thereafter papers were distributed to reviewers with the intent of authenticating the integrity of the research study before publication. The Royal Society of Edinburgh adhered to the following peer review process, published in their *Medical Essays and Observations* in 1731: “*Memoirs sent by correspondence are distributed according to the subject matter to those members who*

are most versed in these matters. The report of their identity is not known to the author.” (7). The Royal Society of London adopted this review procedure in 1752 and developed the “Committee on Papers” to review manuscripts before they were published in *Philosophical Transactions* (6).

Peer review in the systematized and institution-alized form has developed immensely since the Second World War, at least partly due to the large increase in scientific research during this period (7). It is now used not only to ensure that a scientific manuscript is experimentally and ethically sound, but also to determine which papers sufficiently meet the journal’s standards of quality and originality before publication. Peer review is now standard practice by most credible scientific journals, and is an essential part of determining the credibility and quality of work submitted.

IMPACT OF THE PEER REVIEW PROCESS

Peer review has become the foundation of the scholarly publication system because it effectively subjects an author’s work to the scrutiny of other experts in the field. Thus, it encourages authors to strive to produce high quality research that will advance the field. Peer review also supports and maintains integrity and authenticity in the advancement of science. A scientific hypothesis or statement is generally not accepted by the academic community unless it has been published in a peer-reviewed journal (8). The Institute for Scientific Information (*ISI*) only considers journals that are peer-reviewed as candidates to receive Impact Factors. Peer review is a well-established process which has been a formal part of scientific communication for over 300 years.

OVERVIEW OF THE PEER REVIEW PROCESS

The peer review process begins when a scientist completes a research study and writes a

manuscript that describes the purpose, experimental design, results, and conclusions of the study. The scientist then submits this paper to a suitable journal that specializes in a relevant research field, a step referred to as pre-submission. The editors of the journal will review the paper to ensure that the subject matter is in line with that of the journal, and that it fits with the editorial platform. Very few papers pass this initial evaluation. If the journal editors feel the paper sufficiently meets these requirements and is written by a credible source, they will send the paper to accomplished researchers in the field for a formal peer review. Peer reviewers are also known as referees (this process is summarized in Figure 1). The role of the editor is to select the most appropriate manuscripts for the journal, and to implement and monitor the peer review process. Editors must ensure that peer reviews are conducted fairly, and in an effective and timely manner. They must also ensure that there are no conflicts of interest involved in the peer review process.

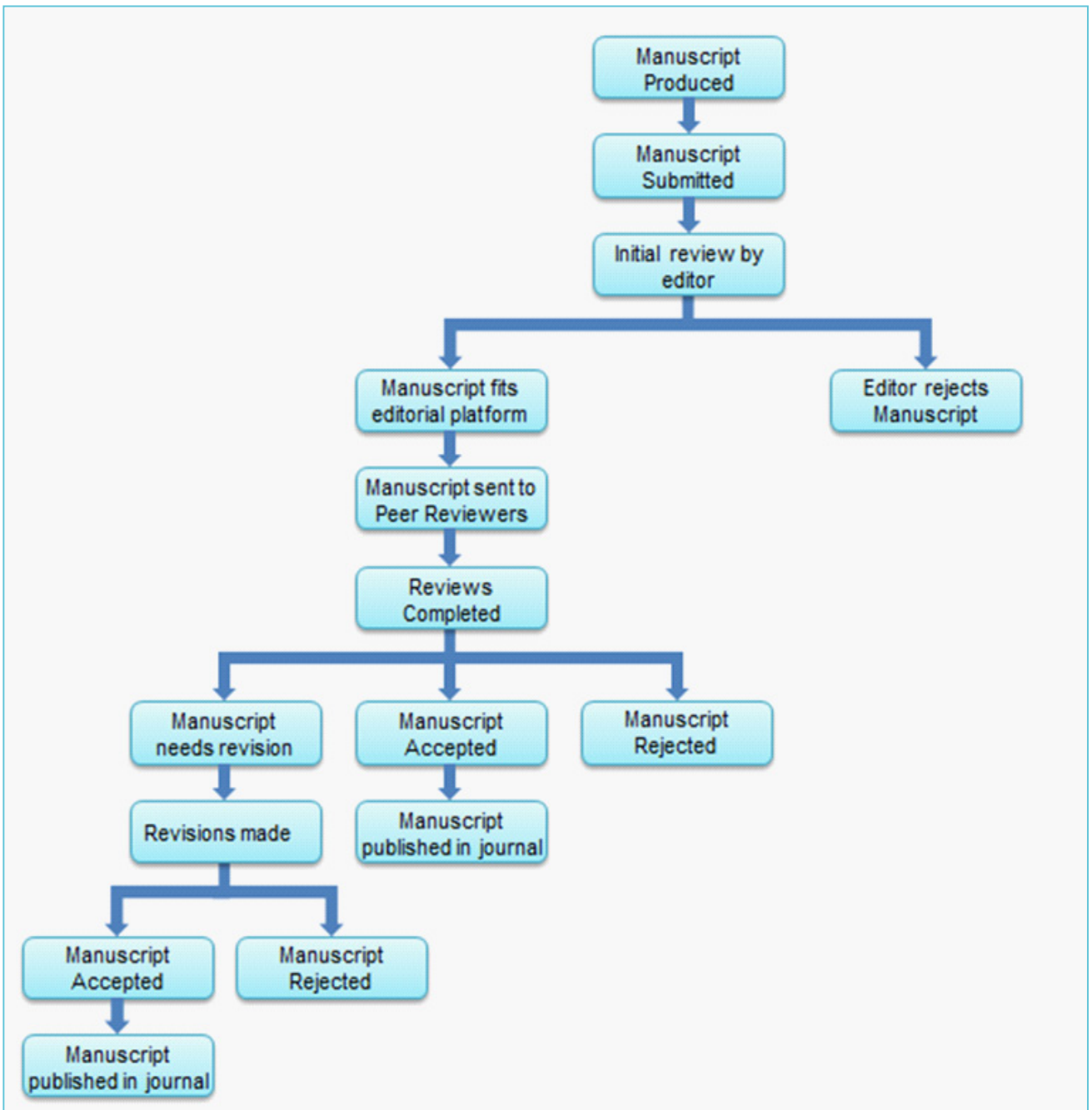
When a reviewer is provided with a paper, he or she reads it carefully and scrutinizes it to evaluate the validity of the science, the quality of the experimental design, and the appropriateness of the methods used. The reviewer also assesses the significance of the research, and judges whether the work will contribute to advancement in the field by evaluating the importance of the findings, and determining the originality of the research. Additionally, reviewers identify any scientific errors and references that are missing or incorrect. Peer reviewers give recommendations to the editor regarding whether the paper should be accepted, rejected, or improved before publication in the journal. The editor will mediate author-referee discussion in order to clarify the priority of certain referee requests, suggest areas that can be strengthened, and overrule reviewer recommendations that are beyond the study’s scope (9). If

