

Research Ecosystems and Research Quality

Marcus Munafò



Committees

[UK Parliament](#) > [Business](#) > [Committees](#) > [Science and Technology Committee](#) > [Reproducibility and research integrity](#)

Reproducibility and research integrity

Inquiry

As the UK seeks to recover from the pandemic, research and innovation has the ability to drive economic growth, with UKRI estimating that every £1 spent on research and development delivers £7 in economic and social benefit. However, the integrity of research, especially medical and social science research, is at risk from what is known as the 'reproducibility crisis' (i.e. it being very difficult or impossible to replicate a scientific study).



Research integrity: a landscape study

June 2020



Science is Self-Correcting



Why Science Is Not Necessarily Self-Correcting

John P. A. Ioannidis

Stanford Prevention Research Center, Department of Medicine and Department of Health Research and Policy, Stanford University School of Medicine, and Department of Statistics, Stanford University School of Humanities and Sciences

Perspectives on Psychological Science
7(6) 645–654
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DOI: 10.1177/1745691612464056
<http://pps.sagepub.com>



HOME > SCIENCE > VOL. 274, NO. 5292 > ASSOCIATION OF ANXIETY-RELATED TRAITS WITH A POLYMORPHISM IN THE SEROTONIN TRANSPORTER GENE REGULATORY REGION

REPORT



Association of Anxiety-Related Traits with a Polymorphism in the Serotonin Transporter Gene Regulatory Region

[KLAUS-PETER LESCH](#), [DIETMAR BENG](#)

SCIENCE • 29 Nov 1996 • Vol 274,

HOME > SCIENCE > VOL. 297, NO. 5580 > SEROTONIN TRANSPORTER GENETIC VARIATION AND THE RESPONSE OF THE HUMAN AMYGDALA

REPORTS



Serotonin Transporter Genetic Variation and the Response of the Human Amygdala

[AHMAD R. HARIRI](#), [VENKATA S. MATTI](#)

SCIENCE • 19 Jul 2002 • Vol 297,

HOME > SCIENCE > VOL. 301, NO. 5631 > INFLUENCE OF LIFE STRESS ON DEPRESSION: MODERATION BY A POLYMORPHISM IN THE 5-HTT GENE

REPORTS



Influence of Life Stress on Depression: Moderation by a Polymorphism in the 5-HTT Gene

[AVSHALOM CASPI](#), [KAREN SUGDEN](#), [TERRIE E. MOFFITT](#), [ALAN TAYLOR](#), [...], AND [RICHIE POULTON](#)

[+6 authors](#) [Authors Info & Affiliations](#)

SCIENCE • 18 Jul 2003 • Vol 301, Issue 5631 • pp. 386-389 • DOI: 10.1126/science.1083968

N ~ 500





Slate Star Codex

5-HTTLPR: A POINTED REVIEW

POSTED ON MAY 7, 2019 BY SCOTT ALEXANDER

“This isn’t just an explorer coming back from the Orient and claiming there are unicorns there. It’s the explorer describing the life cycle of unicorns, what unicorns eat, all the different subspecies of unicorn, which cuts of unicorn meat are tastiest, and a blow-by-blow account of a wrestling match between unicorns and Bigfoot.”



The Serotonin Transporter Length Polymorphism, Neuroticism, and Depression: A Comprehensive Assessment of Association

Saffron A.G. Willis-Owen   • [Maria G. Turri](#) • [Marcus R. Munafò](#) • ... [Nick W.J. Wainwright](#)

[Richard D. Brixey](#) • [Jonathan Flint](#) • [Show all authors](#)

Published: July 18, 2005 • DOI: <https://doi.org/10.1016/j.biopsych.2005.04.050>

N ~ 100,000



Gene × Environment Interactions at the Serotonin Transporter Locus

[Marcus R. Munafò](#)   • [Caroline Durrant](#) • [Glyn Lewis](#) • [Jonathan Flint](#)

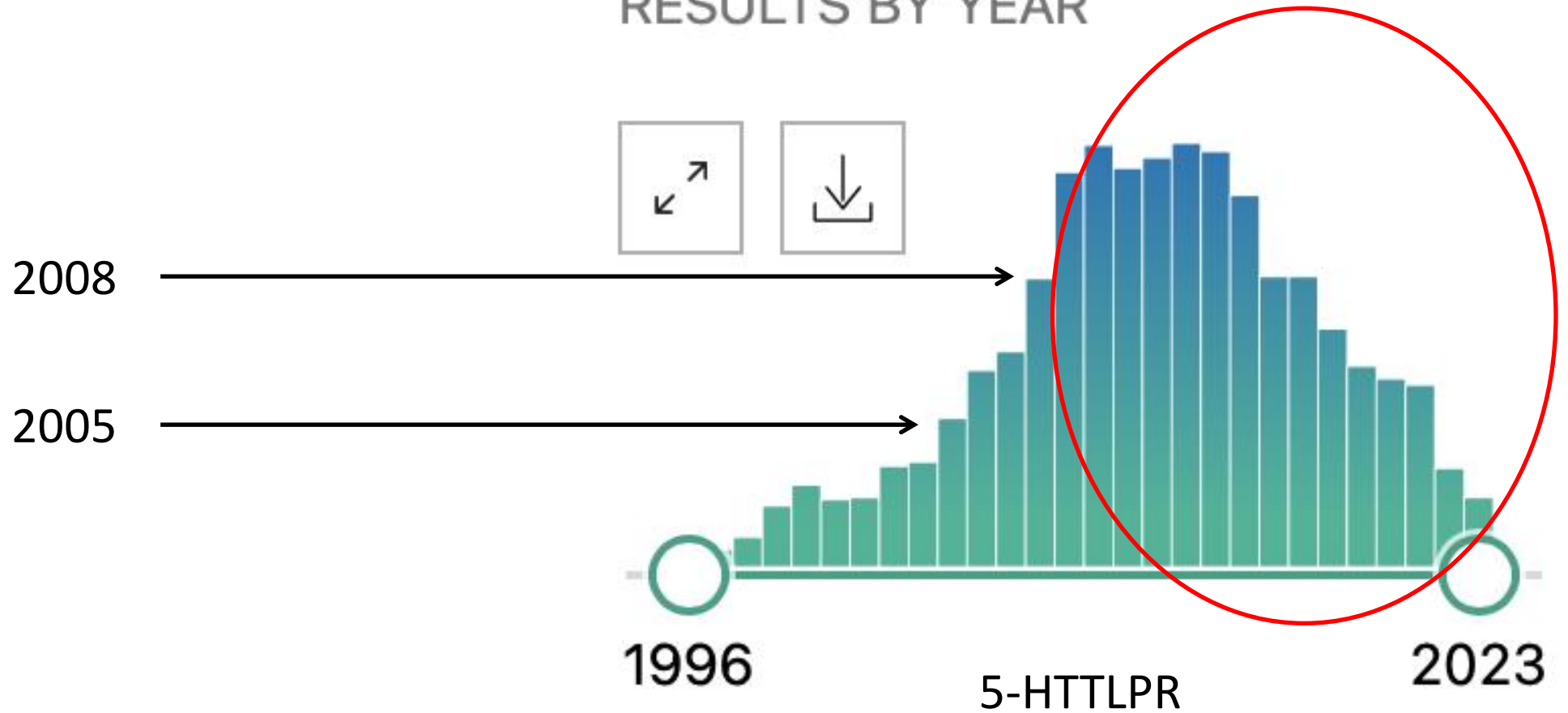
Published: August 11, 2008 • DOI: <https://doi.org/10.1016/j.biopsych.2008.06.009>

“Given reasonable assumptions ... our simulations indicate that published studies are underpowered. This ... leads us to suggest that the positive results for the 5-HTTLPR × SLE interactions in logistic regression models are compatible with chance findings.”



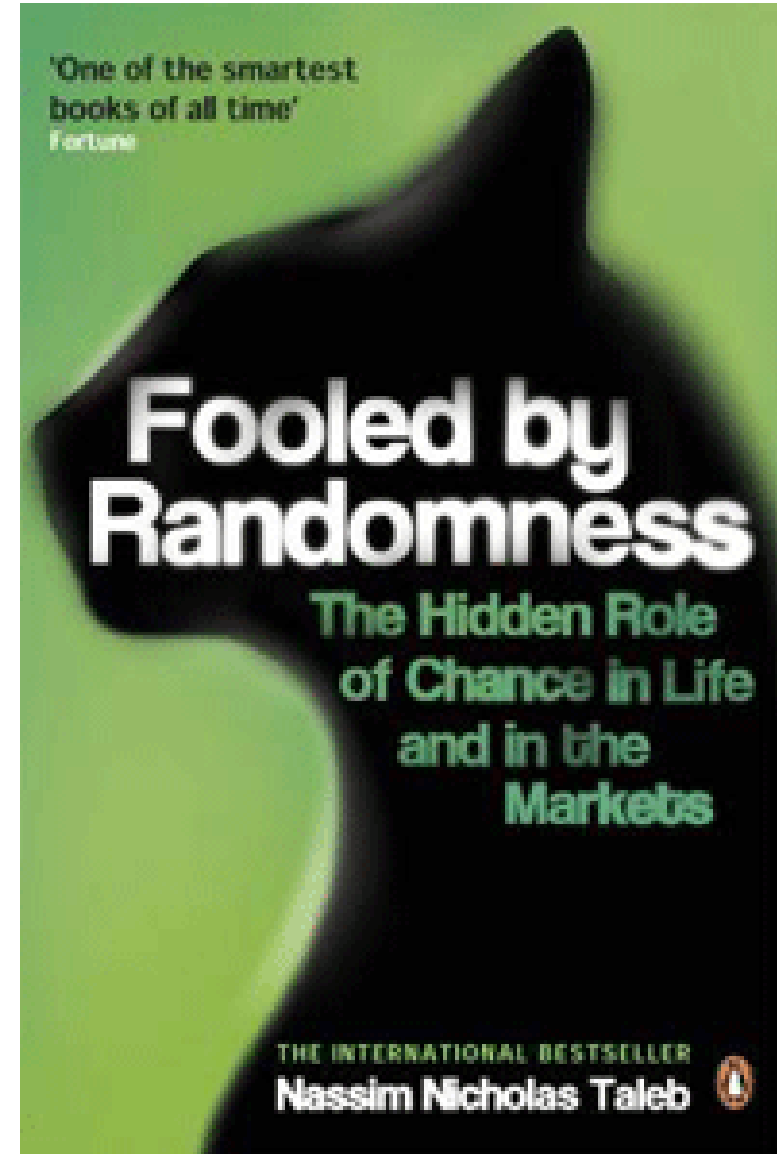
Science is self-correcting?

