Open Peer Review to Save the World

By Philip Gibbs

We live in a world of strange contradictions. On the one hand humanity has sent men to the moon, built the largest and most complicated machine on Earth to complete the standard model of particle physics and developed technical gadgets that provide access to much of the world's knowledge from a device we carry in a pocket. Yet at the same instant we spend trillions fighting wars that serve only to destroy the lives of millions based on no more than our tribal instinct for feuds, and when it appears that our impact on Earth endangers our future we argue about it with name calling and political rhetoric instead of carefully considered logic, then we plunge the world into economic decline because we fail to see the manifest risks of bad investment practices. What is going wrong?

In fact the answer is not a mystery. It has been figured out by behavioural psychologists over the last few decades and a Nobel Prize has even been awarded for its discovery. It affects us all but few take it into consideration. Meanwhile as our civilisations becomes ever more complex and intertwined the risks we face become potentially more dangerous and at the same time harder to understand. Could pollution melt the icecaps and swamp our major cities under the rising sea? Might an unexpected cyberwar unleash an economic disaster of unprecedented proportions? Could a deadly virus sweep round the world in days wiping out billions of people? Are genetically modified organisms a godsend or a global accident waiting to happen? Should we be investing more resources into the development of nuclear fusion reactors or are they another dangerous technology we should avoid? Is it perhaps even possible that a scientific experiment could destabilize the vacuum of space-time sending a wave of Armageddon into the universe at the speed of light?

The answers to such questions are not always as cut and dried as some scientists would make believe, but the answers can be found. All it takes is rational arguments and careful experiments. Where there is uncertainty it can be highlighted for further research. Getting it right is important to everyone. A misguided conclusion could be a disaster for humanity on the one hand, or a missed opportunity for progress on the other. We have the intellectual capacity to figure these things out and steer the right course, yet we fail.

A large part of the problem is simply that the academic processes of peer review are hidden and restricted only to those affiliated with the right institutions. The rest of us are ignored and told that a scientific consensus has been reached that we just have to accept. Never mind that the ones who decide the truth have self-interests driven by the funding that supports them. No matter that many people outside the walls of academia themselves are well educated even up to the level of doctorates. Only the impact factor of journals run for the profits of big corporate publishers and the academic societies are good enough to decide out fate, we are told.

What then should be done to save humanity? I propose that we need open peer review where any person's view can be taken into account and considered rationally. We must base decisions on what is said and done, not on the status of the person reporting it. We must eradicate unethical editorial

practices such as rejecting papers without review simply because of who wrote the paper. Only the content and quality of their work should count, not their race, gender or their affiliation or lack of it.

We are biased

Why then are we so illogical? To answer in a word: "Bias." For the last sixty years behavioural psychologists have studied and classified many types of cognitive bias, social bias and memory bias that affect our thinking processes, replacing good logical conclusions with nonsense ideas. In 2002 the Nobel Prize for economics was awarded to Daniel Kahneman for his pivotal role in understanding how biases affect our decisions in uncertain situations. Previously it had been assumed that only rational processes affect market forces but Kahneman showed that we act with a combination of thought out rational decisions mixed with faster less rational choices that are influenced by cognitive bias. Such biases have now been studied in psychological experiments where people faced with unusual problems act in surprising ways. For example, when asked to estimate the value of a bottle of champagne people can be influenced by the mention of an irrelevant number prior to being asked the question.

Of course it is not just financing reasoning that is affected by bias. Scientific arguments where a level of uncertainty exists can be equally affected. To demonstrate this I will list the top eight biases that in my opinion are the most likely to affect scientific reasoning, in reverse order, but remember, this is just a tiny sample of the biases identified by psychologists that affect our logical reasoning.

8 – **Normalcy Bias** is a mental state that people enter when facing a disaster. They want to believe that everything will be OK. It makes them underestimate the likelihood and severity of potential dangers they face, especially the more serious ones. It leads to people building huge cities in major Earthquake zones and failing to prepare for pandemics.

7 – **Experimenter's Bias** (a.k.a Expectation Bias) is what leads experimenters to adjust an experiment to get the result they expect. Good experimenters are supposed to avoid this by blinding results until the analysis is fixed. The most prominent example of this I know may have happened when ATLAS and CMS were striving towards the discovery of the Higgs boson in 2012. They particularly wanted to reach a 5-sigma result in each experiment with the data they had because if they did not quite make it individually then theorists would combine the results on the back of an envelope. In the run-up to the famous Higgs announcement they reanalysed their results several times, claiming to have found new events that boosted the result and better analysis methods that improved sensitivity. Although the results were supposed to be blinded they adjusted the analysis and "reblinded" to add in a little more data, finally making the 5.0 sigma level for both experiments by a hair's breadth. This gave them cross-sections that were well in excess of the standard-model prediction leading some of us to hope that beyond-SM effects were in play. With the pressure off, more data was collected and the excess went away. Was the excess in fact a measure of the effect of experimental bias?