the paper is accepted, as per suggestion by the peer reviewer, the paper goes into the production stage, where it is tweaked and formatted by the editors, and finally published in the scientific journal. An overview of the review process is presented in Figure 1.

WHO CONDUCTS REVIEWS?

Peer reviews are conducted by scientific experts with specialized knowledge on the content of the manuscript, as well as by scientists with a more general knowledge base. Peer reviewers can be anyone who has competence and

Figure 1 Overview of the review process



expertise in the subject areas that the journal covers. Reviewers can range from young and up-and-coming researchers to old masters in the field. Often, the young reviewers are the most responsive and deliver the best quality reviews, though this is not always the case. On average, a reviewer will conduct approximately eight reviews per year, according to a study on peer review by the Publishing Research Consortium (PRC) (7). Journals will often have a pool of reviewers with diverse backgrounds to allow for many different perspectives. They will also keep a rather large reviewer bank, so that reviewers do not get burnt out, overwhelmed or time constrained from reviewing multiple articles simultaneously.

WHY DO REVIEWERS REVIEW?

Referees are typically not paid to conduct peer reviews and the process takes considerable effort, so the question is raised as to what incentive referees have to review at all. Some feel an academic duty to perform reviews, and are of the mentality that if their peers are expected to review their papers, then they should review the work of their peers as well. Reviewers may also have personal contacts with editors, and may want to assist as much as possible. Others review to keep up-to-date with the latest developments in their field, and reading new scientific papers is an effective way to do so. Some scientists use peer review as an opportunity to advance their own research as it stimulates new ideas and allows them to read about new experimental techniques. Other reviewers are keen on building associations with prestigious journals and editors and becoming part of their community, as sometimes reviewers who show dedication to the journal are later hired as editors. Some scientists see peer review as a chance to become aware of the latest research before their peers, and thus be first to develop new insights from the material. Finally, in terms

of career development, peer reviewing can be desirable as it is often noted on one's resume or CV. Many institutions consider a researcher's involvement in peer review when assessing their performance for promotions (11). Peer reviewing can also be an effective way for a scientist to show their superiors that they are committed to their scientific field (5).

ARE REVIEWERS KEEN TO REVIEW?

A 2009 international survey of 4000 peer reviewers conducted by the charity Sense About Science at the British Science Festival at the University of Surrey, found that 90% of reviewers were keen to peer review (12). One third of respondents to the survey said they were happy to review up to five papers per year, and an additional one third of respondents were happy to review up to ten.

HOW LONG DOES IT TAKE TO REVIEW ONE PAPER?

On average, it takes approximately six hours to review one paper (12), however, this number may vary greatly depending on the content of the paper and the nature of the peer reviewer. One in every 100 participants in the "Sense About Science" survey claims to have taken more than 100 hours to review their last paper (12).

HOW TO DETERMINE IF A JOURNAL IS PEER REVIEWED

Ulrichsweb is a directory that provides information on over 300,000 periodicals, including information regarding which journals are peer reviewed (13). After logging into the system using an institutional login (eg. from the University of Toronto), search terms, journal titles or ISSN numbers can be entered into the search bar. The database provides the title, publisher, and country of origin of the journal, and indicates

whether the journal is still actively publishing. The black book symbol (labelled 'refereed') reveals that the journal is peer reviewed.