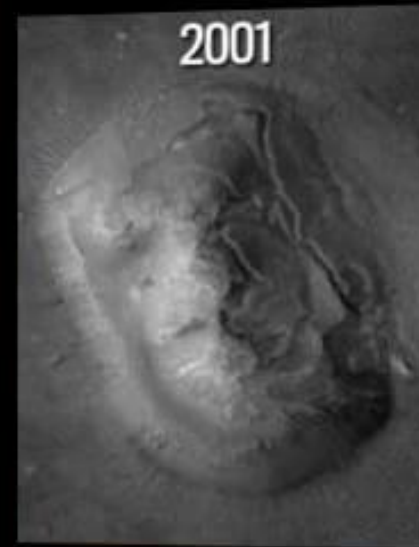
RESULTS BY YEAR



“Scientists may be in the business of laughing at their predecessors, but owing to an array of human mental dispositions, few realize that someone will laugh at their beliefs in the (disappointingly near) future”

Taleb (2007). Fooled by Randomness.





COMMENTARY

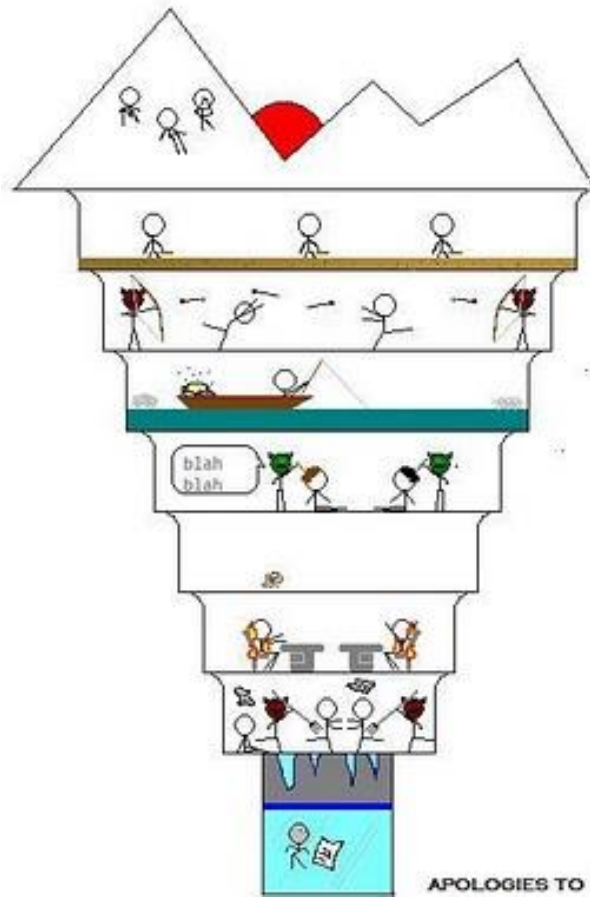
Scientists behaving badly

To protect the integrity of science, we must look beyond falsification, fabrication and plagiarism, to a wider range of questionable research practices, argue **Brian C. Martinson, Melissa S. Anderson** and **Raymond de Vries**.

“Certain features of the working environment of science may have unexpected and potentially detrimental effects on the ethical dimensions of scientists’ work”

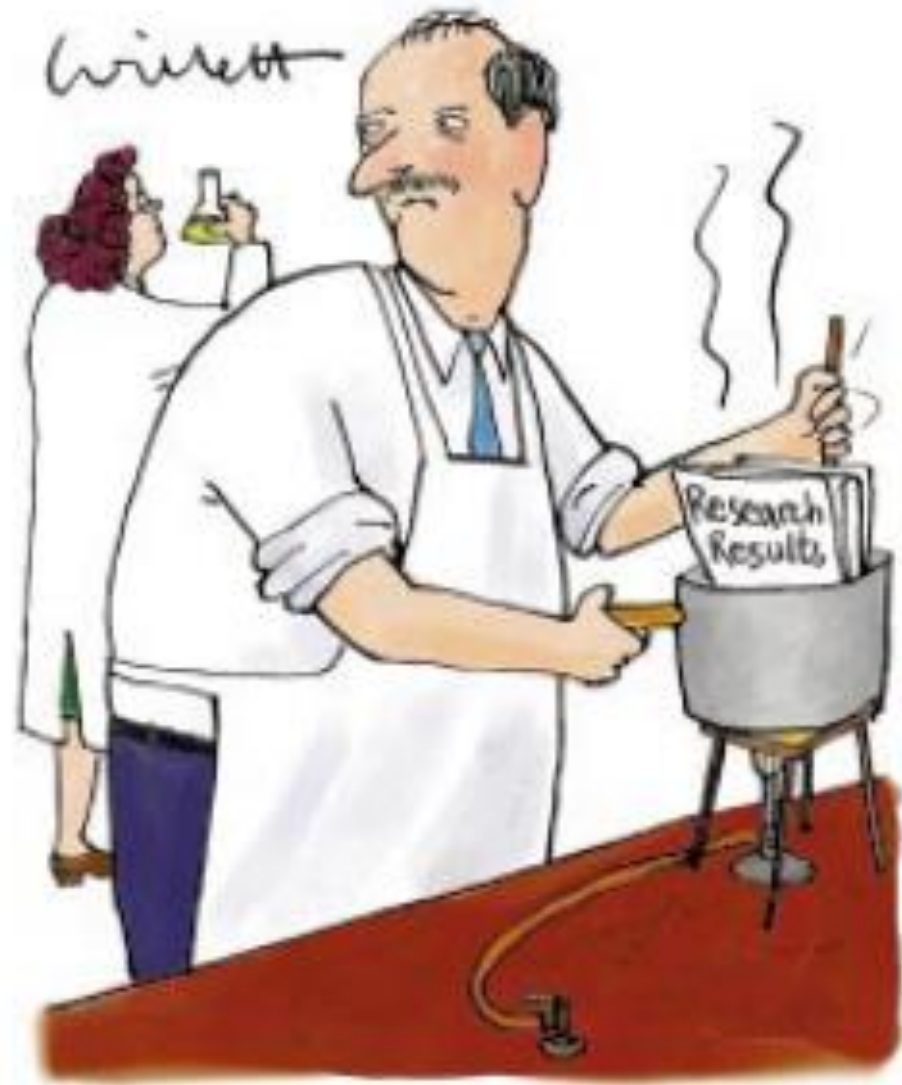
Martinson et al. (2005). *Nature*, 435, 737-738.





