Publication ethics and the Centre for Nanoscale BioPhotonics: towards an enduring legacy of best practice

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This draft document outlines the need for strong leadership in the space of research integrity and publication practices. It covers issues of authorship, reproducibility, acknowledgements, conflict of interest, and correction of the scientific record. I note that although such issues are regularly reported as causing problems that range from lost productivity through to ruined careers, this document is a *proactive* document designed to begin the establishment of a framework of best practice, rather than a reactive document responding to any specific criticism or failure in the governance of the ARC Centre of Excellence for Nanoscale BioPhotonics

I. INTRODUCTION

Science has at its heart, communication. Communication in terms of immediate collaborations, scientific discourse, briefings and outreach with stakeholders (including the general public), and communication with generations of scientists past and future through the literature. Because of the central role of communication in science, it is important that best practice be observed through that communication.

The question of best practice in communication is likely to be personal and to vary between sub-disciplines. Nevertheless, we believe that there are certain norms that are essential for scientific communication. Although much of what follows may seem self-evident or 'common sense', it is nevertheless important to articulate the principles of best practice so that misunderstandings and the creep of poor practice should not be allowed to take hold.

There are many ways to understand and analyse the practice of science. Certainly the development of science cannot be divorced from the scientists and their environment, and this leads to the Sociology of Science [1]. It is not the purpose of this document to explore such sociologies. Instead we take as our central tenet that the goal of scientists is to extend the scientific record and to always ensure the integrity of our understanding of science. In short, the integrity of scientific discourse is our primary aim.

There are many reasons why integrity is the key. Falsified results have a detrimental impact on world science by diverting resources from productive activities and shining positive attention away from diligent works, see for example the Schön scandal [2]. Mistakes in research (including cherry picked data) can also lead to false impressions that, although not as serious as deliberate misconduct, can slow down scientific progress.

Lack of integrity seriously damages peoples reputations. For example, young scientists whose contributions are ignored or downplayed in the author list may lose career opportunities. Conversely, senior scientists with little contribution or scientific interest in a particular work may dilute perceived impact of the authors who 'actually did the work'. Without open and fair criteria for authorship, collaborations run the risk of compartmentalising their science which restricts communication.

Fairness, efficiency and integrity are common themes in this document, and it is important to stress why we believe these themes are necessary. Some of this rationale is summarised below:

- *Our funders demand it*: As recipients of public money, we have an obligation to use those funds as efficiently as possible and to the best of our ability. We must never forget that these funds are provided to generate outcomes, and that we are competing with many other worthy scientific causes, but also other public good causes.
- *Our science changes lives*: Whatever the time to outcome for the research that we perform, we believe that our research will results in some positive benefit for humanity. That may be an improved diagnosis or therapy, or some new insight into scientific processes. In every case, the speed of translation leads to enhanced outcomes and there is therefore a significant opportunity cost for lack of efficiency.

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- *We must be seen positively by our wider community*: We live in an age where science is more important than ever, yet paradoxically, mistrust of science and scientists is also increasing (see for example [3]). To overcome perceptions of bias, collusion and elitism requires us to communicate honestly, collegially and clearly.

Within such a framework, this document is designed to outline our approach to scientific publishing best practice. This document is designed to provoke comment and feedback, so it should not be considered a final document in any sense of the term. Topics to be explored are: Authorship, Reproducibility, Acknowledgements (funding and scientific), conflicts of interest, and corrections to the scientific record.

II. AUTHORSHIP

Authorship, including author order, is an issue for many scientists, especially early career researchers who may feel confused and/or disempowered when it comes to this topic. Authorship is necessary to recognise contributions to work and is used as a standard metric in considering career progression (including suitability for positions and funding). Conversely, ghost authorship (where someone who should be an author is deliberately left off) can hide conflict of interests and thereby skew the understanding of the scientific literature [4]. The official CNBP policy on authorship is described in the CNBP Authorship Policy [5]

There are a number of different protocols that have been discussed for authorship, and some minor variants for different sub disciplines, however the approach that appears to be gaining most traction is the Vancouver Protocol (which covers publishing in general). This statement of authorship from the International Committee of Medical Journal Editors (ICMJE) [6] states

> The ICMJE recommends that authorship be based on the following 4 criteria:
>
> - Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
> - Drafting the work or revising it critically for important intellectual content; AND
> - Final approval of the version to be published; AND
> - Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
>
> In addition to being accountable for the parts of the work he or she has done, an author should be able to identify which co-authors are responsible for specific other parts of the work. In addition, authors should have confidence in the integrity of the contributions of their co-authors.

Note the following important restrictions on authorship (from a statement of the Vancouver principle from Macquarie University [7])

> Participation solely in the acquisition of funding or the collection of data does not justify authorship. General supervision of the research group is not sufficient for authorship.