THE EVALUATION CRITERIA FOR PEER REVIEW OF SCIENTIFIC PAPERS

As previously mentioned, when a reviewer receives a scientific manuscript, he/she will first determine if the subject matter is well suited for the content of the journal. The reviewer will then consider whether the research question is important and original, a process which may be aided by a literature scan of review articles.

Scientific papers submitted for peer review usually follow a specific structure that begins with the title, followed by the abstract, introduction, methodology, results, discussion, conclusions, and references. The title must be descriptive and include the concept and organism investigated, and potentially the variable manipulated and the systems used in the study. The peer reviewer evaluates if the title is descriptive enough, and ensures that it is clear and concise. A study by the National Association of Realtors (NAR) published by the Oxford University Press in 2006 indicated that the title of a manuscript plays a significant role in determining reader interest, as 72% of respondents said they could *usually* judge whether an article will be of interest to them based on the title and the author, while 13% of respondents claimed to *always* be able to do so (14).

The abstract is a summary of the paper, which briefly mentions the background or purpose, methods, key results, and major conclusions of the study. The peer reviewer assesses whether the abstract is sufficiently informative and if the content of the abstract is consistent with the rest of the paper. The NAR study indicated that 40% of respondents could determine whether an article would be of interest to them based on the abstract alone 60-80% of the time, while

32% could judge an article based on the abstract 80-100% of the time (14). This demonstrates that the abstract alone is often used to assess the value of an article.

The introduction of a scientific paper presents the research question in the context of what is already known about the topic, in order to identify why the question being studied is of interest to the scientific community, and what gap in knowledge the study aims to fill (15). The introduction identifies the study's purpose and scope, briefly describes the general methods of investigation, and outlines the hypothesis and predictions (15). The peer reviewer determines whether the introduction provides sufficient background information on the research topic, and ensures that the research question and hypothesis are clearly identifiable.

The methods section describes the experimental procedures, and explains why each experiment was conducted. The methods section also includes the equipment and reagents used in the investigation. The methods section should be detailed enough that it can be used to repeat the experiment (15). Methods are written in the past tense and in the active voice. The peer reviewer assesses whether the appropriate methods were used to answer the research question, and if they were written with sufficient detail. If information is missing from the methods section, it is the peer reviewer's job to identify what details need to be added.

The results section is where the outcomes of the experiment and trends in the data are explained without judgement, bias or interpretation (15). This section can include statistical tests performed on the data, as well as figures and tables in addition to the text. The peer reviewer ensures that the results are described with sufficient detail, and determines their credibility. Reviewers also confirm that the text is consistent with the information presented in

tables and figures, and that all figures and tables included are important and relevant (15). The peer reviewer will also make sure that table and figure captions are appropriate both contextually and in length, and that tables and figures present the data accurately.

The discussion section is where the data is analyzed. Here, the results are interpreted and related to past studies (15). The discussion describes the meaning and significance of the results in terms of the research question and hypothesis, and states whether the hypothesis was supported or rejected. This section may also provide possible explanations for unusual results and suggestions for future research (15). The discussion should end with a conclusions section that summarizes the major findings of the investigation. The peer reviewer determines whether the discussion is clear and focused, and whether the conclusions are an appropriate interpretation of the results. Reviewers also ensure that the discussion addresses the limitations of the study, any anomalies in the results, the relationship of the study to previous research, and the theoretical implications and practical applications of the study.

The references are found at the end of the paper, and list all of the information sources cited in the text to describe the background, methods, and/or interpret results. Depending on the citation method used, the references are listed in alphabetical order according to author last name, or numbered according to the order in which they appear in the paper. The peer reviewer ensures that references are used appropriately, cited accurately, formatted correctly, and that none are missing.

Finally, the peer reviewer determines whether the paper is clearly written and if the content seems logical. After thoroughly reading through the entire manuscript, they determine whether it meets the journal's standards for publication,