6 – **Reactive devaluation** is a bias that makes you more likely to disagree with someone about something if you already disagree with them about something else. In one experiment random people in the US were asked to evaluate an argument for bilateral nuclear disarmament but some were told the argument came from Raegan and others that it came from Gorbachev at a time when they were in power. Unsurprisingly the subjects were much more likely to agree with the policy if they thought it came from their own president. It is because of this reactive devaluation that party

politics is an almost one dimensional spectrum of opinions from left to right on diverse subjects from economics to ecology and even religion.

5 – the **IKEA effect** explains why theorists strongly defend their own theories despite the fact that they got there more by a series of accidental direction changes in their academic career than proper logic. We all have more faith and pride in something we built ourselves, whether it's a scientific theory or an item of Swedish furniture.

4 – **In-group favouritism** is simply the preference for ideas that are favoured by people in the same group. It includes gender bias, national bias and everything else linked to prejudice, but the effect can also be detected in much smaller groups. It is the other side of the coin to reactive devaluation and together they are at the root of many bitter "tribal" disputes.

3 – The **Bandwagon-effect** is a form of group-think where people start to believe that something has to be true because lots of other people are saying it is true. My favourite example is that all internet physics pundits (except a few people like myself) think that there is something wrong with energy conservation in general relativity despite good theory that shows that it is conserved and that all arguments to the contrary are easily dismissed. The origins of this particular bandwagon can be traced back to the influence of a small group of influential people who wrote an article about it in the usenet Physics FAQ about 20 years ago [1].

2 – **Confirmation Bias** is one of the most familiar biases and it greatly affects the way we form arguments. It is the tendency to favour arguments that support what we already believe in and to ignore or form counterarguments against those that may contradict it. To put it bluntly, we have a bad habit of forming our opinions too quickly based on incomplete information and other biases. Then we use confirmation bias to back it up. Confirmation bias is near the top of the list because it amplifies the effect of all the other biases overwhelming all attempts at logical argument.

1 – **Bias Blind-spot**. At this point you may be thinking exactly the same as me, namely that I understand and am aware of all these biases to the point where they no longer affect me, making me a wonderfully logical person. Biases are the faults of others who take a different view from me. Sadly not. Bias Blind-spot is what makes us fail to recognise the effects of bias even when we know about them. Everyone is subject to these biases (but perhaps some more than others)

The biases I have listed here are just a small sample of the biases that affect scientific reasoning. These are largely responsible for why humanity is failing to steer itself clear of obvious dangers to its future. How can we better avoid them? The answer is peer-review. If we examine each other's arguments carefully we can root out the biases and come to more logical conclusions, but not just any old peer-review will do. It needs to be good peer-review. Bad peer-review just reinforces the biases.

The problem with peer-review

Peer-review is a cornerstone of science and it takes many forms. The traditional peer-review that we are all familiar with is the formal process orchestrated by academic journals. Experts in the field check a paper and ask for corrections and clarifications before approving for publication, but that is just one part of the process. Most papers are internally reviewed within collaborative groups or by an author's colleagues before they are even made public. Increasingly papers are released as

preprints so that they can be circulated more quickly before publication. This also allows others to point out errors. Formal peer-review is not the end of the process either. Experimental results remain uncertain until they have been replicated and for more theoretical work it is the citations and follow-on work that determines its ultimate importance.

Increasingly the formal part of the review is becoming problematical. The process itself is often too slow for the modern pace of research. In fields like physics this makes it irrelevant for the purposes of checking, so that papers are mostly read and cited in preprint form. In areas like medicine where peer-review is still an essential seal of approval, progress is delayed. There are even risks that work may be plagiarised or deliberately delayed by a rival asked to review it, but thankfully actual cases of this are rare.

It is common for good papers to be rejected by top journals. Often they are rejected by an editor (for a variety of reasons such as lack of importance) without even being sent to a reviewer. This makes it more likely that biases can enter the system. When rejected, the author can submit to another journal. A less prestigious one might accept it. In this way people get a very crude measure of the quality of someone's work by looking at the quality of the journals they publish in. The trouble is that this is very unreliable. A paper may have been rejected several times for good reasons before being accepted. Reviews are hidden and there is no record of reviewer's comments. At the lowest end of the scale there are journals that accept papers for a fee without any proper peer-review.

