Reproducible Research through Open Science

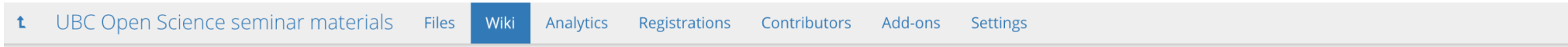
November 20, 2019

Supporting materials at
https://osf.io/vgjpq/

Jason Pither (UBC Okanagan, Biology) & Mathew Vis-Dunbar (UBC SMP Librarian)

With additional materials from the Open Science Ambassadors Program
at the Center for Open Science

CENTER FOR OPEN SCIENCE



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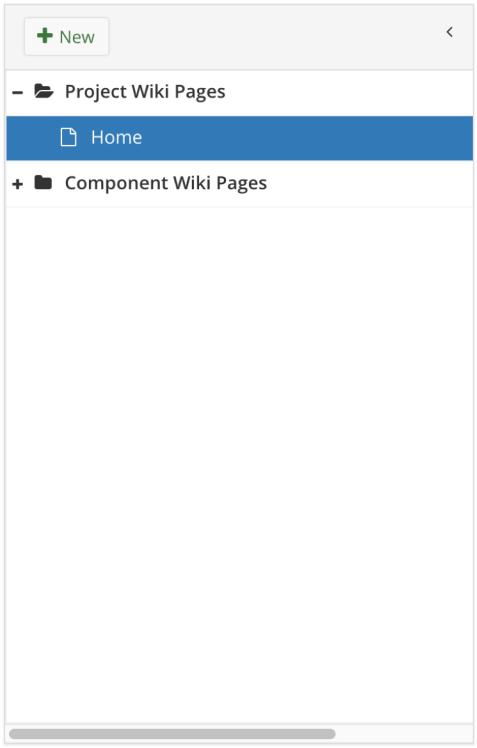

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UBC Open Science

This OSF component links to resources referred to in Open Science seminars and workshops delivered at the University of British Columbia.

Presentations

- Presentations delivered at UBC are available here.

Articles openly available as PDFs

- Some OS-related resources are provided as PDF documents, which are available for download from the files page, and links to others are provided below.

Articles open online

Smaldino, P.E. and McElreath, R. 2016. The natural selection of bad science. Royal Society Open Science.

Ali-Khan, S.E., Jean, A., and Gold, R.E. 2018. Identifying the challenges in implementing Open Science. MNI Open Research.

Campbell et al. 2019. Early career researchers embrace data sharing. Trends Ecol. Evol. 24:95-98.

Nelson et al. 2018. Psychology's renaissance. Ann. Rev. Psych. 69:511-534.

Nosek et al. 2017. The pregistration revolution. PNAS.

Nosek et al. 2015. Estimating the reproducibility of psychological science. Science, 349.

Simmons et al. 2011. False-positive psychology: undisclosed flexibility in data collection and analysis allows presenting anything as significant. Psych. Sci. 22(11):1359-1366.

Plesser. 2018. Reproducibility vs. Replicability: a brief history of a confused terminology. Frontiers in Neuroinformatics. 11:1-4.

*Lazic et al. 2018. What exactly is "n" in cell culture and animal experiments? *please be sure to read the commentary that corrects serious flaws with the Lazic et al. article