APOLOGIES TO DANTE, XKCD

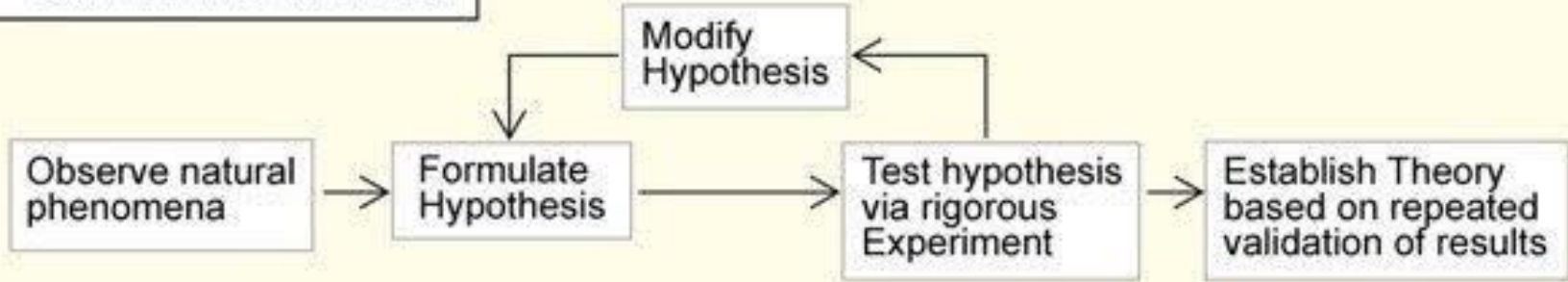
- I Limbo
- II Overselling
- III Post-Hoc Storytelling
- IV P-Value Fishing
- V Creative Outliers
- VI Plagiarism
- VII Non-Publication
- VIII Partial Publication
- IX Falsification



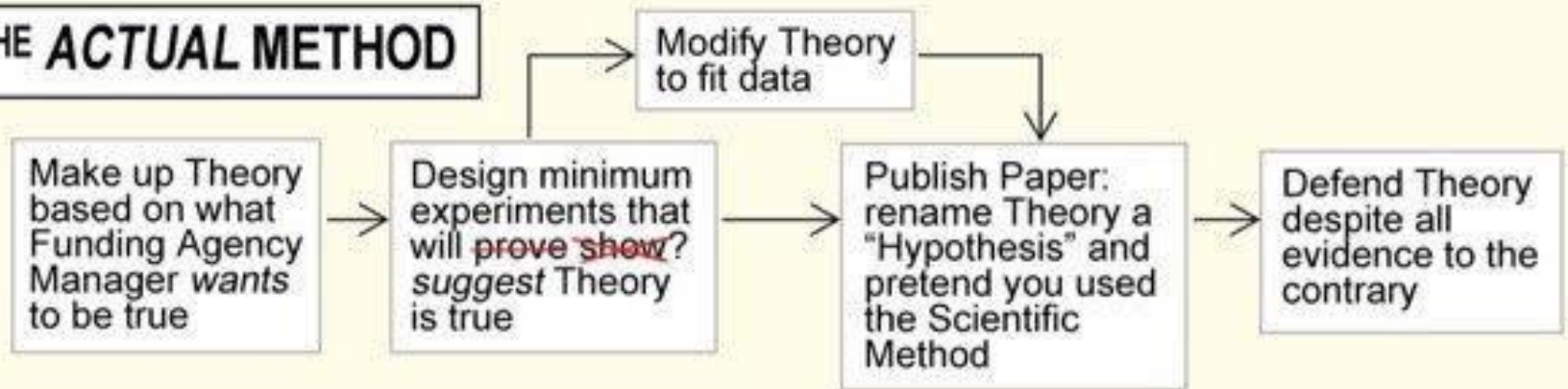
Neuroskeptic (2012). *Perspect Psychol Sci*, 7, 643-644.

Real Scientific Method

THE SCIENTIFIC METHOD



THE ACTUAL METHOD



www.phdcomics.com



False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant

Psychological Science
22(11) 1359–1366
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DOI: 10.1177/0956797611417632
http://pss.sagepub.com
SAGE

Joseph P. Simmons¹, Leif D. Nelson², and Uri Simonsohn¹

¹The Wharton School, University of Pennsylvania, and ²Haas School of Business, University of California, Berkeley

Using the same method as in Study 1, we asked 20–34 University of Pennsylvania undergraduates to listen only to either “When I’m Sixty-Four” by The Beatles or “Kalimba” or “Hot Potato” by the Wiggles. We conducted our analyses after every session of approximately 10 participants; we did not decide in advance when to terminate data collection. Then, in an ostensibly unrelated task, they indicated only their birth date (mm/dd/yyyy) and how old they felt, how much they would enjoy eating at a diner, the square root of 100, their agreement with “computers are complicated machines,” their father’s age, their mother’s age, whether they would take advantage of an early-bird special, their political orientation, which of four Canadian quarterbacks they believed won an award, how often they refer to the past as “the good old days,” and their gender. We used father’s age to control for variation in baseline age across participants.

An ANCOVA revealed the predicted effect: According to their birth dates, people were nearly a year-and-a-half younger after listening to “When I’m Sixty-Four” (adjusted $M = 20.1$ years) rather than to “Kalimba” (adjusted $M = 21.5$ years), $F(1, 17) = 4.92, p = .040$. Without controlling for father’s age, the age difference was smaller and did not reach significance ($M_s = 20.3$ and 21.2 , respectively), $F(1, 18) = 1.01, p = .33$.



Science is Self-Correcting



Why Science Is Not Necessarily Self-Correcting

John P. A. Ioannidis

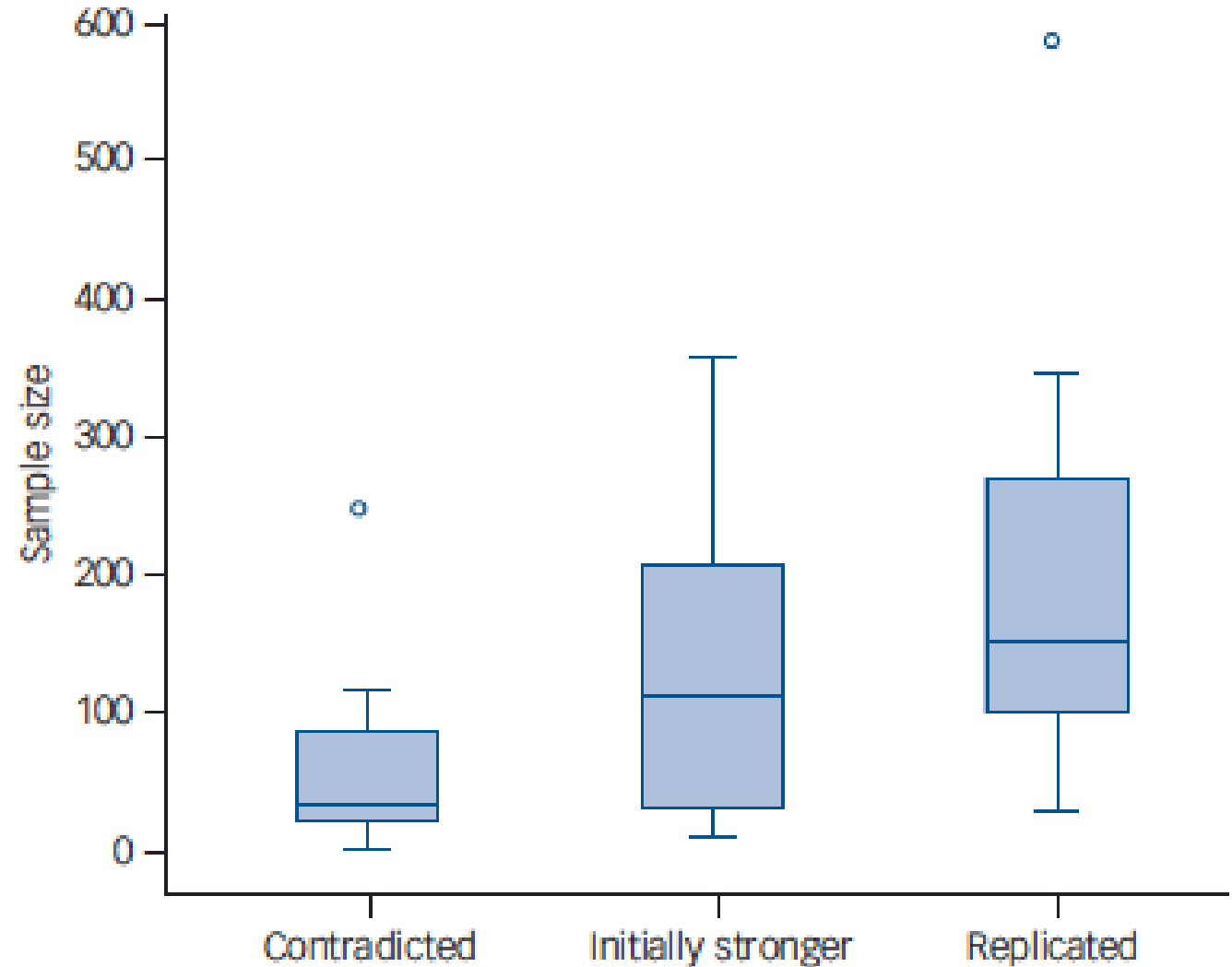
Stanford Prevention Research Center, Department of Medicine and Department of Health Research and Policy, Stanford University School of Medicine, and Department of Statistics, Stanford University School of Humanities and Sciences

Perspectives on Psychological Science
7(6) 645–654
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DOI: 10.1177/1745691612464056
<http://pps.sagepub.com>



“Among 83 articles recommending effective interventions, 40 had not been subject to any attempt at replication...”

Tajika et al. (2015). Br J Psychiatry, 207, 357-362.