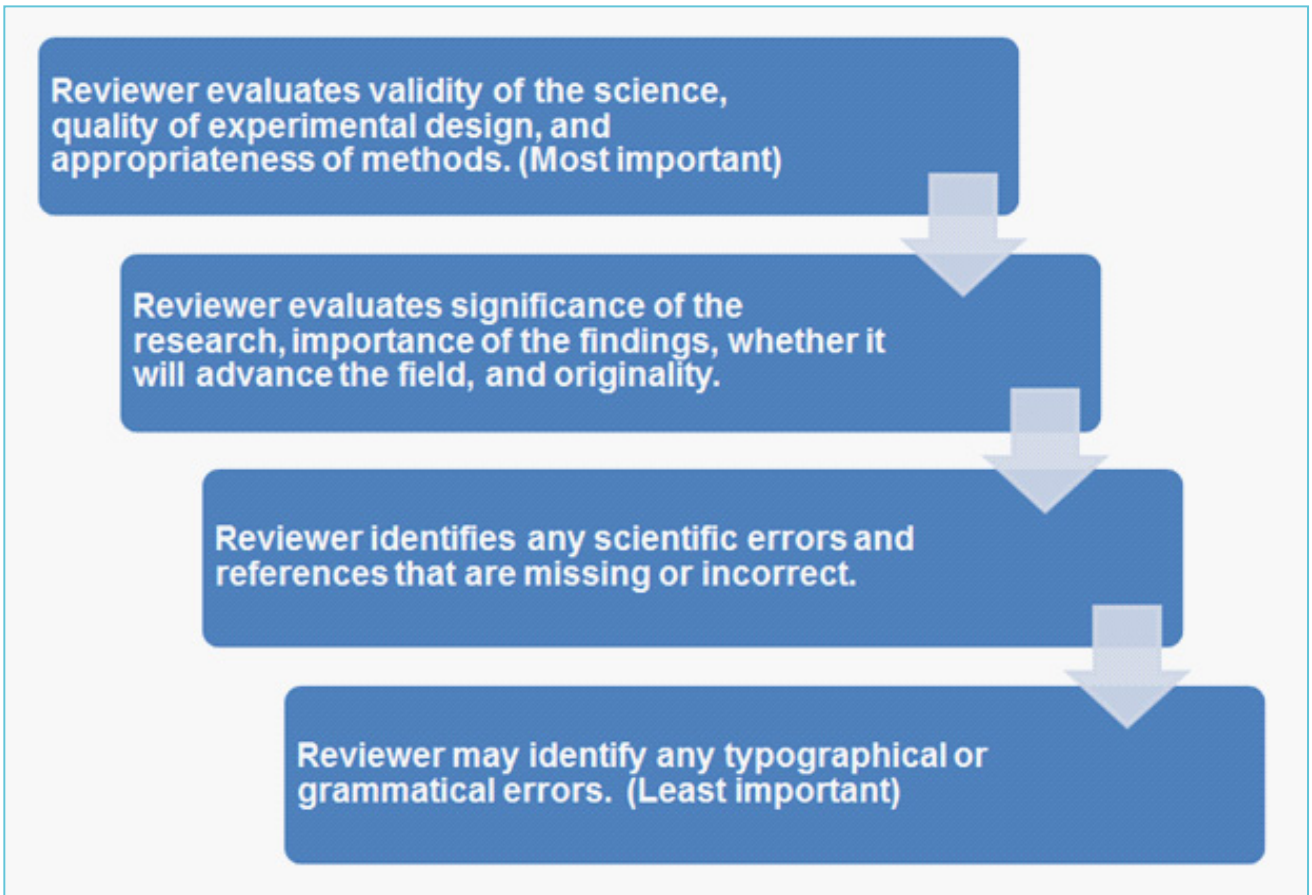
and whether it falls within the top 25% of papers in its field (16) to determine priority for publication. An overview of what a peer reviewer looks for when evaluating a manuscript, in order of importance, is presented in Figure 2.

To increase the chance of success in the peer review process, the author must ensure that the paper fully complies with the journal guidelines before submission. The author must also be open to criticism and suggested revisions, and learn from mistakes made in previous submissions.

ADVANTAGES AND DISADVANTAGES OF THE DIFFERENT TYPES OF PEER REVIEW

The peer review process is generally conducted in one of three ways: open review, single-blind review, or double-blind review. In an open review, both the author of the paper and the peer reviewer know one another's identity. Alternatively, in single-blind review, the reviewer's identity is kept private, but the author's identity is revealed to the reviewer. In double-blind review, the identities of both the reviewer and author are kept anonymous. Open peer review is advantageous in that it prevents the reviewer from leaving malicious comments, being careless, or procrastinating completion of the review (2). It encourages reviewers to be open and honest without being disrespectful. Open reviewing also discourages plagiarism amongst authors (2). On the other hand, open peer review can also prevent reviewers from being honest for fear of developing bad rapport with the author. The reviewer may withhold or tone down their criticisms in order to be polite (2). This is especially true when younger reviewers are given a more esteemed author's work, in which case the reviewer may be hesitant to provide criticism for fear that it will dampen their relationship with a superior (2). According to the Sense About Science survey, editors

Figure 2 How a peer review evaluates a manuscript



find that completely open reviewing decreases the number of people willing to participate, and leads to reviews of little value (12). In the aforementioned study by the PRC, only 23% of authors surveyed had experience with open peer review (7).

Single-blind peer review is by far the most common. In the PRC study, 85% of authors surveyed had experience with single-blind peer review (7). This method is advantageous as the reviewer is more likely to provide honest feedback when their identity is concealed (2). This allows the reviewer to make independent decisions without the influence of the author (2). The main disadvantage of reviewer anonymity, however, is that reviewers who receive manuscripts on subjects similar to their own research may

be tempted to delay completing the review in order to publish their own data first (2).