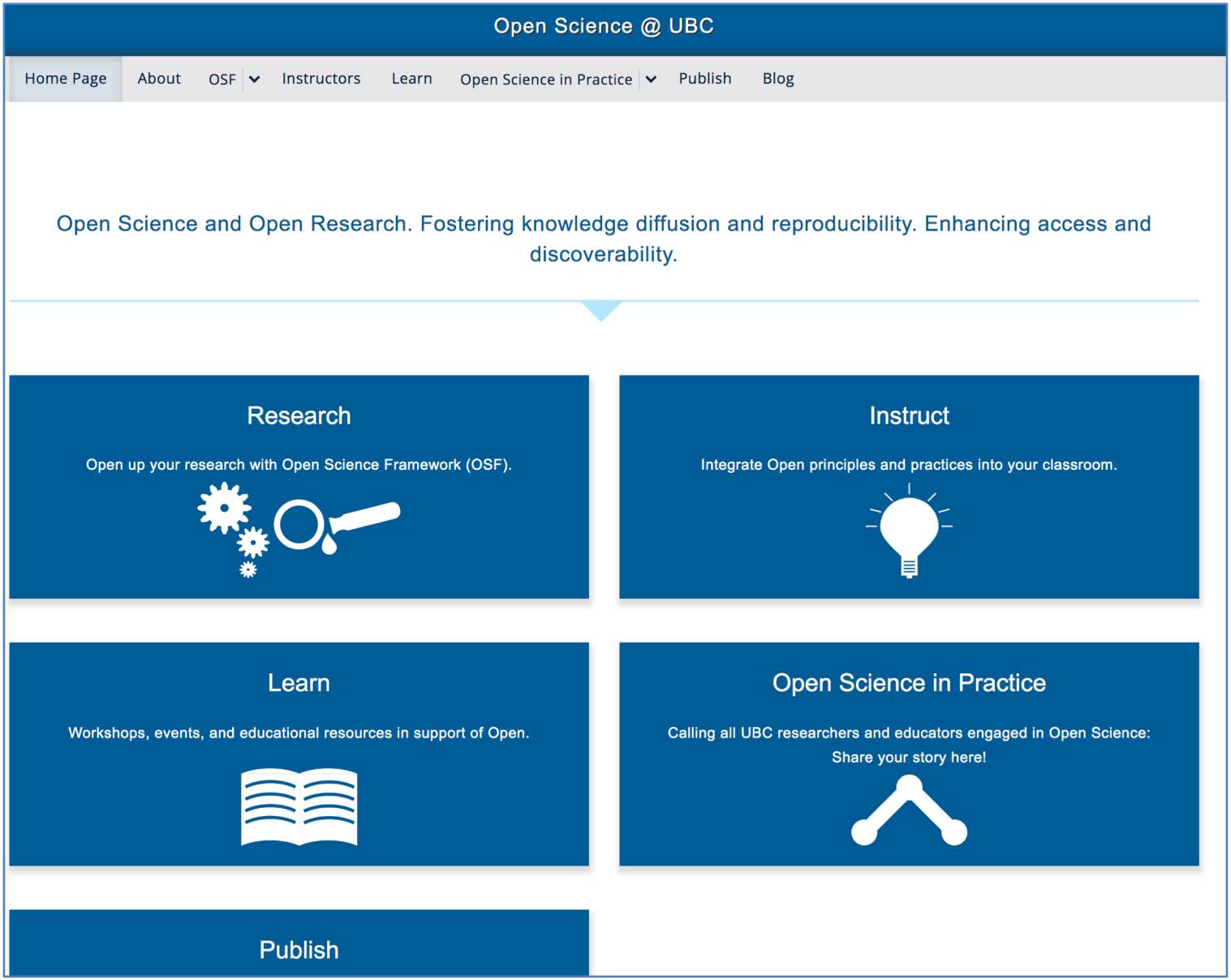
Reproducibility bibliography

- Librarians at the University of Minnesota maintain excellent discipline-specific bibliographies pertaining to reproducibility.

General OS resources

- Transparency and Openness Promotion Guidelines

openscience.ubc.ca



Background

Problem

- Irreproducible research
- Sources of the problem

Solutions

- Practices that improve reproducibility – Open Science
- Other benefits of Open Science best practices
- Tools that facilitate Open Science best practices

Open Science initiatives at UBC

- Excellence fund strategic initiative
- Okanagan pilot project

Discussion / Q&A

Terminology

One of many possible definitions of **Open Science:**

Scientific research conducted and communicated in an honest, accessible, and transparent way, such that independent researchers can reproduce the results

OPEN LETTER

Identifying the challenges in implementing open science [version 1; referees: 2 approved]

Sarah E. Ali-Khan [1,2], Antoine Jean[1], E. Richard Gold [1,3]

MNI Open Research 2018, 2:5 Last updated: 04 FEB 2019

Open science (OS) comprises a set of institutional policies, infrastructure and relationships related to open access publication, open data and scientific resources, and lack of restrictive intellectual and other proprietary rights with the goal of increasing the quality and credibility of scientific outputs, increasing efficiency, and spurring both discovery and innovation.

Terminology

Computational Reproducibility:

If we took your data and code/analysis scripts and reran it, we can reproduce the numbers/graphs in your paper

Methods Reproducibility:

We have enough information to rerun the experiment or survey the way it was originally conducted

Results Reproducibility/Replicability:

We reproduce the methods (as above), collect new data, and get the same statistical conclusion