ORIGINAL ARTICLE

Primary study authors of significant studies are more likely to believe
that a strong association exists in a heterogeneous meta-analysis
compared with methodologists

Orestis A. Panagiotou^a, John P.A. Ioannidis^{b,c,d,e,*}



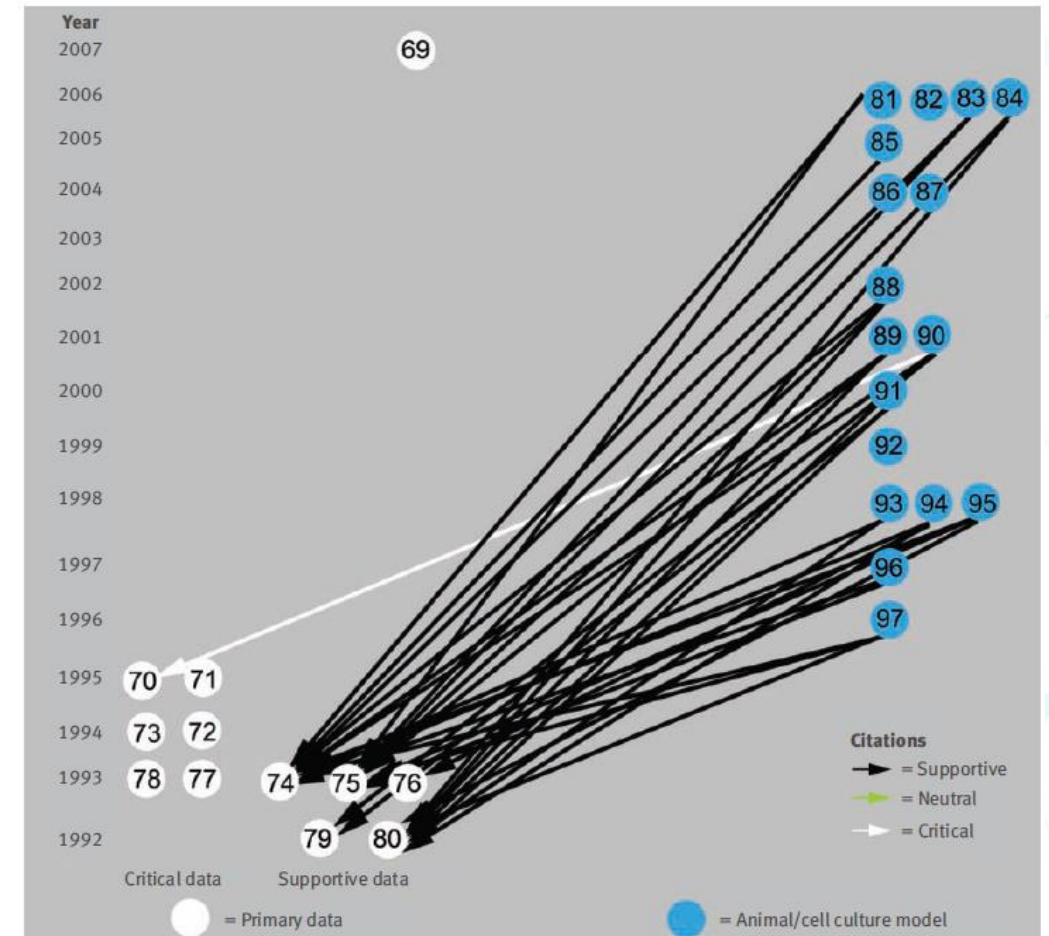
How citation distortions create unfounded authority: analysis of a citation network

Steven A Greenberg, associate professor of neurology

Papers addressing the belief that B amyloid, a protein accumulated in the brain in Alzheimer's disease, is produced by and injures skeletal muscle of patients with inclusion body myositis.



Greenberg (2009). Br Med J, 339, b2680.



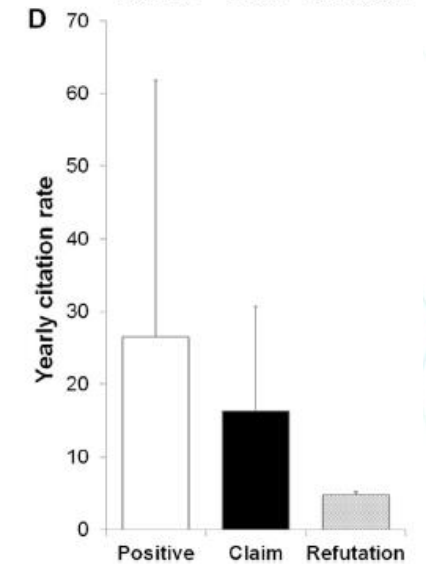
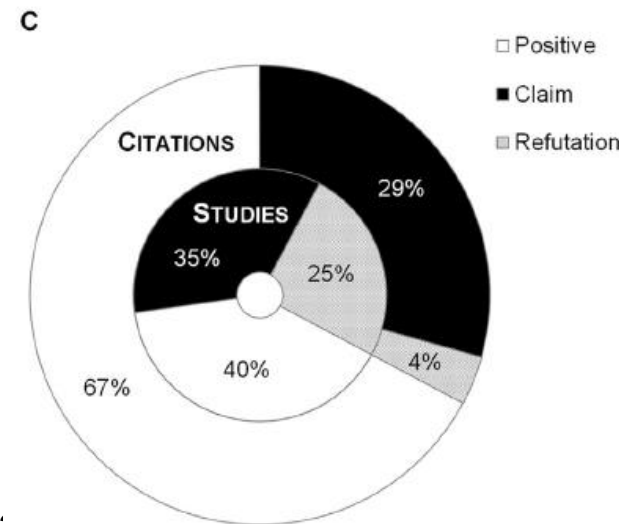
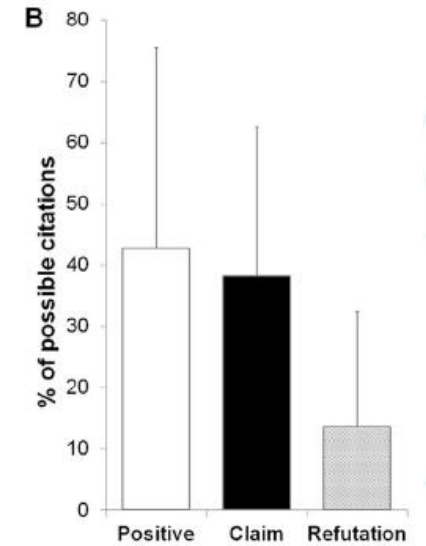
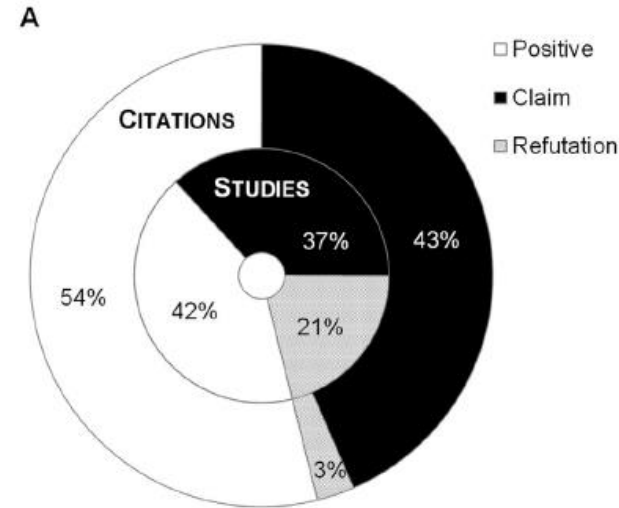
Abstracts often “spin” results to give impression that results are positive when they are not.

Citation inflation exists for both “positive” studies and “claim” studies in this literature.

True both within this literature (A, B) and in the wider (Web of Science) literature (C, D).



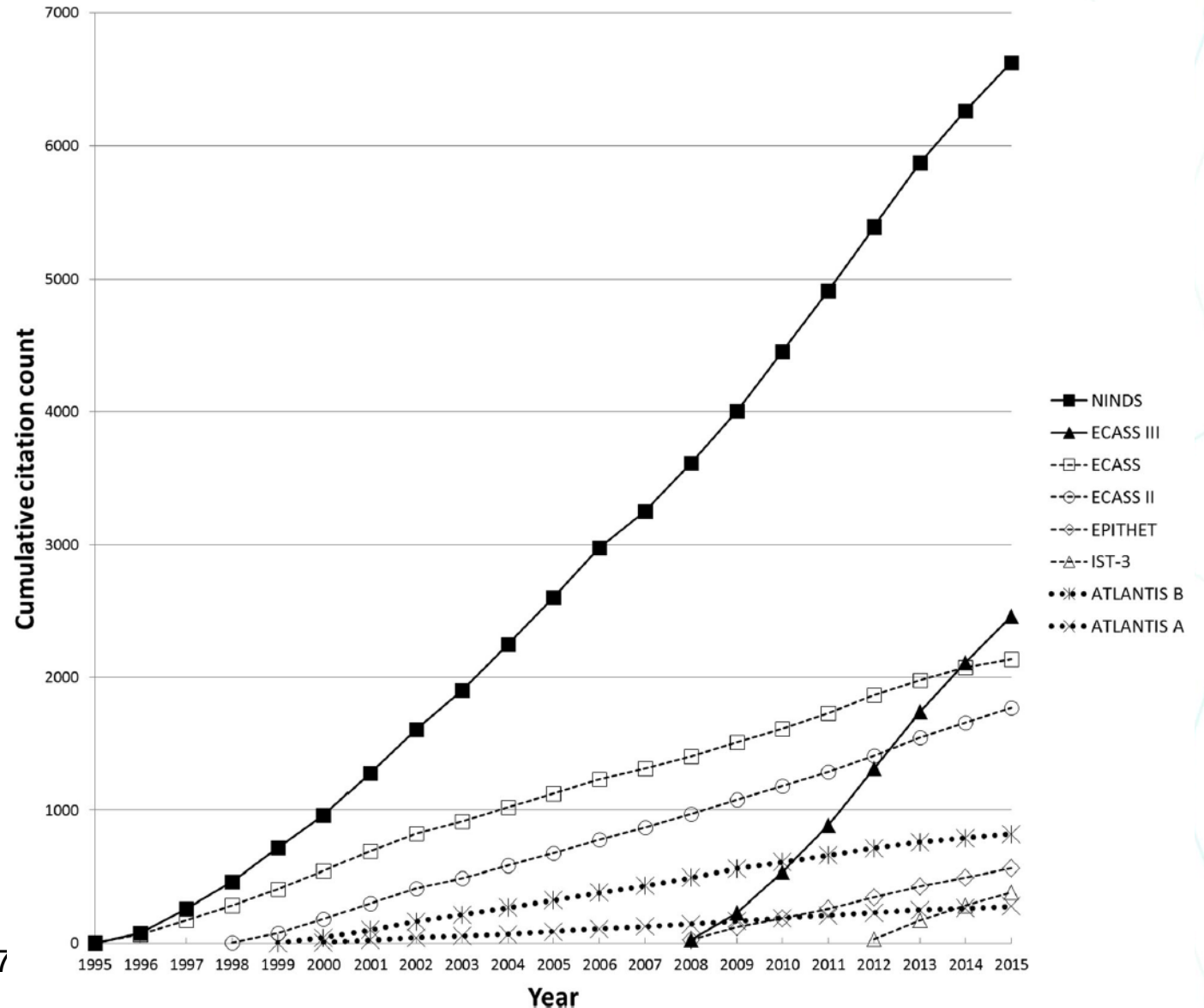
Bastiaansen et al. (2015). *Biol Psychiatry*, 78, e:



Two positive trials,
four neutral trials,
two negative trials
(stopped early for
safety concerns).



Misemer et al. (2016). *Trials*, 17



Wellcome Case Control Consortium

Science

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 | [REPORTS](#)



A Common Variant in the *FTO* Gene Is Associated with Body Mass Index and Predisposes to Childhood and Adult Obesity

[TIMOTHY M. FRAYLING](#), [NICHOLAS J. TIMPSON](#), [MICHAEL N. WEEDON](#), [ELEFThERIA ZEGGINI](#), [...], AND [MARK I. MCCARTHY](#)

[+37 authors](#)

[Authors Info & Affiliations](#)

SCIENCE • 11 May 2007 • Vol 316, Issue 5826 • pp. 889-894 • [DOI: 10.1126/science.1141634](#)

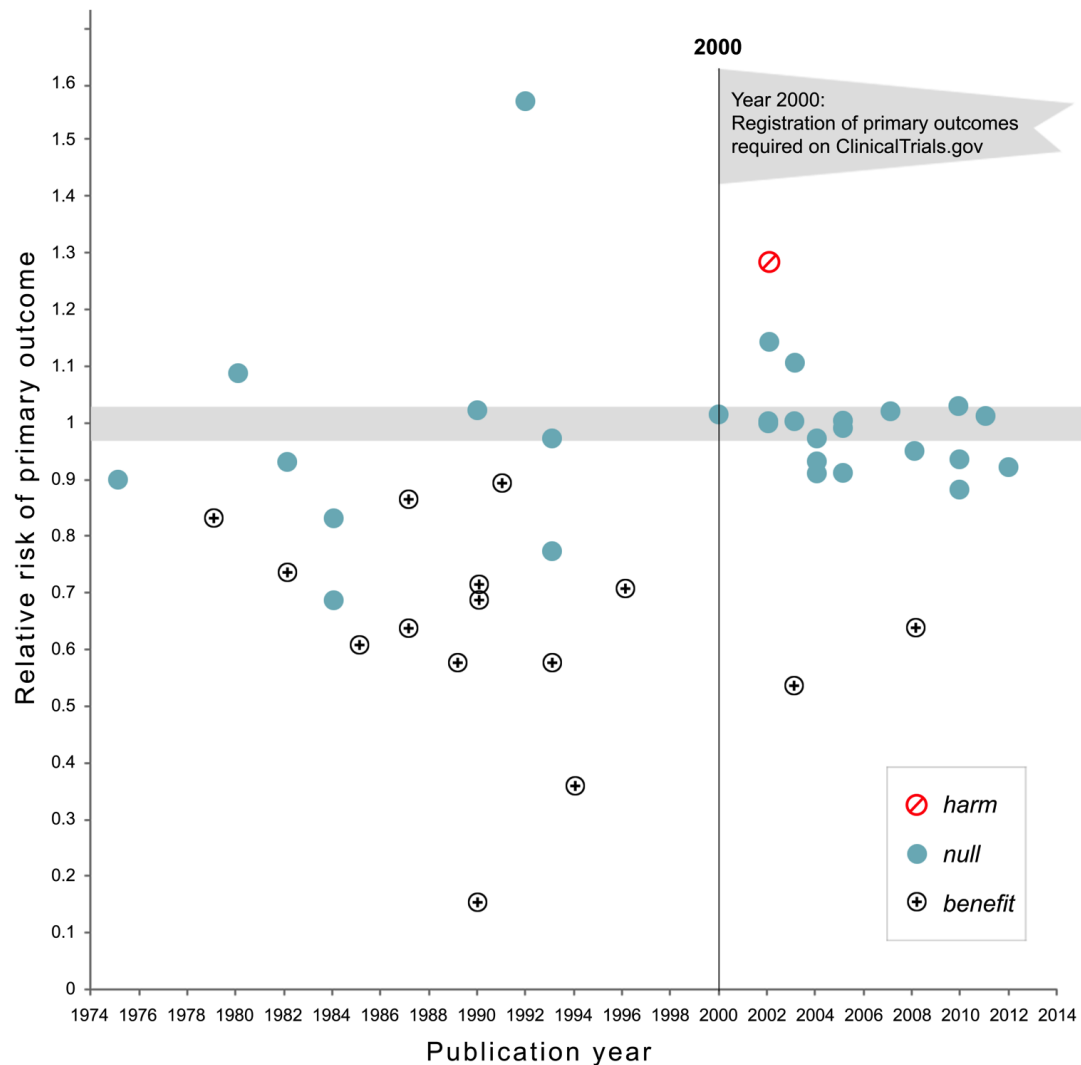


Wellcome Case Control Consortium

- Multi-site collaboration
 - large sample size
- Data and code sharing
 - transparency / quality control
- Agreed framework for authorship
 - contributorship



In 2000 the National Heart Lung, and Blood Institute required the registration of primary outcome on ClinicalTrials.gov for all their grant-funded activity



Kaplan & Irvin (2015). PLoS One, 10, e0132382.



Welcome to the UK Reproducibility Network



www.ukrn.org

@UKRepro



A manifesto for reproducible science

Marcus R. Munafò^{1,2*}, Brian A. Nosek^{3,4}, Dorothy V. M. Bishop⁵, Katherine S. Button⁶, Christopher D. Chambers⁷, Nathalie Percie du Sert⁸, Uri Simonsohn⁹, Eric-Jan Wagenmakers¹⁰, Jennifer J. Ware¹¹ and John P. A. Ioannidis^{12,13,14}

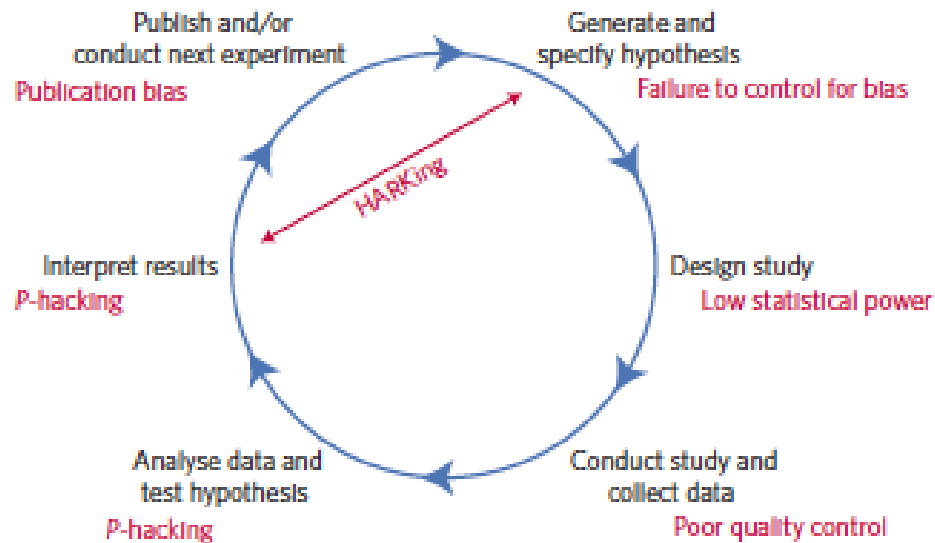


Table 1 | A manifesto for reproducible science.

