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PEER REVIEW

Peer review (box 1) is the process used to determine how science funding is allocated (£1.6 billion to be distributed by the UK research councils in 2002-03), which research is published and where it is published. It is of interest not only to the scientific community: the trend towards evidence based policy means that peer-reviewed science informs decision making across an increasingly wide range of areas. In recent years a number of high profile cases have emerged highlighting possible flaws in the peer review process. This briefing note describes how peer review operates, provides an overview of its strengths and weaknesses, and considers what improvements might exist.

Peer review in the UK

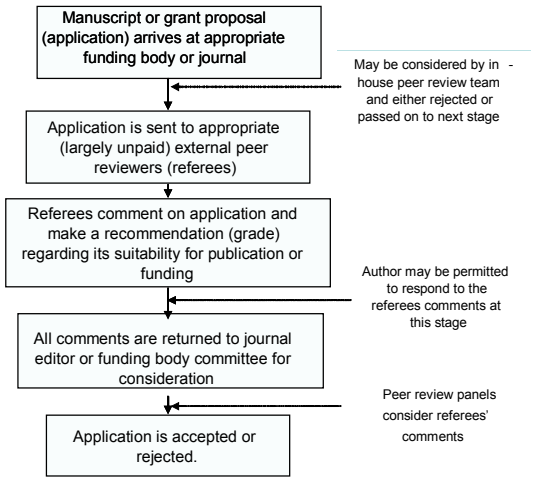
Peer review is used in the UK for three main purposes:

- Allocation of research funding. The main funding bodies such as the research councils and biomedical charities all use peer review for advice on which research projects should be funded in the first place and to assess the progress of funded projects. An indication of the scale of research spending by such bodies is given in the table below.
- Publication of research in scientific journals. Peer review is used to assess the quality of research submitted for publication and to assess its importance. The process thus influences what science enters the public domain, where it is published and what impact it will have (the more prestigious the journal, the greater the likely impact of the publication).
- Assess the research rating of university departments. Peer review has been used as part of the Research Assessment Exercise (RAE)[1] to judge the quality of research conducted by each department. The results are used to direct the distribution of public funds (£5 billion following the 2001 RAE) to each institute.

In addition to the above, peer reviewed science is playing an increasingly influential role in the formulation of UK policy and decision making. The following sections analyse the issues arising from the use of peer review.

Box 1 What is peer review?

Peer review is a system whereby research – or a research proposal - is scrutinised by (largely unpaid) independent experts (peers). In general, the process serves a technical (ensuring that the science is sound) and a subjective function (is the science interesting, important and/or groundbreaking?). The flowchart below gives a brief overview of how the process works to select science for funding and publication, although in practice, there is considerable variation in peer review processes between funding bodies and journals.



Research expenditure by main funders (2001)

Funding body	£M
Engineering and Physical Sciences Research Council (EPSRC)	£417M
Medical Research Council (MRC)	£368M
Biotechnology and Biological Sciences Research Council (BBSRC)	£226M
Natural Environment Research Council (NERC)	£197M
Particle Physics and Astronomy Research Council (PPARC)	£213M
Economic and Social Research Council (ESRC)	£82M
Arts and Humanities Research Board (AHRB)	£51M
The Royal Society	£36M
The Wellcome Trust	£544M
Cancer Research UK	£176M

Issues

Peer review is designed to improve the quality of research reporting and to prevent poor research from taking place. It is generally regarded as having the confidence of the research community. Processes such as the RAE are widely accepted as having raised standards, but there is surprisingly little evidence on the effectiveness of peer review from formal studies. One recent review found some evidence that the accuracy and readability of manuscripts is improved between submission and publication, although it was not clear whether this was due to peer review, or to technical editing[2]. There is also some evidence that it is effective at weeding out poor quality research both at funding and at publication[3]. In general, peer review is held to be beneficial to the scientific community and has become central to the process by which science is conducted. Issues raised by peer review are discussed below.