Double-blind peer review is advantageous as it prevents the reviewer from being biased against the author based on their country of origin or previous work (2). This allows the paper to be judged based on the quality of the content, rather than the reputation of the author. The Sense About Science survey indicates that 76% of researchers think double-blind peer review is a good idea (12), and the PRC survey indicates that 45% of authors have had experience with double-blind peer review (7). The disadvantage of double-blind peer review is that, especially in niche areas of research, it can sometimes be easy for the reviewer to determine the identity of the author based on

writing style, subject matter or self-citation, and thus, impart bias (2).

Masking the author's identity from peer reviewers, as is the case in double-blind review, is generally thought to minimize bias and maintain review quality. A study by Justice *et al.* in 1998 investigated whether masking author identity affected the quality of the review (17). One hundred and eighteen manuscripts were randomized; 26 were peer reviewed as normal, and 92 were moved into the 'intervention' arm, where editor quality assessments were completed for 77 manuscripts and author quality assessments were completed for 40 manuscripts (17). There was no perceived difference in quality between the masked and unmasked reviews. Additionally, the masking itself was often unsuccessful, especially with well-known authors (17). However, a previous study conducted by McNutt *et al.* had different results (18). In this case, blinding was successful 73% of the time, and they found that when author identity was masked, the quality of review was slightly higher (18). Although Justice *et al.* argued that this difference was too small to be consequential, their study targeted only biomedical journals, and the results cannot be generalized to journals of a different subject matter (17). Additionally, there were problems masking the identities of well-known authors, introducing a flaw in the methods. Regardless, Justice *et al.* concluded that masking author identity from reviewers may not improve review quality (17).

In addition to open, single-blind and double-blind peer review, there are two experimental forms of peer review. In some cases, following publication, papers may be subjected to post-publication peer review. As many papers are now published online, the scientific community has the opportunity to comment on these papers, engage in online discussions and post a formal review. For example, online publishers PLOS and BioMed Central have enabled

scientists to post comments on published papers if they are registered users of the site (10). *Philica* is another journal launched with this experimental form of peer review. Only 8% of authors surveyed in the PRC study had experience with post-publication review (7). Another experimental form of peer review called Dynamic Peer Review has also emerged. Dynamic peer review is conducted on websites such as Naboj, which allow scientists to conduct peer reviews on articles in the preprint media (19). The peer review is conducted on repositories and is a continuous process, which allows the public to see both the article and the reviews as the article is being developed (19). Dynamic peer review helps prevent plagiarism as the scientific community will already be familiar with the work before the peer reviewed version appears in print (19). Dynamic review also reduces the time lag between manuscript submission and publishing. An example of a preprint server is the 'arXiv' developed by Paul Ginsparg in 1991, which is used primarily by physicists (19). These alternative forms of peer review are still unestablished and experimental. Traditional peer review is time-tested and still highly utilized. All methods of peer review have their advantages and deficiencies, and all are prone to error.

PEER REVIEW OF OPEN ACCESS JOURNALS

Open access (OA) journals are becoming increasingly popular as they allow the potential for widespread distribution of publications in a timely manner (20). Nevertheless, there can be issues regarding the peer review process of open access journals. In a study published in Science in 2013, John Bohannon submitted 304 slightly different versions of a fictional scientific paper (written by a fake author, working out of a non-existent institution) to a selected group of OA journals. This study was performed in order to determine whether papers submitted to OA journals are properly reviewed

before publication in comparison to subscription-based journals. The journals in this study were selected from the Directory of Open Access Journals (DOAJ) and Biall's List, a list of journals which are potentially predatory, and all required a fee for publishing (21). Of the 304 journals, 157 accepted a fake paper, suggesting that acceptance was based on financial interest rather than the quality of article itself, while 98 journals promptly rejected the fakes (21). Although this study highlights useful information on the problems associated with lower quality publishers that do not have an effective peer review system in place, the article also generalizes the study results to all OA journals, which can be detrimental to the general perception of OA journals. There were two limitations of the study that made it impossible to accurately determine the relationship between peer review and OA journals: 1) there was no control group (subscription-based journals), and 2) the fake papers were sent to a non-randomized selection of journals, resulting in bias.

JOURNAL ACCEPTANCE RATES

Based on a recent survey, the average acceptance rate for papers submitted to scientific journals is about 50% (7). Twenty percent of the submitted manuscripts that are not accepted are rejected prior to review, and 30% are rejected following review (7). Of the 50% accepted, 41% are accepted with the condition of revision, while only 9% are accepted without the request for revision (7).

SATISFACTION WITH THE PEER REVIEW SYSTEM

Based on a recent survey by the PRC, 64% of academics are satisfied with the current system of peer review, and only 12% claimed to be 'dissatisfied' (7). The large majority, 85%, agreed with the statement that '*scientific communication is*

greatly helped by peer review' (7). There was a similarly high level of support (83%) for the idea that peer review '*provides control in scientific communication'* (7).

HOW TO PEER REVIEW EFFECTIVELY

The following are ten tips on how to be an effective peer reviewer as indicated by Brian Lucey, an expert on the subject (22):

1) Be professional

Peer review is a mutual responsibility among fellow scientists, and scientists are expected, as part of the academic community, to take part in peer review. If one is to expect others to review their work, they should commit to reviewing the work of others as well, and put effort into it.