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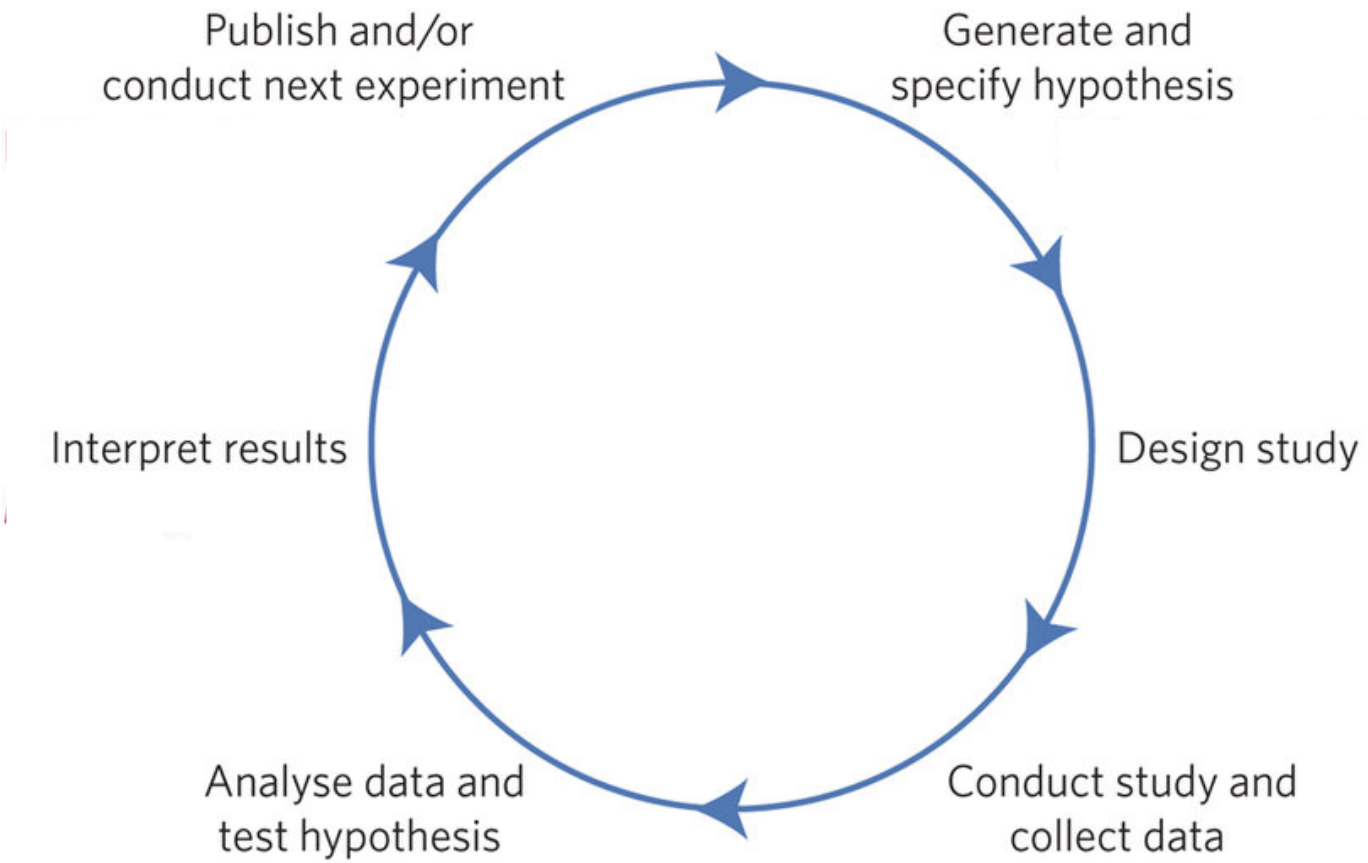
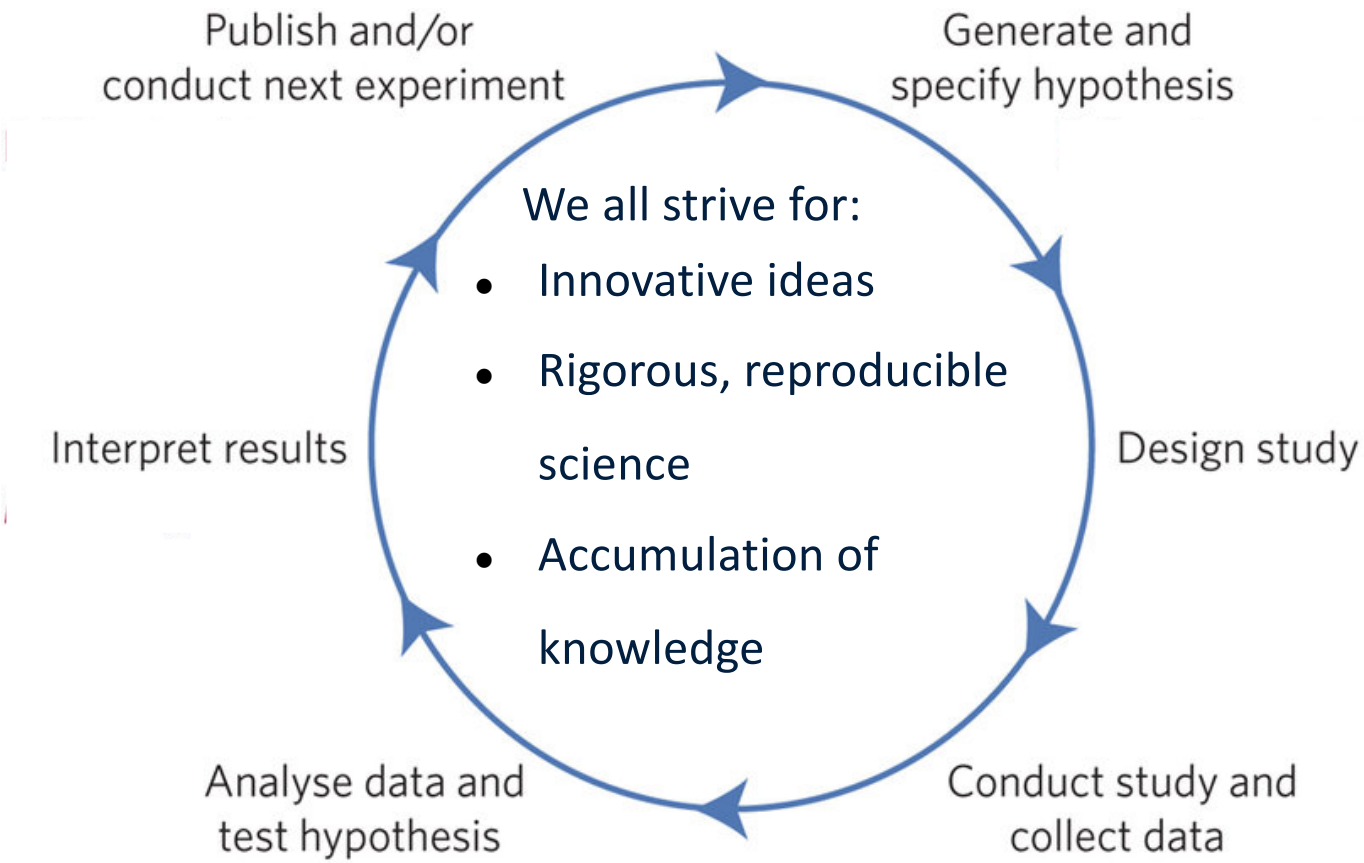
Foundational to science