Fraudulent research

Different types of fraud

Peer review relies on mutual trust and honesty: researchers must entrust their data/ideas to referees while referees must trust that researchers are telling the truth. Because of this reliance on trust, the peer review system is open to abuse. Recent years have seen a small number of high profile cases where the system has failed to detect fraudulent research, although these cases are though to account for only a tiny proportion of peer reviewed research. Fraudulent research can take a number of forms (see box 2) including:

- Fabrication – where data or cases in manuscripts submitted for publication are simply invented. The ectopic pregnancy case outlined in box 2 is just one example of fabrication, and illustrates just how difficult it is for peer reviewers to pick up on this type of fraud.
- Falsification – where data in manuscripts submitted for publication are distorted or manipulated in some way (see the example of the German cancer researchers given in box 2). This can include ignoring 'inconvenient' results and analysing data in inappropriate ways.
- Plagiarism – copying of data, papers or ideas. This can occur in manuscripts submitted for publication and in research proposals for which funding is sought (see the NSF example in box 2).
- Failure to disclose conflicts of interest. The increasingly close links between science and industry have lead to concerns that commercial interests may bias the scientific literature. For example, a study conducted in 1986 examined the background of published papers supporting the use of a particular drug and found that some 96% of studies had financial relations with the drug manufacturer[4].
- Other forms of scientific misconduct. These can include (undisclosed) redundant publication (where authors publish the same paper in a number of different journals) and gift authorship (where senior members of staff lend their names to papers with which they have had little or no involvement, see box 2).

Box 2 Fraudulent research

The Pearce affair

In August 1996, Malcom Pearce, a senior lecturer at St George's Hospital Medical School in London published a paper in the British Journal of Obstetrics and Gynaecology. He claimed to have rescued an ectopic pregnancy by transferring it into the uterus, resulting in a successful birth. This would have been the first time such a feat had been accomplished. However, it later transpired that the work had never taken place and the 'patient' did not exist. A subsequent investigation into Pearce's previous publications identified four other fraudulent papers, two of which had been published in the British Medical Journal. Pearce was fired and struck off by the General Medical Council. A second author (Geoffrey Chamberlain) on the 'ectopic pregnancy' paper also retired or resigned from a number of senior positions. Chamberlain's 'crime' was gift authorship – he was unaware that the papers to which he had lent his name were fraudulent.

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In 1998, the main German research funding agency set up an inquiry to investigate misconduct allegations against two German cancer researchers. The inquiry looked at 347 papers published by the researchers since the early 1980s. It concluded that 29 of these contained falsified material and found evidence of data manipulation leading to a suspicion of fraud in a further 65 papers. In most cases the falsification concerned illustrations of blood and other types of cell contained in the publications.

US National Science Foundation (NSF)

The NSF recently conducted an inquiry into suspected plagiarism and violation of confidential peer review. A researcher was asked to peer review a proposal for research, which was turned down on the basis of the reviewers' comments. The researcher subsequently submitted his own research proposal to another funding body, which was accepted for funding. This proposal was found to have plagiarised the original proposal to a large extent – the rationale and methodology had been lifted word for word. The researcher was subsequently found to have submitted a number of other research proposals plagiarised from proposals he had been asked to peer review.

Detecting fraud

Recent years have seen a number of developments aimed at reducing scientific fraud, particularly in the area of medical research. For instance, both the MRC and the Wellcome Trust have published guidance on good research practice and on procedures for inquiring into allegations of research misconduct. In 1997, a group of UK journal editors formed the Committee on Publication Ethics (COPE), to provide a discussion forum for issues concerned with potential breaches in research and publication ethics. It published guidelines on good publication practice in 1999, and meets regularly to consider possible cases of research misconduct referred to it by editors. By 2001, COPE had considered 137 cases, finding '*evidence of misconduct*' in 106 of these. Not all concerned fraud – for instance in some cases research was found to be unethical, lacking informed consent or involving breaches of confidentiality. The most common cases involved unacknowledged redundant publications (43 cases), authorship problems (24) falsification of data (17) and fabrication (9).