Theme	Proposal	Examples of initiatives/potential solutions (extent of current adoption)	Stakeholder(s)
Methods	Protecting against cognitive biases	All of the initiatives listed below (* to ****) Blinding (**)	J, F
	Improving methodological training	Rigorous training in statistics and research methods for future researchers (*) Rigorous continuing education in statistics and methods for researchers (*)	I, F
	Independent methodological support	Involvement of methodologists in research (**) Independent oversight (*)	F
	Collaboration and team science	Multi-site studies/distributed data collection (*) Team-science consortia (*)	I, F
Reporting and dissemination	Promoting study pre-registration	Registered Reports (*) Open Science Framework (*)	J, F
	Improving the quality of reporting	Use of reporting checklists (**) Protocol checklists (*)	J
	Protecting against conflicts of interest	Disclosure of conflicts of interest (***) Exclusion/containment of financial and non-financial conflicts of interest (*)	J
Reproducibility	Encouraging transparency and open science	Open data, materials, software and so on (* to **) Pre-registration (**** for clinical trials, * for other studies)	J, F, R
Evaluation	Diversifying peer review	Preprints (* in biomedical/behavioural sciences, **** in physical sciences)	J
		Pre- and post-publication peer review, for example, Publons, PubMed Commons (*)	
Incentives	Rewarding open and reproducible practices	Badges (*) Registered Reports (*) Transparency and Openness Promotion guidelines (*) Funding replication studies (*) Open science practices in hiring and promotion (*)	J, I, F

Estimated extent of current adoption: *, <5%; **, 5-30%; ***, 30-60%; ****, >60%. Abbreviations for key stakeholders: J, journals/publishers; F, funders; I, institutions; R, regulators.



Munafò et al. (2017). Nat Hum Behav, 1, 0021.

Open Science

Open Data

Open Source

Open Methodology

Open Peer Review

Open Access

Open Educational
Resources



Research Culture

“Research culture encompasses the behaviours, values, expectations, attitudes and norms of our research communities.”



Scientific rigor and the art of motorcycle maintenance

Marcus Munafò, Simon Noble, William J Browne, Dani Brunner, Katherine Button, Joaquim Ferreira, Peter Holmans, Douglas Langbehn, Glyn Lewis, Martin Lindquist, Kate Tilling, Eric-Jan Wagenmakers & Robi Blumenstein

The reliability of scientific research is under scrutiny. A recently convened working group proposes cultural adjustments to incentivize better research practices.



Munafò et al. (2014), Nat Biotech, 32, 871-873.

Scientific rigor and the art of motorcycle maintenance

Marcus Munafò, Simon Noble, William J Browne, Dani Brunner, Katherine Button, Joaquim Ferreira, Peter Holmans, Douglas Langbehn, Glyn Lewis, Martin Lindquist, Kate Tilling, Eric-Jan Wagenmakers & Robi Blumenstein

The reliability of scientific research is under scrutiny. A recently convened working group proposes cultural adjustments to incentivize better research practices.

Continuous Improvement

Respect for People

The Right Process will Produce the Right Results

Develop People and Partners

Solving Problems Drives Organizational Learning

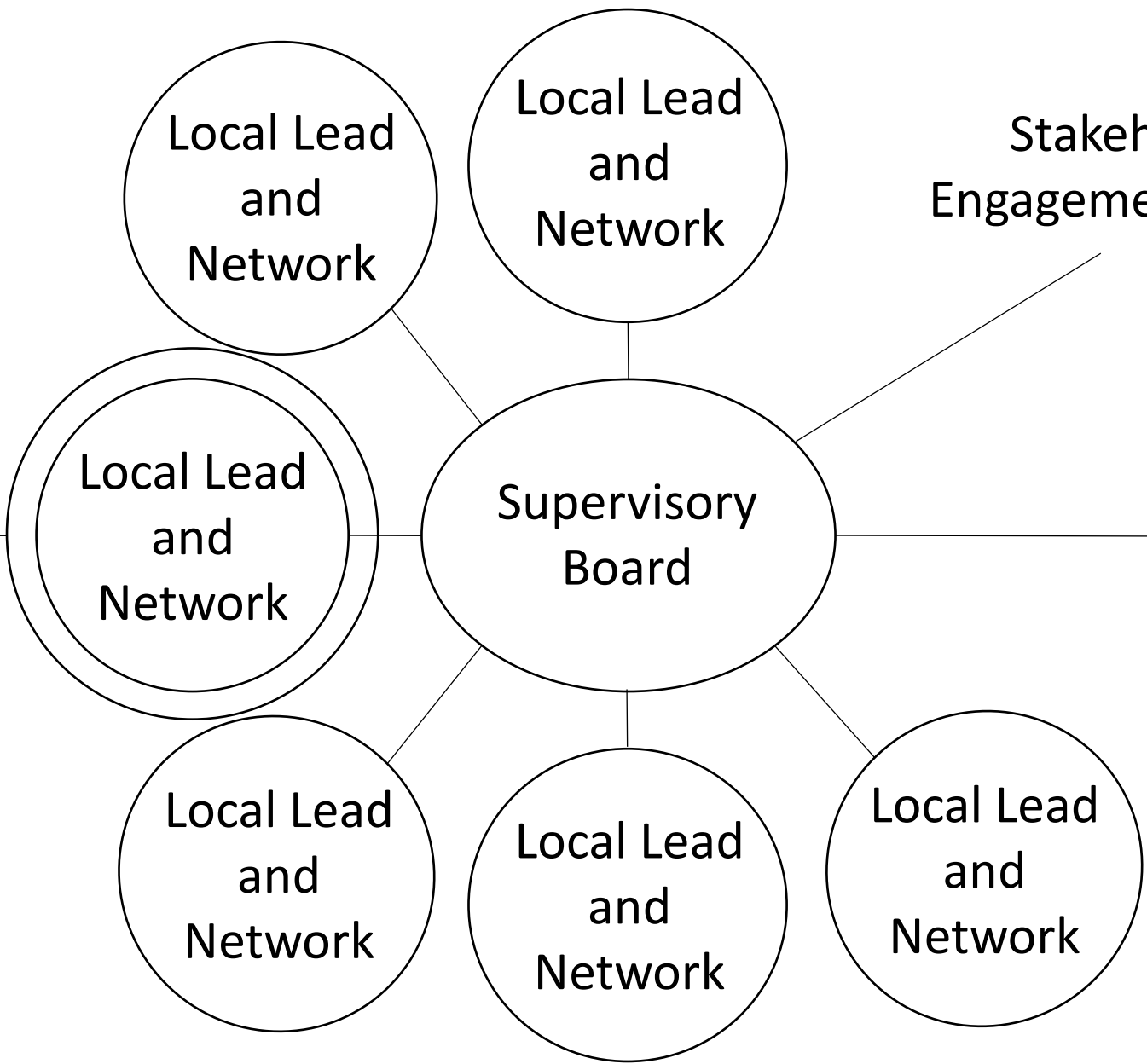


Munafò et al. (2014), Nat Biotech, 32, 871-873.



UKRN

Institutional
Lead



International
Advisory Ctte

Stakeholder
Engagement Group

UKRN

Peer-led consortium

Involves researchers,
institutions and other orgs

Opportunity to improve research

Working collaboratively to
reform culture and practice

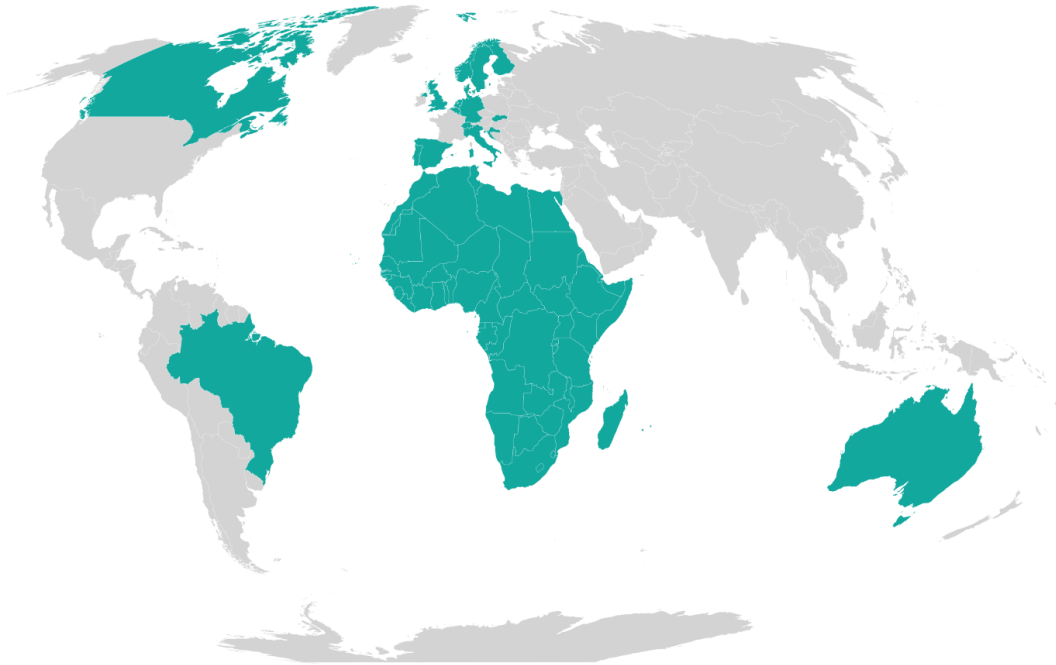
Broad disciplinary representation

Focus on open research for
inclusivity beyond the sciences





Global RNs



Africa AREN ✉ Twitter	Australia aus-rn.org ✉ Twitter	Belgium reproducibilitynetwork.be ✉ Twitter	Brazil reproduzibilidade.org ✉ Twitter
Canada carn-recar.ca ✉ Twitter	Croatia corin.hr ✉ Twitter	Denmark danish-repro.github.io ✉ Twitter	Finland finnish-rn.org ✉ Twitter
Germany reproducibilitynetwork.de ✉ Twitter	Italy itrn.org ✉ Twitter	Luxembourg uni.lu ✉ Twitter	Netherlands reproducibilitynetwork.nl ✉ Twitter
Norway nornr.no ✉ Twitter	Portugal ptrn.pt ✉ Twitter	Slovakia slovakrn.wixsite.com/skrn ✉ Twitter	Spain sprn.es ✉ Twitter
Sweden swern.org ✉ Twitter	Switzerland swissrn.org ✉ Twitter	United Kingdom ukrn.org ✉ Twitter	

Open Research Programme

“to accelerate the uptake of high quality open research practices”



UK reproducible science project wins £8.5 million

UK Reproducibility Network will run training on open research methods thanks to 'major strategic investment' by Research England

September 15, 2021

[Jack Grove](#)

Twitter: [@jgro_the](#)

A UK initiative to promote rigour and reproducibility in science has been awarded £8.5 million to encourage open research practices.