The system is strongly biased against researchers from institutions that lack a good reputation and even more so for those with no academic affiliation at all. As an independent researcher I have had first-hand experience of this. Recently I made progress with on a well-known 100 year old problem in discrete geometry known as Lebesgue's Universal Covering Problem after experts in the field has said that further progress would be very difficult [2]. Previous work on this problem has been well cited. I submitted my paper to a Geometry Journal and completed steps to create a scopus researcher ID as they requested. This would have given them information about my past publication record in physics and mathematics that gives me a respectable H-index of about 11. A few weeks later I was asked to add my affiliation to the paper so that it could proceed to review. I informed them that I am an independent researcher with no affiliation. Just two hours later I was informed that my submission was not appropriate for the journal. No peer-review had taken place and it was clear to me that the lack of affiliation was the only possible reason for the rejection. I pointed out that the code of practice of the Committee on Publication Ethics that they claim to adhere to forbids rejection in this way. After a few more weeks I was told that they would reconsider.

Instances of bad science that are endorsed by peer-review can have serious repercussions for society, as in the recent case where the UK government spent £580 million on the drug Tamiflu to combat flu epidemics, only to learn that the research was flawed and not properly checked[3].

Why does traditional peer-review persist?

It is one of the great mysteries of the internet age that the system of peer-review by journals has persisted and even flourished despite widespread predictions that the internet would lead to its demise. The arXiv e-print repository was founded just as the World Wide Web appeared and was one of its earliest successes. Many people thought that if scientists could disseminate their work so much more quickly and cheaply in electronic form then the print-based journals would soon die. All it needed was for someone to introduce a new web-based system for peer-review. After all, the hard

work of peer-review and editing on behalf of journals is carried out for free by scientists, while the journals place publications behind expensive pay-walls and take away the author's copyright. There seems to be little upside in the system for the academics.

Twenty years later we are still waiting for this revolution to happen. Why is that? Why do academics still submit to journals and give away their copyright? Why do they agree to review and act as editors for the journals for free? Why don't the academic societies or libraries provide new electronic peer-review services instead of paying huge subscriptions to journals. Why do governments funding agencies agree to perpetuate the traditional publication system? This essay is too short to address these questions fully, but it may be that the answer lies in a system of feed-back loops exploited by corporate journals to preserve their business model.

Authors publish in prestigious journals because this is necessary for their CV, even if there is no other reason. A candidate for a new academic role is judged on the quality of his publication list and this is measured largely by the impact factors of the journals he publishes in. It takes time for a new journal to build up a good impact factor and new ways of doing peer-review are even harder to slot into the system. Researchers agree to perform the often unpopular task of peer-review for free because the journals hire the most respected academics in the field as editors and these are the people everyone needs to impress to get a new position in the cut-throat academic job market. Editors perform their role for free because being the editor of a major journal is a privileged position that gives them a unique picture of who is active in the field as authors and reviewers. Breaking this cycle of practicalities is very hard.

In January 2012 a group of mathematicians organised a boycott of Elsevier publishers because of their high subscription rates and bundling practices that cost university libraries large sums of money. They saw open access as the key to breaking the journals business model and encouraged governments to require that all publically funded research must be published in an open access form. Some governments have agreed that open access is important so that businesses have easy access to scientific research, but the publishers lobbied to have open access on their own terms. In the UK the Finch report led to a new policy on open access but it also aimed to support the corporate publishers [4]. The government allocated a proportion of science funding to pay for the gold open access model to pay up-front for publication in existing journals, which the libraries also continue to pay for. Elsevier's share price which is listed on the London stock exchange had previously been stagnant, but since the start of the Cost of Knowledge Boycott it has risen to nearly twice it's value in two years.

Principles for a new peer-review

I firmly believe that for humanity to steer its future we need a new system of peer-review to replace the journal based system. Without a solid means to judge the validity of research how can we make decisions on issues such as climate change or prepare properly for disasters such as floods and epidemics without wasting valuable resources on foiled research? For a new system I propose 6 basic principles:

(1) Publication must be separate from peer-review
(2) The process of peer-review must be public and openly recorded (whether anonymous or not)
(3) Everyone must be allowed to have their say whether expert of not
(4) All conclusions are subject to revision in the light of new evidence
(5) Logical arguments and evaluation must be designed to combat bias
(6) Open access to data should be an important requirement where applicable

The new movement to open peer-review

Now that open-access in academic publication has sufficient momentum we need to move to the next step – open peer-review. Ideally this should adhere to the principles I have outlined above. Already some examples of this change are coming into effect. I believe that it will be open peer-review rather than open access that finally breaks the business model of corporate publishers.

