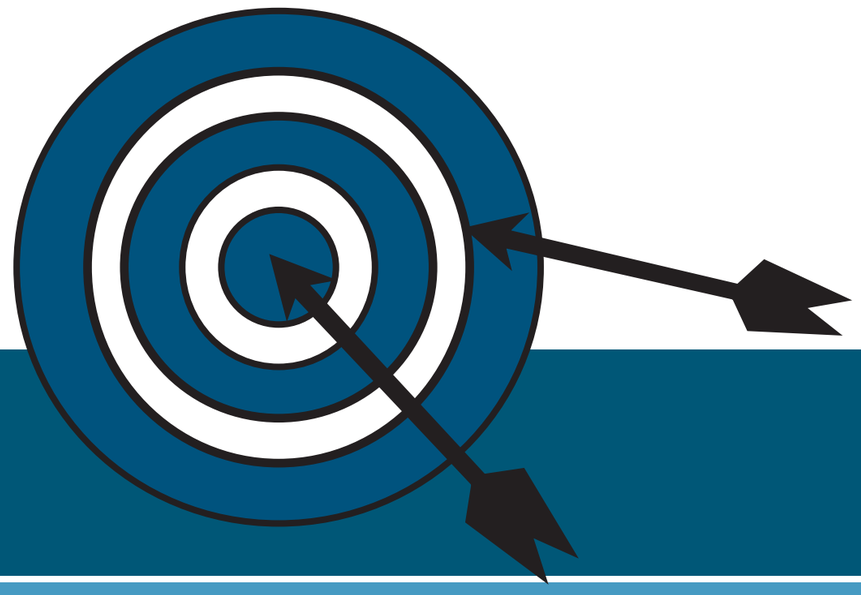
Collaborative effort needed to address the ‘Reproducibility Crisis’



Some large-scale efforts to reproduce scientific findings have been unsuccessful. Reproducibility depends on robust design, and also the availability and transparency of the data and methods.

‘Reproducibility’ – the ability of a researcher to duplicate the results of a prior study using the same materials and procedures as were used by the original investigator. (National Science Foundation)

Selected high-profile publications revealing the crisis

2005

John Ioannidis publishes his landmark paper in Plos Medicine titled: ‘Why most research findings are false’.[1]

2011–2015

‘Reproducibility Project: Psychology’, led by Brian Nosek, co-founder of the Center for Open Science, attempted to replicate 100 original psychology studies. Only 36% could be replicated.[2]

2012

Biotech company Amgen set out to confirm cancer research findings. 47/53 preclinical research papers could not be reproduced.[3]

2013 to present

‘Reproducibility Project: Cancer Biology’ aimed to replicate 50 preclinical studies published in *Nature, Science* and *Cell*. Early findings indicate these papers do not contain sufficient details about the method to allow them to be reproduced.[4]

2014

Prominent *Nature* survey revealed the perception of a reproducibility crisis among researchers (see Figure 1).[5]

2017

Munafò, Nosek and co-authors propose the adoption of key measures for reproducible science in their manifesto.[6]

Contributing factors underpinning the crisis

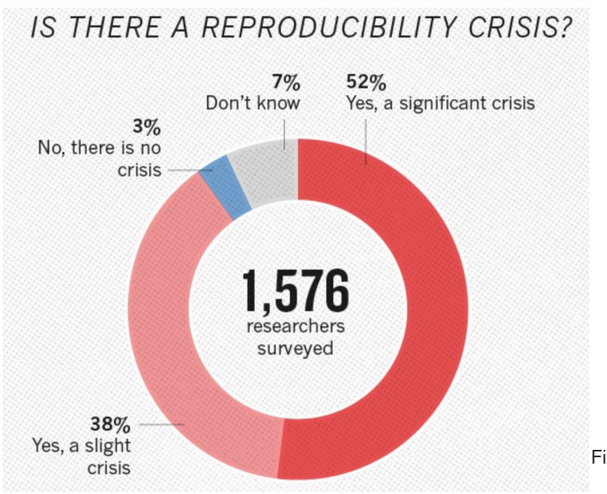


Figure 1. Reprinted by permission from Macmillan Publishers Ltd: *Nature* (doi: 10. 1038/533452a), copyright (2016)

- Quality of reporting (i.e. insufficient detail to replicate the experiment)
- Data not made available
- Poor experimental design (e.g. no blinding or randomisation and low statistical power)
- Misinterpretation of data and cognitive bias
- Selective reporting
- Pressure to publish

Potential initiatives from stakeholders

Researchers

- Follow appropriate guidelines for experimental design[7]
- Make research processes transparent and accessible (e.g. ARRIVE guidelines for reporting animal studies)
- Adopt data management, sharing and storage procedures and guidelines
- Participate in open peer-review processes
- Provide mentorship to early career researchers
- As a peer reviewer, closely scrutinise the experimental section and statistical analysis

Funders

- Promote study pre-registration (where relevant)
- Provide incentives for open-science practices
- Allocate funding for replication studies
- Discourage awardees from publishing in predatory journals
- Use checklists to ensure robust experimental design
- Enforce greater transparency of open data and methods

Publishers

- Improve the quality of reporting
  - Increase transparency and openness (TOP guidelines)
  - Consolidated Standards of Reporting Trials (CONSORT)
  - Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
  - Use field-specific checklists upon submission
- Incorporate pre- and post-publication peer review
- Avoid actively promoting impact factor (DORA guidelines)
- Encourage the publication of replication studies and negative findings

Institutions

- Invest in methodological training particularly in research design and statistical analysis
- Acknowledge and provide incentives for open-science practices
- Support open-access initiatives
- Provide access to tools that facilitate reproducible research

Working together at Monash

- Facilitating research transparency by providing a repository for sharing and archiving data and research outputs e.g. monash.figshare
- Librarians and research managers partner to provide in-house education, advice and resources for researchers
- Provision of consulting services for statistical methods and approaches

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