III. REPRODUCIBILITY

Lack of reproducibility in scientific results is a serious problem world wide [8, 9]. The causes for such issues are complex, multi-faceted, and in many cases likely unknowable. According to a recent *Nature* survey, "More than 70 % of researchers have tried and failed to reproduce another scientists's experiments, and more than half have failed to reproduce their own experiments." [9] These results suggest that peer review is only one part of the publication route, we must be prepared for our results to be scrutinised for years to come, and if our science cannot bear such scrutiny then we are open to a loss of our reputation.

A. Scientific fraud

Lack of reproducibility can come from a number of factors, and understanding some of the motivation can help in mitigating such effects. Cases of outright fraud are fairly rare, although these can occur. Goodstein [10] made an extensive study of scientific fraud and comments

> Among the incidents of scientific fraud that I have looked at, three motives, or risk factors, have been present. In all the cases, the perpetrators (1) were under career pressure, (2) knew, or thought they knew, what the result would be if they went to all the trouble of doing the work properly, and (3) were in a field in which individual experiments are not expected to be precisely reproducible. Simple monetary gain is seldom, if ever, a factor in scientific fraud.

Goldstein also notes that of the cases he personally investigated in 1980 to 1986,

> twenty-one came from the biomedical sciences, two from chemistry and biochemistry, one from physiology, and two from psychology.

It is important to note that the most infamous recent fraud in physics, that of Jan-Hendrik Schön (see for example Reich [11]) has all of the motives discussed by Goldstein.

One important factor is that fraudsters appear to start with small indiscretions that yield positive (short term) benefits for them. In this way a pattern of increasing misconduct can start from relatively small beginnings. It is therefore important for supervisors and senior academics to appropriately mentor more junior scientists and students, to encourage open and positive discussion of failures, negative or problematic results, and wherever possible to limit career pressure. Although there can never be grounds for complacency on such a significant topic as scientific fraud, the Nurturing environment and the culture of collegiality and openness that has been fostered within the Centre is a strong guard against the risk factors that promote scientific fraud.

B. Cherry picking and data manipulation

The same risk factors that lead to scientific fraud can also lead to less serious, but still significant, cases of misconduct with regards to the representation of results. Cherry picking is where sometimes atypical or 'special' cases are presented as if the are representative of wider trends. Related to this is data manipulation where results may be altered, perhaps to account for some poorly characterised noise signal or offset.

Often such cases can occur due to pressure, or simply a feeling that the trends are understood by the researchers, but the data just doesn't show it. In other words, the manipulation may be well intentioned rather than a deliberate attempt to defraud the scientific community. In certain cases, the manipulation may not even be recognised as such by the manipulator. To counter such misconduct, early mentoring in appropriate scientific practice must be performed. Data must be scrutinised in open and collegial settings, with the researchers prepared to defend their results and the implications of those results. The Centre has good processes in place, with student and postdoctoral seminars, as well as supervisors routinely meeting with junior researchers. Nevertheless, for best feedback and opportunities to prevent problems taking hold, such seminars must be honest and fearless in presenting all data including limitations to the current research. In other words, if a culture that presentations should only present final results is allowed to persist, then this can make junior researchers stressed about poor quality or incomplete results, which in turn creates incentives to 'massage' data. Again, actions to avoid such a culture from taking hold are already outlined in the CNBP strategy document [12]

IV. CORRECTIONS TO THE SCIENTIFIC RECORD

Although every effort must be taken to ensure that publications are correct, it is acknowledged that errors can happen. This can be due to misconceptions or misinterpretations or results, equipment malfunctions, or inadvertent generalisations of rare events (when deliberate, this is often referred to as *cherry-picking*, as discussed above). To make a mistake is not, by itself, scientific misconduct. However, it is important to correct the scientific record as soon as is practicable to avoid any perception of misconduct.

There are several avenues for correcting the scientific record, depending on the scale of the correction that is required.

Errata/Corrigenda: Errata are typically errors introduced by the publishers, e.g. of a typographical nature, whereas corrigenda are often minor errors. Where noticed, the authors should contact the journal with a short letter (often suitable for publication) briefly describing the what corrections are required, and the effect of those corrections on the conclusions of the work. In most cases, journals will not change the original publication, but will often include a link to the correction.

Comments: Many journals allow comments. Quoting from the Physical Review A editorial policies [13]

> Comments are publications that criticize or correct papers of other authors previously published in Physical Review A. Each Comment should contain an abstract and should state clearly the paper to which it refers.

> To be considered for publication, a Comment must be written in a collegial tone (free from polemics) and must be pertinent and without egregious errors. A Reply to a Comment must also conform to these requirements.