As part of one of the largest awards made to support robust and transparent research methods, the UK Reproducibility Network (UKRN) will receive £4.5 million from Research England as part of a five-year project to deliver training in open research practices.



Source: iStock

EBSCO ✓ [protocols.io](https://www.protocols.io) **SPRINGER NATURE** **WILEY**

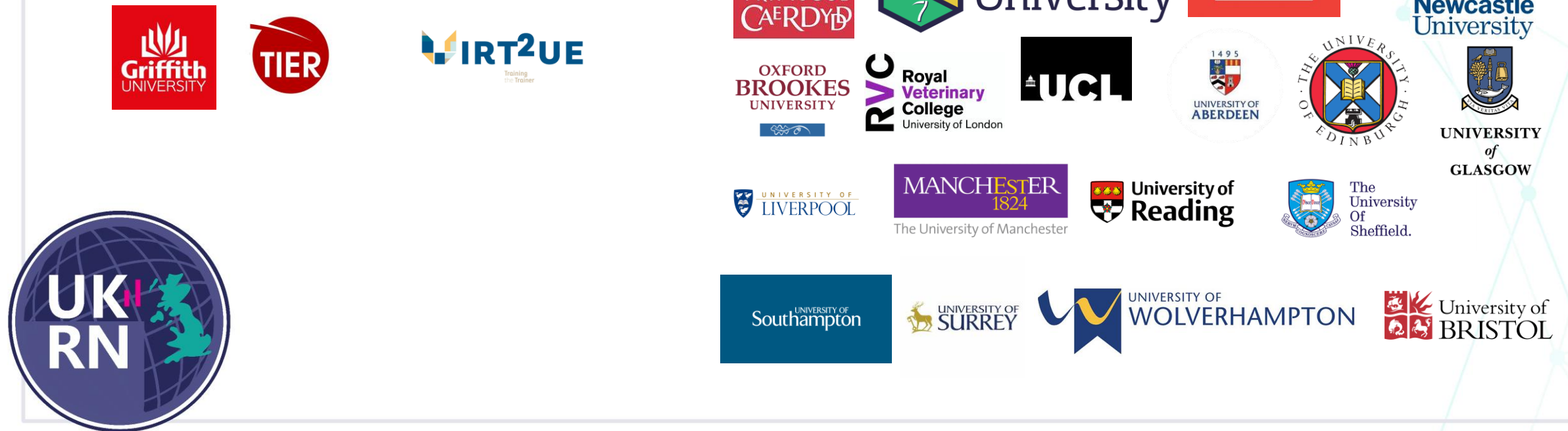


Research England

UK-based centres of expertise



International centres of expertise



Infrastructure

- Open research requires high quality **repositories**
- **Curated** repositories ensure high quality deposits
- Data teams embedded in library services can provide this



A screenshot of the University of Bristol Research Data Repository website. The header includes the University of Bristol logo and navigation links: Faculties, Datasets, Licence, About, Depositing, Accessing, Metrics, and a search bar. The main content area features a large search bar with the text 'Search the Research Data Repository' and a search input field. Below the search bar, there is a section titled 'Top 10 datasets by page views (all time)' with a sub-link for 'All metrics'. This section lists ten datasets with their ranks and titles, such as 'EPIC-KITCHENS 2018' and 'MRC IEU UK Biobank GWAS pipeline version 2'. To the right of the top 10 list, there is a section titled 'The data.bris Research Data Repository' which provides a mission statement and information about the repository's management and contact details.

Training

- Researchers need to understand how to engage
- This requires **training** that can reach all researchers
- **Train-the-trainer courses** offer a scalable solution



Open research primers

Each primer includes an overview of the topic in the introductory "What?" section, reasons for undertaking these practices in the "Why?" section, followed by a longer "How?" section that provides guidance on how to do that open research behaviour practically.

Throughout the primers, there are embedded explanatory weblinks, and at the end of each is a collated list of links to useful further resources.

The primers are licensed under [Creative Commons license CC BY 3.0](#). You can link to, quote, share, and adapt the primers freely.



Pre-registration & Registered Reports

Help reduce questionable research practices, and prevent selective reporting.



Preprints

Upload, describe and disseminate your scholarly article prior to peer review.



Open access

Universal open and barrier-free access to research benefits all knowledge users.



Data sharing

Make research data available to ensure transparency and a reliable scientific record.



Open code & software

Encourage collaboration between code users, developers and researchers.



Open research awards

Run a competition to recognise and reward researchers who have used open practices.

Incentives

- Open research offers a number of benefits
- But changing working practices take an investment of **effort**
- This change therefore needs to be **incentivised**



* Research Professional News

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POLICY 30 OCT 2019 |

Bristol University includes open research in promotion criteria

By Sophie Inge

Share

Open Research Awards: a Primer from UKRN

Authors (Z-A): [Kirsty Merrett](#), [Mitul Mehta](#), [Emily Farran](#), [Robert Darby](#).



Interoperability

- Researchers don't stay in the same institutions forever
- Open research practices need to be **interoperable**
- Similarly, incentives need to be **aligned** across institutions



The screenshot shows the UKRN website header with the logo and navigation menu (Community, Resources, Activities, Join UKRN, Contact). Below the header is a teal banner for 'Common statements'. The main content area is titled 'Statements for institutional use' and includes a paragraph of text. Below this are three circular icons representing 'Transparency in Research', 'Responsible Research Evaluation', and 'Rewards and Incentives', each with a brief description.

Common statements
A set of common standards for our network of institutions

Statements for institutional use
The UK Reproducibility Network supports responsible research evaluation, transparency in research, and appropriate incentives to promote open research. We have developed statements that can be developed and used by institutions and organisations. These common statements are intended to encourage uptake and promote a degree of interoperability across these institutions and organisations. We welcome suggestions for how these statements could be modified.

- Transparency in Research**
Commit to transparency and rigour in research across all disciplines.
- Responsible Research Evaluation**
A Policy Statement and associated guidance on responsible research assessment.
- Rewards and Incentives**
Commit to a research culture that promotes and rewards open research practices.

Collaboration

Research culture is not zero-sum. There are advantages and efficiencies we can achieve through collaboration.

Research culture catalogue for improved collaboration and healthy competition

Mar 31, 2023 | News



<https://www.ukrn.org/2023/03/31/research-culture-catalogue-for-improved-collaboration-and-competition/>

GW4 Alliance launches inaugural GW4 Open Research Week for 2023

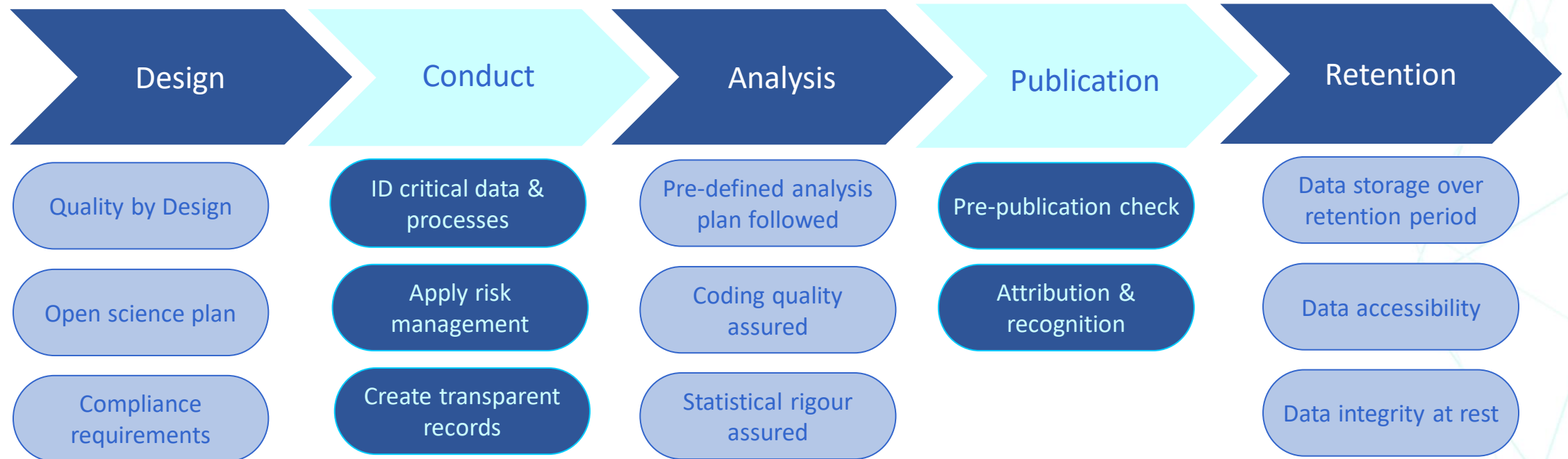
How to enter the 2023 GW4 Open Research Prize



Take part in-person or online in an afternoon celebrating the work of GW4 researchers to promote all themes of Open Research.