COPE's activities suggest that research fraud still occurs within the UK, although it is difficult to assess the extent of the problem. It is unlikely that improvements to the peer review system to address this issue could be made. Some see the way forward as being to set up a UK national body along the lines of the Office of Research Integrity, the body responsible for investigating claims of scientific misconduct involving public funds in the US. While there is growing support for such a body in the UK, a COPE meeting in October 2001 at the British Medical Association identified a number of issues to be resolved:

- What activities would it be regulating? This would require an agreed definition of research fraud.
- What form would the body take? Would it be a statutory body with a remit to regulate publicly funded research? Or a non-statutory body, relying on voluntary participation?
- What powers and duties would it have? Its remit could include reacting to allegations of fraud, training and guidance (to reduce research misconduct) and active monitoring of research.
- How would such a body interact with existing bodies such as the General Medical Council? Should it be entirely focused on the UK or take a wider approach?
- Funding and accountability. It was suggested that funding could come from a wide range of interested parties (government, the NHS, research councils, the Wellcome Trust, professional bodies such as the Royal Colleges and trade organisations). One suggestion for accountability was that the body should report to a select committee within Parliament.

Other potential disadvantages

Bias

It has been suggested that peer review may introduce a number of different biases to decisions on funding and publication. For instance, a 1997 investigation by the Swedish Medical Research Council reported that female applicants had to be 2.5 times more productive than their male colleagues to get the same peer-review rating. Separate investigations by the Wellcome Trust[5] and MRC of research funded in the UK found no evidence of gender bias: grant award rates and publication records were about the same for men and women. However, fewer women applied for funding than might be expected from the gender balance of biomedical researchers. A related concern is that research funding committees tend to be male dominated as there is a relatively small pool of senior female scientists from which to select reviewers.

There are also concerns that peer review tends to favour publication of positive results. One possible reason for this may be that editors are under pressure to publish results that generate big impact factors (e.g. as measured by the Science Citation Index[6]). This has led to concerns that the non-publication of negative results leads to bias in the scientific record. Other possible biases that may be introduced by peer review include language (with publication being biased in favour of papers written in English) and institutional bias (with some studies suggesting that reviewers favour submissions from researchers at prestigious institutions)[7].

Preserving the status quo

It has been suggested[8] that peer review is an inherently conservative process, that encourages the emergence of self-serving cliques of reviewers, who are more likely to review each others' grant proposals and publications favourably than those submitted by researchers from outside the group. This could have a number of consequences. For instance, it may:

- discourage researchers from moving into new fields in which they have no track record;
- make it difficult for junior researchers to obtain grants or publish their research;
- present difficulties for multidisciplinary work, since peer review committees that do not contain individuals qualified to judge all aspects of a proposal may be less likely to approve the funding;
- result in the funding/publication of 'safe' research that fits neatly into the conventional wisdom and work against innovative, 'risky' or unconventional ideas.

Inefficiency

Peer review can be relatively slow and inefficient both for funding and publication. Reasons for this may include:

- failure of referees to keep to deadlines -reviewers are commonly given 3-4 weeks to complete and submit reviews, but typically only 50% keep to this deadline;
- inconsistency between referees often means that more must be sought, thus slowing the process;
- recruiting and retaining referees is increasingly difficult (acceptance rates are typically as low as 50%);
- the lengthy time taken for editors and funding bodies to reach a decision regarding the fate of an application (sometimes up to six months).

An increase in the amount of peer review exacerbates the above points. On the publications side, an increase in the number of journals (partly due to the birth of on-line publishing) may have increased the load on reviewers. On the research funding front, a report by the Royal Society in 1995[9] found that demand from proposals has increasingly outstripped the supply of funding, resulting in increased rejection rates.

Ways forward

Concerns over the peer review system are nothing new; in 1989, the Secretary of State for Education questioned whether peer review was over-bureaucratic, too conservative, and too time-consuming. In response the (then) Advisory Board for the Research Councils established a working group to examine peer review. The resulting Boden report concluded that there was 'no practical alternative to peer review for the assessment of basic research', a sentiment echoed in a report from the Royal Society in 1995. Peer review is also likely to continue to be the mainstay by which papers are assessed for publication, although recent advances in technology offer the possibility of new forms of peer review (box 3). Overall, both the Boden and Royal Society reports recognised that peer review is under pressure, that a number of inadequacies requiring attention exist.