2) Be pleasant

If the paper is of low quality, suggest that it be rejected, but do not leave ad hominem comments. There is no benefit to being ruthless.

3) Read the invite

When emailing a scientist to ask them to conduct a peer review, the majority of journals will provide a link to either accept or reject. Do not respond to the email, respond to the link.

4) Be helpful

Suggest how the authors can overcome the shortcomings in their paper. A review should guide the author on what is good and what needs work from the reviewer's perspective.

5) Be scientific

The peer reviewer plays the role of a scientific peer, not an editor for proofreading or decision-making. Don't fill a review with comments on editorial and typographic issues. Instead, focus on adding value with scientific knowledge and commenting on the credibility of the research

conducted and conclusions drawn. If the paper has a lot of typographical errors, suggest that it be professionally proof edited as part of the review.

6) Be timely

Stick to the timeline given when conducting a peer review. Editors track who is reviewing what and when and will know if someone is late on completing a review. It is important to be timely both out of respect for the journal and the author, as well as to not develop a reputation of being late for review deadlines.

7) Be realistic

The peer reviewer must be realistic about the work presented, the changes they suggest and their role. Peer reviewers may set the bar too high for the paper they are editing by proposing changes that are too ambitious and editors must override them.

8) Be empathetic

Ensure that the review is scientific, helpful and courteous. Be sensitive and respectful with word choice and tone in a review.

9) Be open

Remember that both specialists and generalists can provide valuable insight when peer reviewing. Editors will try to get both specialised and general reviewers for any particular paper to allow for different perspectives. If someone is asked to review, the editor has determined they have a valid and useful role to play, even if the paper is not in their area of expertise.

10) Be organised

A review requires structure and logical flow. A reviewer should proofread their review before submitting it for structural, grammatical and spelling errors as well as for clarity. Most publishers provide short guides on structuring

a peer review on their website. Begin with an overview of the proposed improvements; then provide feedback on the paper structure, the quality of data sources and methods of investigation used, the logical flow of argument, and the validity of conclusions drawn. Then provide feedback on style, voice and lexical concerns, with suggestions on how to improve.

In addition, the American Physiology Society (APS) recommends in its Peer Review 101 Handout that peer reviewers should put themselves in both the editor's and author's shoes to ensure that they provide what both the editor and the author need and expect (11). To please the editor, the reviewer should ensure that the peer review is completed on time, and that it provides clear explanations to back up recommendations. To be helpful to the author, the reviewer must ensure that their feedback is constructive. It is suggested that the reviewer take time to think about the paper; they should read it once, wait at least a day, and then re-read it before writing the review (11). The APS also suggests that Graduate students and researchers pay attention to how peer reviewers edit their work, as well as to what edits they find helpful, in order to learn how to peer review effectively (11). Additionally, it is suggested that Graduate students practice reviewing by editing their peers' papers and asking a faculty member for feedback on their efforts. It is recommended that young scientists offer to peer review as often as possible in order to become skilled at the process (11). The majority of students, fellows and trainees do not get formal training in peer review, but rather learn by observing their mentors. According to the APS, one acquires experience through networking and referrals, and should therefore try to strengthen relationships with journal editors by offering to review manuscripts (11). The APS also suggests that experienced reviewers provide constructive feedback

to students and junior colleagues on their peer review efforts, and encourages them to peer review to demonstrate the importance of this process in improving science (11).

The peer reviewer should only comment on areas of the manuscript that they are knowledgeable about (23). If there is any section of the manuscript they feel they are not qualified to review, they should mention this in their comments and not provide further feedback on that section. The peer reviewer is not permitted to share any part of the manuscript with a colleague (even if they may be more knowledgeable in the subject matter) without first obtaining permission from the editor (23). If a peer reviewer comes across something they are unsure of in the paper, they can consult the literature to try and gain insight. It is important for scientists to remember that if a paper can be improved by the expertise of one of their colleagues, the journal must be informed of the colleague's help, and approval must be obtained for their colleague to read the protected document. Additionally, the colleague must be identified in the confidential comments to the editor, in order to ensure that he/she is appropriately credited for any contributions (23). It is the job of the reviewer to make sure that the colleague assisting is aware of the confidentiality of the peer review process (23). Once the review is complete, the manuscript must be destroyed and cannot be saved electronically by the reviewers (23).