Repositories following the model of arXiv are now becoming prevalent in all the important areas of academic research. These support and promote the idea that publication should come before peer-review which is necessary for speed and so that research can be judged openly. Most of the repositories have some level of filtering to remove research considered to be pseudoscience, e.g. the endorsement and moderation policies for arXiv. This is unnecessary if we recognise that acceptance by a repository does not constitute an endorsement of any work of research. A repository is just a means to make research available immediately so that it can be independently time-stamped for the purposes of establishing priority and to make it available for evaluation by open peer-review. Only articles that may violate laws or cause liable need to be rejected at this stage.

One of the few repositories that is fully open to submissions is the one I founded myself in 2009 – viXra. This was designed to fill the hole created by arXiv's policies that reject many papers, often simply because the authors do not have access to someone who can endorse them. Even with such endorsements arXiv moderators can reject papers for a wide range of reasons in a closed process where often the justification is not given. For example, I used to wonder why so few references to papers on viXra appeared on arXiv until one author forwarded me an e-mail from an arXiv moderator in which he was asked to remove a citation of a paper on viXra to allow acceptance of his submission.

viXra's separation of publication and peer-review is very unpopular with academics who fear the open publication of pseudoscience without realising that this does not mean it is being given any greater credibility than if it was published on a blog. As well as the suppression by arXiv we found that many university departments forbid their researchers to use viXra. Sometimes they have told us that they are forced by their department heads to withdraw submissions. Papers from viXra used to be listed on Google Scholar but as our success mounted Google decided to quietly block all viXra papers in the search engine. We also used to be included in HEP-SPIRES but after CERN took charge and moved the database to inspirehep we are no longer added. These exclusions are a nuisance because they make ti hard to measure how many citations viXra papers receive. Nevertheless, we continue to flourish with a rapidly increasing submission rate and there are still plenty of places that do not automatically judge a viXra paper without regard.

One feature of viXra that you will not find on arXiv is the ability to comment on papers. While most papers receive no feedback at all there are some that generate useful comments that can serve as a defacto open peer-review even for papers that might be rejected without comment by many journals.

ViXra is not the only place where open peer-review is slowly taking hold. At the other end of the scale many high profile discoveries are announced publically before the process of peer-review begins and within days they have been openly supported or criticised on social media such as facebook or specialist blogs. Some examples of this include Perelman's proof of the Poincaré conjecture (accepted in open peer-review), Deolalikar proof of P vs NP, (refuted), The claimed sighting of a meteoroid during a skydive (refuted), BIXEP2 results (conditionally accepted pending confirmation) and many more.

The recent case of the Meteoroid sighting is of particular interest because of the biases that appear to have misled the experts [5]. It may have been the case that they knew their subject too well and therefore found many clues that seemed to confirm their initial hopes that the rock captured on the skydiver's camera was a meteoroid. Even an optical illusion played its part. They were convinced that it was a large heavy fast moving meteorite from its appearance on the wide angle camera. However, when the news was made public after two years of checking, many non-experts quickly expressed scepticism and suggested either a hoax or that it was a small rock falling from the parachute. The reason was simply that the probability of a meteoroid in its dark flight phase being captured on a skydivers camera is incredibly small given that nobody has ever seen this on the ground. With a fresh perspective they also realised that the video could equally well be explained as a small stone much nearer the camera moving slowly. Confirmation bias had made the experts reject these arguments against their beliefs. After only a few days of public comment it was acknowledged that the rock-in-the-chute theory was most likely correct.

For the large bulk of papers however, such open peer-review is still a dream. It is hard to overcome the practices that keep the traditional system going. To bring change it will be important to recognise the forces that are at play. In particular it will require the support of leading academics to convince researchers that publications which pass open peer-review will be valued on people's CVs.

But already progress is being made. PloS is encouraging a system of open peer-review for some of its papers. Philica is an experimental repository set up by social scientists that uses a system of open peer-review for all fields. Just today I heard that ResearchGate has also launched a new open review feature. There are many more example springing up and hopefully open-review will soon be the norm.

Unbiased evaluation

The hardest part of open peer-review will be to design a system of unbiased evaluation. Some early systems are likely to continue to rely on expert peer-reviewers but that will mean that part of the process remains as separate discussions in social media. How do you let anyone have their say while still maintaining an orderly process and arriving at an unbiased conclusion?

The answer to that is not yet clear but there is hope that letting anyone have their say is not necessarily a recipe for disaster. Wikipedia is a good example of a system that allows anyone to contribute. It is not perfect yet it is not completely filled with nonsense. The secret to success there

is a carefully set out system of rules for deciding what is acceptable. Another example is the stackexchange web-sites which allow anyone to answer questions and the best are rated by other users. Again it does not always work perfectly but similar evaluation systems can be adapted for use in open peer-review.

The most important requirement is to prefer arguments that favour logical reasoning over biased judgements. It will not be easy but I think someone will find the right way to do this and the world will be a better place.

References

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