Perspective and review articles: Where a misunderstanding or misinterpretation is widespread within a particular field, sometimes the best way to reach a wide audience is through the use of influential, agenda setting articles. Certainly for wide-spread misunderstandings, individual comment style articles are unlikely to have much impact, and can even be misconstrued as being unfair to the authors commented on. Where an entire field has a misconception about a particular idea, it is unlikely that correction of that misconception will occur from low impact, low readership type articles. Conversely, articles that demonstrate wide-spread confusion in the literature, or that critically evaluate a field can have very high impact and are likely to be of wide interest and scientific importance.

Retraction: Retraction of papers is typically an extremely serious step and not to be taken likely. Again, quoting from the Physical Review A editorial policies [13].

> A Retraction is a notice that the paper should not be regarded as part of the scientific literature. Possible reasons for this include, among others, presentation of invalid results and inclusion of results that were published previously in substantially similar form. (In the latter case, the prior publication, not the retracted article, should be regarded as the source of the information.) To protect the integrity of the record, the retracted article is not removed from the online journal, but notice of Retraction is given. Retractions are sometimes published by the authors when they have discovered substantial scientific errors; in other cases, the editors conclude that a retraction is appropriate. In all cases, the Retraction indicates the reason for the action and who is responsible for the decision. If a Retraction is made without the unanimous agreement of the authors, the approval of the Editor in Chief of APS is required.

V. ACKNOWLEDGEMENTS

The Acknowledgements section of a paper is one that is, unfortunately, often not regarded with sufficient importance. There are several roles that this section plays in a publication. The first is in the acknowledgement of necessary scientific contributions to a publication that, although important, do not qualify a person for authorship. This may be of the style of 'useful conversations', or work of a purely technical nature (e.g. routine data collection not involving scientific evaluation of the obtained results).

Acknowledgement of funding is an essential feature of any funded research. It is necessary for several reasons. It is necessary to publicise publicly funded research, and so funding bodies require pithy statements to identify what research has been funded under which scheme. This derives from issues of accountability and demonstration of appropriate use of public monies. It also provides an opportunity for funding bodies to identify and advertise their science, which leads to a virtuous cycle of improved outcomes and good will towards scientific endeavours.

In addition to the positive aspects of the acknowledgement of funding, the identification of potential bias through funding also needs to be highlighted. There are examples in the literature of research funded by industry bodies where questions have been raised as to the independence of that research (see for example extreme examples from the tobacco industry [14]), although it must be stressed that funding by for-profit organisations should certainly not be considered as negative and does not necessarily lead to different reporting from not-for-profit funded research [15], instead the research funding must be transparently reported and the science conducted honestly and without bias.

In reporting public funding, there are several standard templates that can be used. Such acknowledgements should typically include the grant numbers for all funded grants (including fellowships and LIEF grants), and may also include access to facilities or infrastructure (including National Computing Infrastructure and major laboratory infrastructure of national or international significance).

VI. CONFLICTS OF INTEREST

Conflicts of interest are common eventualities across many spheres of endeavour, and all university institutions have policy documents that define and manage them. The Australian Research Council defines a conflict of interest as [16]

> A conflict of interest is a situation in which someone in a position of trust has competing professional or personal interests. Such competing interests could make it difficult for an individual to fulfil his or her duties impartially, and potentially could improperly influence the performance of their official duties and responsibilities.

The ARC then proceeds to define two distinct forms of conflict of interest, and these definitions are useful

> An **apparent** (or perceived) conflict of interest exists where it appears that individual private interests could improperly influence the performance of their duties and responsibilities whether or not this is, in fact, the case. Individuals must be conscious that perceptions of conflict of interest may be as important as an actual conflict.
>
> A **potential** conflict of interest arises where an individual has a private interest which is such that an actual conflict of interest would arise if the member were to become involved in relevant (that is conflicting) official duties and responsibilities in the future.

Conflicts of interest are inevitable and therefore *transparent* management of them is necessary. The key is to identify and declare as early as possible any actual or potential conflicts of interest. Management of such conflicts will typically be handled on a case by case basis. In some cases the interest merely needs to be noted, in other cases conflicted parties may need to be removed from particular decision-making responsibilities as required. Sometimes, conflicts may not be apparent when activities are commenced, they only become apparent during an activity. Again, the key requirement is to declare an apparent or potential conflict of interest as soon as it is noticed.

It is important to stress that the perception of a conflict of interest can be as damaging as an actual conflict of interest. For this reason it is better to declare and note possible conflicts early and with reference to what an outside observer may think. For this reasons it is usually not advisable for someone to make decisions on what constitutes an apparent conflict of interest alone - it is better to discuss apparent conflicts of interest to get external validation.

Finally, conflicts of interest are usually framed in the context of providing unfair benefit to an individual. However enmity towards an individual can also be seen as a conflict of interest.

In all cases the Centre must act and be seen to act fairly in all its dealing. Transparency and appropriate recording of conflicts of interests (apparent and potential) is therefore important to maintain our high reputation.

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