COMMON ERRORS IN SCIENTIFIC PAPERS

When performing a peer review, there are some common scientific errors to look out for. Most of these errors are violations of logic and common sense: these may include contradicting statements, unwarranted conclusions, suggestion of causation when there is only support for correlation, inappropriate extrapolation,

circular reasoning, or pursuit of a trivial question (24). It is also common for authors to suggest that two variables are different because the effects of one variable are statistically significant while the effects of the other variable are not, rather than directly comparing the two variables (24). Authors sometimes oversee a confounding variable and do not control for it, or forget to include important details on how their experiments were controlled or the physical state of the organisms studied (24). Another common fault is the author's failure to define terms or use words with precision, as these practices can mislead readers (24). Jargon and/or misused terms can be a serious problem in papers. Inaccurate statements about specific citations are also a common occurrence (24). Additionally, many studies produce knowledge that can be applied to areas of science outside the scope of the original study, therefore it is better for reviewers to look at the novelty of the idea, conclusions, data, and methodology, rather than scrutinize whether or not the paper answered the specific question at hand (24). Although it is important to recognize these points, when performing a review it is generally better practice for the peer reviewer to not focus on a checklist of things that could be wrong, but rather carefully identify the problems specific to each paper and continuously ask themselves if anything is missing (24). An extremely detailed description of how to conduct peer review effectively is presented in the paper *How I Review an Original Scientific Article* written by Frederic G. Hoppin, Jr. It can be accessed through the American Physiological Society website under the Peer Review Resources section.

CRITICISM OF PEER REVIEW

A major criticism of peer review is that there is little evidence that the process actually works, that it is actually an effective screen for good quality scientific work, and that it actually

improves the quality of scientific literature. As a 2002 study published in the *Journal of the American Medical Association* concluded, 'Editorial peer review, although widely used, is largely untested and its effects are uncertain' (25). Critics also argue that peer review is not effective at detecting errors. Highlighting this point, an experiment by Godlee *et al.* published in the *British Medical Journal* (BMJ) inserted eight deliberate errors into a paper that was nearly ready for publication, and then sent the paper to 420 potential reviewers (7). Of the 420 reviewers that received the paper, 221 (53%) responded, the average number of errors spotted by reviewers was two, no reviewer spotted more than five errors, and 35 reviewers (16%) did not spot any.

Another criticism of peer review is that the process is not conducted thoroughly by scientific conferences with the goal of obtaining large numbers of submitted papers. Such conferences often accept any paper sent in, regardless of its credibility or the prevalence of errors, because the more papers they accept, the more money they can make from author registration fees (26). This misconduct was exposed in 2014 by three MIT graduate students by the names of Jeremy Stribling, Dan Aguayo and Maxwell Krohn, who developed a simple computer program called SCigen that generates nonsense papers and presents them as scientific papers (26). Subsequently, a nonsense SCigen paper submitted to a conference was promptly accepted. *Nature* recently reported that French researcher Cyril Labbé discovered that sixteen SCigen nonsense papers had been used by the German academic publisher Springer (26). Over 100 nonsense papers generated by SCigen were published by the US Institute of Electrical and Electronic Engineers (IEEE) (26). Both organisations have been working to remove the papers. Labbé developed a program to detect SCigen papers and has made it freely available

to ensure publishers and conference organizers do not accept nonsense work in the future. It is available at this link: <http://scigendetection.imag.fr/main.php> (26).

Additionally, peer review is often criticized for being unable to accurately detect plagiarism. However, many believe that detecting plagiarism cannot practically be included as a component of peer review. As explained by Alice Tuff, development manager at Sense About Science, 'The vast majority of authors and reviewers think peer review should detect plagiarism (81%) but only a minority (38%) think it is capable. The academic time involved in detecting plagiarism through peer review would cause the system to grind to a halt' (27). Publishing house Elsevier began developing electronic plagiarism tools with the help of journal editors in 2009 to help improve this issue (27).

It has also been argued that peer review has lowered research quality by limiting creativity amongst researchers. Proponents of this view claim that peer review has repressed scientists from pursuing innovative research ideas and bold research questions that have the potential to make major advances and paradigm shifts in the field, as they believe that this work will likely be rejected by their peers upon review (28). Indeed, in some cases peer review may result in rejection of innovative research, as some studies may not seem particularly strong initially, yet may be capable of yielding very interesting and useful developments when examined under different circumstances, or in the light of new information (28). Scientists that do not believe in peer review argue that the process stifles the development of ingenious ideas, and thus the release of fresh knowledge and new developments into the scientific community.

Another issue that peer review is criticized for, is that there are a limited number of people that are competent to conduct peer review

compared to the vast number of papers that need reviewing. An enormous number of papers published (1.3 million papers in 23,750 journals in 2006), but the number of competent peer reviewers available could not have reviewed them all (29). Thus, people who lack the required expertise to analyze the quality of a research paper are conducting reviews, and weak papers are being accepted as a result. It is now possible to publish any paper in an obscure journal that claims to be peer-reviewed, though the paper or journal itself could be substandard (29). On a similar note, the US National Library of Medicine indexes [39 journals that specialize in alternative medicine](#), and though they all identify themselves as “peer-reviewed”, they rarely publish any high quality research (29). This highlights the fact that peer review of more controversial or specialized work is typically performed by people who are interested and hold similar views or opinions as the author, which can cause bias in their review. For instance, a paper on homeopathy is likely to be reviewed by fellow practicing homeopaths, and thus is likely to be accepted as credible, though other scientists may find the paper to be nonsense (29). In some cases, papers are initially published, but their credibility is challenged at a later date and they are subsequently retracted. Retraction Watch is a website dedicated to revealing papers that have been retracted after publishing, potentially due to improper peer review (30).