Research Process Spot Checks



Registered Reports Funder Partnership

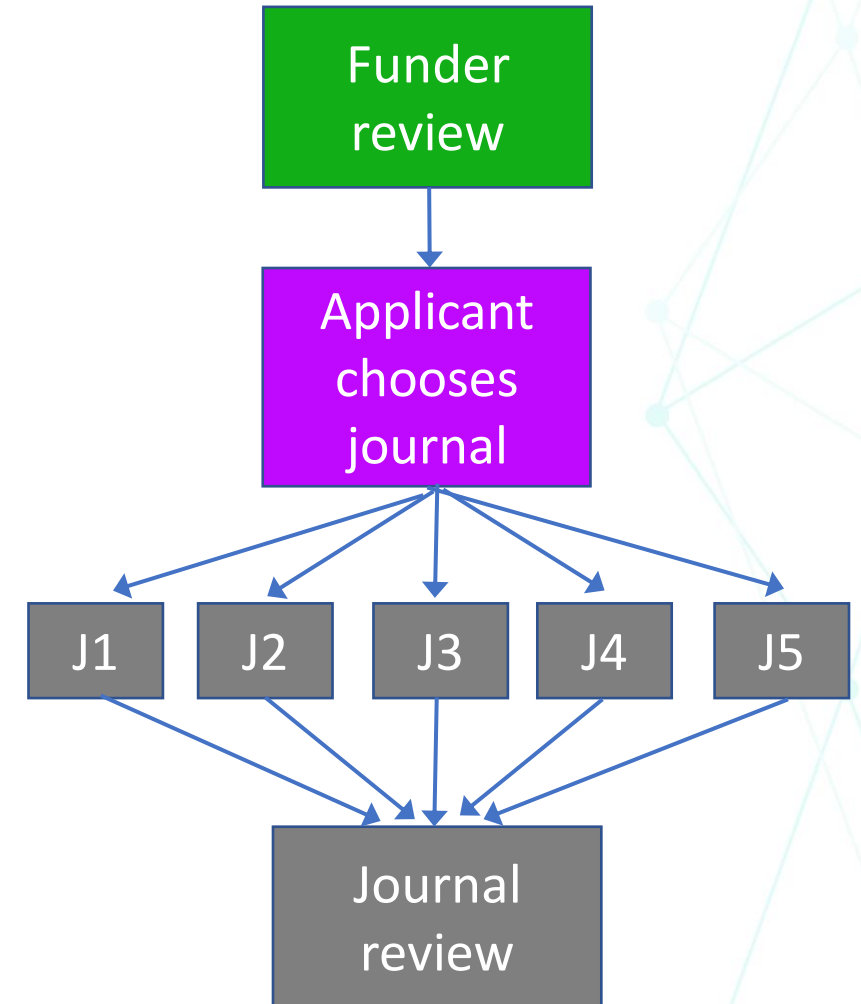
- CRUK partnering with multiple journals
- Timeline – began May 2022, twice yearly
- Roughly 50% opt-in rate so far



WILEY



SPRINGER NATURE



Octopus

WONKHE

✕ Q ≡

We need to decide what good research looks like

Alexandra Freeman sets out the problems that lead to research results not getting published – and offers some possible solutions



COMMENT
| 26/10/23



<https://www.octopus.ac>

Reproducibility Across Disciplines

Age of Invention: Does History have a Replication Crisis?

ANTON HOWES

29 AUG 2023



Arts and
Humanities
Research Council



Telling But Not Twisting the Story of Research

Challenge: To explore whether and how to shift the orientation of research reports away from persuading readers and more towards informing readers. The Story Associate will explore how to retain the benefits of accessible narrative forms, whilst maintaining standards of rigour within research.

Transparency Across Disciplines



Research
England

Open research in disciplines

Disciplines are arranged alphabetically



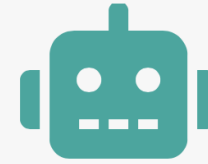
Archaeology
and Classics



Architecture,
Built
Environment
and Planning



Art and Design



Artificial
Intelligence



Biological
Sciences



Business and
Management
Studies



Chemistry



Computational
Modelling



Computer
Science



Cultural and
Media Studies



Economics



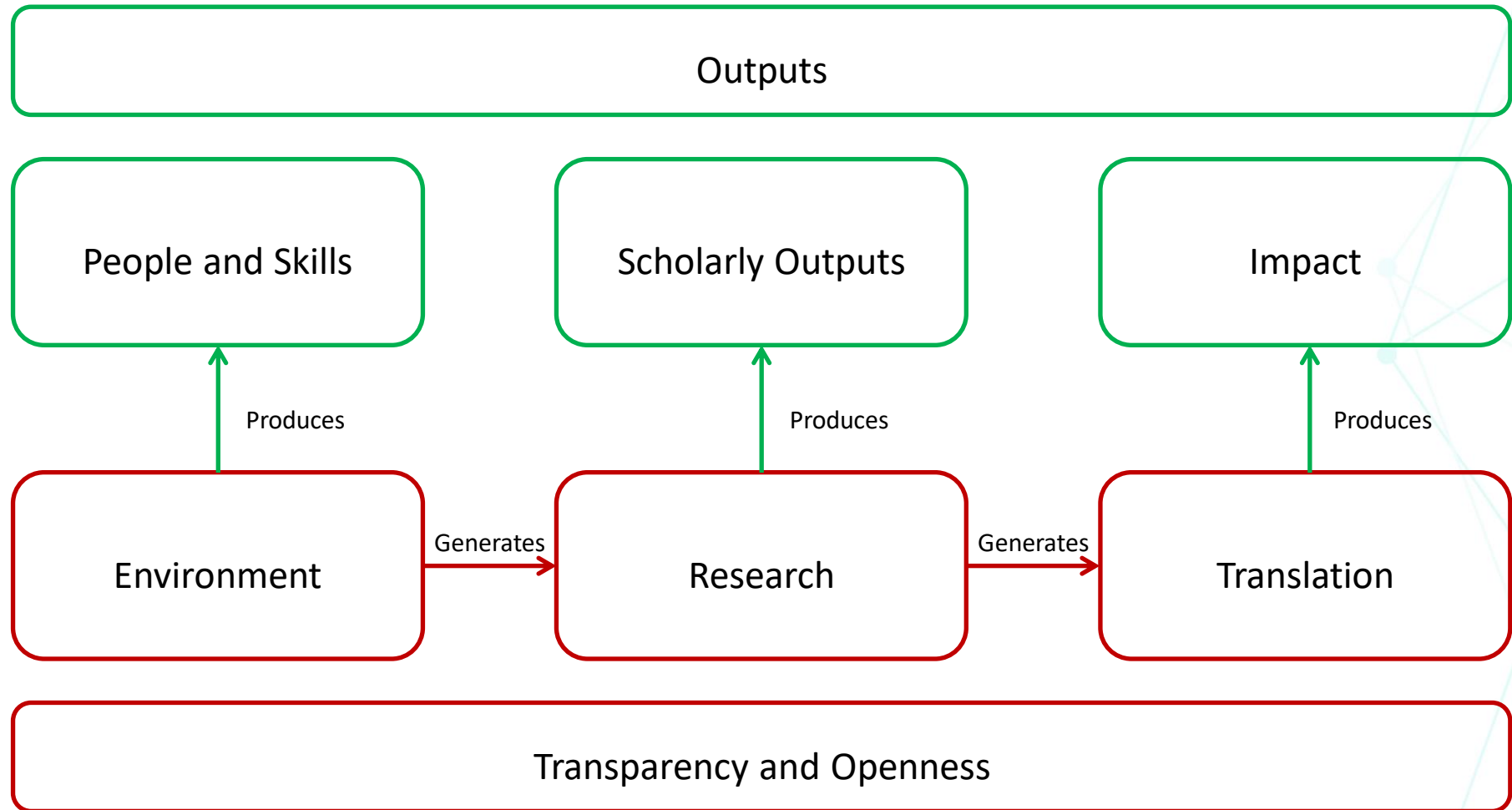
Education



<https://www.ukrn.org/disciplines/>

People, Culture and Environment

The Right Process will Produce the Right Results



Thank you!

marcus.munafo@bristol.ac.uk

@marcusmunafo

@ukrepro