Box 3 Peer review and the internet

Advances in electronic technology offer a number of obvious advantages to peer reviewed publishing; for instance, reduced costs, greater speed of publication and global reach. Many established journals now have on-line sections where fast-breaking research is first published.

The advent of the internet has also promoted the evolution of new peer review systems. One such is the arXiv server, founded in 1991 by scientist Paul Ginsparg at the Los Alamos National Laboratory in New Mexico. arXiv is an electronic archive and distribution server for research papers covering topics including physics and mathematics. It works by allowing scientists to post their pre-publication manuscripts online free of editorial control. Once posted, anyone can read and comment on the manuscript and call up the end result. Within the scientific community this archive and others like it are well regarded - Los Alamos has 25,000 papers submitted annually and 35,000 users daily.

Box 4 Anonymity

The majority of peer review is conducted anonymously. That is, the authors do not know the identity of the referees. This practice has traditionally been based on the assumption that anonymity increases objectivity and honesty. However, some scientists believe that anonymity provides an opportunity for settling old scores and burying rival research. An alternative to the traditional system is open peer review where referees' identities are disclosed to researchers. The relative merits of each system are a topic of lively debate. Arguments against an open system include:

- Junior scientists may be unwilling to give an unfavourable review to a senior scientist.
- Referees are less likely to provide critical reviews.
- It may be difficult to recruit referees to an open system.

Arguments supporting an open system include:

- Reduces abuses of the system.
- Renders referees more accountable for their comments.
- Increases the credit given to referees.

Recruiting and retaining referees

Some research councils (including BBSRC) are looking at requiring researchers awarded grants to act as referees for a certain period. EPSRC has recently started a 'peer miles' scheme whereby referees who return their reviews on time are rewarded with points that can be cashed in at the end of each academic year, with the money being awarded to the reviewer's department. The scheme has resulted in a slight improvement in performance. Finally, there has been much recent debate over whether research funders and publishers should move away from the current (anonymous) system of peer review to a more open system. While there a number of potential advantages (see box 4), any such move might make it more difficult to recruit and retain referees.

Improving efficiency

Initiatives to improve the efficiency of the system include:

- *Lightening the burden on reviewers* – many funders (e,g, EPSRC, ESRC) now place a limit on how many proposals their referees review each year. Research funders also tailor peer review effort according to the complexity or cost of the proposed research..
- *Setting new research in context* – journals are increasingly requiring authors to explicitly state how their research adds to what was already known.
- *Fast-track publication* - many journals now offer fast-track peer review (e.g. by an editorial board) to allow the rapid publication of important research.
- *Reducing referee inconsistency* - EPSRC runs training courses for referees. From October 2002 the ESRC will be providing their referees with anonymised comments made by others who have refereed the same proposal.
- *Moderation of demand* - BBSRC is looking at limiting the number of grants that individual researchers and/or departments may hold at any one time.
- *Improving the quality of funding proposals* - a university-level sift of applications prior to submission has been suggested by the research councils.
- *Auditing the productivity of funding decisions* – it has been proposed[10] that research funders should assess the impact of their decisions on cumulated knowledge.

Encouraging innovation

Research councils increasingly encourage scientists with innovative ideas to apply for small grants in order to conduct pilot studies. Many funding bodies now have special schemes for young researchers and those looking to work outside of their specialist field. The research councils are also increasingly using interdisciplinary committees to provide funds for innovative proposals that might otherwise fall between different funding bodies.

Overview

- Peer review is important – it is the process by which researchers and editors seek to ensure that only high quality research is funded and published.
- Peer review thus has a role to play in maintaining public confidence in scientific research; peer reviewed science also informs an increasingly wide range of policy decisions.
- Although it is the best available system for assessing the quality of science, it is not perfect. Increased efforts are being made to improve the efficiency and transparency of the peer review process.

Endnotes

1 The Research Assessment Exercise is used by the higher education funding bodies to distribute public funds for research.
2 Jefferson T et al (2002), JAMA, 287, 2786-2790.
3 Grayson L (2002), Evidence based policy and the quality of evidence: Rethinking peer review, ESRC, UK.
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10 Chalmers I (2000), BMJ 321, 566.

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