Additionally, despite its many positive outcomes, peer review is also criticized for being a delay to the dissemination of new knowledge into the scientific community, and as an unpaid activity that takes scientists’ time away from activities that they would otherwise prioritize, such as research and teaching, for which they are paid (31). As described by Eva Amsen, Outreach Director for F1000Research, peer review was originally developed as a means of helping

editors choose which papers to publish when journals had to limit the number of papers they could print in one issue (32). However, nowadays most journals are available online, either exclusively or in addition to print, and many journals have very limited printing runs (32). Since there are no longer page limits to journals, any good work can and should be published. Consequently, being selective for the purpose of saving space in a journal is no longer a valid excuse that peer reviewers can use to reject a paper (32). However, some reviewers have used this excuse when they have personal ulterior motives, such as getting their own research published first.

RECENT INITIATIVES TOWARDS IMPROVING PEER REVIEW

F1000Research was launched in January 2013 by Faculty of 1000 as an open access journal that immediately publishes papers (after an initial check to ensure that the paper is in fact produced by a scientist and has not been plagiarised), and then conducts transparent post-publication peer review (32). F1000Research aims to prevent delays in new science reaching the academic community that are caused by prolonged publication times (32). It also aims to make peer reviewing more fair by eliminating any anonymity, which prevents reviewers from delaying the completion of a review so they can publish their own similar work first (32). F1000Research offers completely open peer review, where everything is published, including the name of the reviewers, their review reports, and the editorial decision letters (32).

PeerJ was founded by Jason Hoyt and Peter Binfield in June 2012 as an open access, peer reviewed scholarly journal for the Biological and Medical Sciences (33). PeerJ selects articles to publish based only on scientific and methodological soundness, not on subjective determinants

of 'impact,' 'novelty' or 'interest' (34). It works on a "lifetime publishing plan" model which charges scientists for publishing plans that give them lifetime rights to publish with PeerJ, rather than charging them per publication (34). PeerJ also encourages open peer review, and authors are given the option to post the full peer review history of their submission with their published article (34). PeerJ also offers a pre-print review service called PeerJ Pre-prints, in which paper drafts are reviewed before being sent to PeerJ to publish (34).

Rubriq is an independent peer review service designed by Shashi Mudunuri and Keith Collier to improve the peer review system (35). Rubriq is intended to decrease redundancy in the peer review process so that the time lost in redundant reviewing can be put back into research (35). According to Keith Collier, over 15 million hours are lost each year to redundant peer review, as papers get rejected from one journal and are subsequently submitted to a less prestigious journal where they are reviewed again (35). Authors often have to submit their manuscript to multiple journals, and are often rejected multiple times before they find the right match. This process could take months or even years (35). Rubriq makes peer review portable in order to help authors choose the journal that is best suited for their manuscript from the beginning, thus reducing the time before their paper is published (35). Rubriq operates under an author-pay model, in which the author pays a fee and their manuscript undergoes double-blind peer review by three expert academic reviewers using a standardized scorecard (35). The majority of the author's fee goes towards a reviewer honorarium (35). The papers are also screened for plagiarism using iThenticate (35). Once the manuscript has been reviewed by the three experts, the most appropriate journal for submission is determined based on the topic and quality of the paper (35). The paper is returned to

the author in 1-2 weeks with the Rubriq Report (35). The author can then submit their paper to the suggested journal with the Rubriq Report attached. The Rubriq Report will give the journal editors a much stronger incentive to consider the paper as it shows that three experts have recommended the paper to them (35). Rubriq also has its benefits for reviewers; the Rubriq scorecard gives structure to the peer review process, and thus makes it consistent and efficient, which decreases time and stress for the reviewer. Reviewers also receive feedback on their reviews and most significantly, they are compensated for their time (35). Journals also benefit, as they receive pre-screened papers, reducing the number of papers sent to their own reviewers, which often end up rejected (35). This can reduce reviewer fatigue, and allow only higher-quality articles to be sent to their peer reviewers (35).

According to Eva Amsen, peer review and scientific publishing are moving in a new direction, in which all papers will be posted online, and a post-publication peer review will take place that is independent of specific journal criteria and solely focused on improving paper quality (32). Journals will then choose papers that they find relevant based on the peer reviews and publish those papers as a collection (32). In this process, peer review and individual journals are uncoupled (32). In Keith Collier's opinion, post-publication peer review is likely to become more prevalent as a complement to pre-publication peer review, but not as a replacement (35). Post-publication peer review will not serve to identify errors and fraud but will provide an additional measurement of impact (35). Collier also believes that as journals and publishers consolidate into larger systems, there will be stronger potential for "cascading" and shared peer review (35).

CONCLUDING REMARKS

Peer review has become fundamental in assisting editors in selecting credible, high quality, novel and interesting research papers to publish in scientific journals and to ensure the correction of any errors or issues present in submitted papers. Though the peer review process still has some flaws and deficiencies, a more suitable screening method for scientific papers has not yet been proposed or developed. Researchers have begun and must continue to look for means of addressing the current issues with peer review to ensure that it is a full-proof system that ensures only quality research papers are released into the scientific community.

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