Hypothetico-Deductive Model of the Scientific Method



Note distinction between Confirmatory studies vs Exploratory studies

Hypothetico-Deductive Model of the Scientific Method



The problem

Questionable methods infiltrate the research workflow at various stages (typically unwittingly!), ultimately yielding **irreproducible** research.

Science is broken?

Power failure: why small sample size undermines the reliability of neuroscience

Katherine S. Button[1,2], John P. A. Ioannidis[3], Claire Mokrysz[1], Brian A. Nosek[4], Jonathan Flint[5], Emma S. J. Robinson[6] and Marcus R. Munafò[1]

Abstract | A study with low statistical power has a reduced chance of detecting a true effect, but it is less well appreciated that low power also reduces the likelihood that a statistically significant result reflects a true effect. Here, we show that the average statistical power of studies in the neurosciences is very low. The consequences of this include overestimates of effect size and low reproducibility of results. There are also ethical dimensions to this problem, as unreliable research is inefficient and wasteful. Improving reproducibility in neuroscience is a key priority and requires attention to well-established but often ignored methodological principles.

Believe it or not: how much can we rely on published data on potential drug targets?

NATURE REVIEWS | DRUG DISCOVERY

Florian Prinz, Thomas Schlange and Khusru Asadullah

Open access, freely available online

Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

Summary

There is increasing concern that most current published research findings are false. The probability that a research claim is true may depend on study power and bias, the number of other studies on the same question, and, importantly, the ratio of true to no relationships among the relationships probed in each scientific field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance. Simulations show that for most study designs and settings, it is more likely for a research claim to be false than true. Moreover, for many current scientific fields, claimed research findings may often be simply accurate measures of the prevailing bias. In this essay, I discuss the implications of these problems for the conduct and interpretation of research.

Published research findings are sometimes refuted by subsequent evidence, with ensuing confusion and disappointment. Refutation and controversy is seen across the range of research designs, from clinical trials and traditional epidemiological studies [1–3] to the most modern molecular research [4,5]. There is increasing concern that in modern research, false findings may be the majority or even the vast majority of published research claims [6–8]. However, this should not be surprising. It can be proven that most claimed research findings are false. Here I will examine the key factors that influence this problem and some corollaries thereof.

The Essay section contains opinion pieces on topics of broad interest to a general medical audience.

Modeling the Framework for False Positive Findings

Several methodologists have pointed out [9–11] that the high rate of nonreplication (lack of confirmation) of research discoveries is a consequence of the convenient, yet ill-founded strategy of claiming conclusive research findings solely on the basis of a single study assessed by formal statistical significance, typically for a *p*-value less than 0.05. Research is not most appropriately represented and summarized by *p*-values, but, unfortunately, there is a widespread notion that medical research articles

It can be proven that most claimed research findings are false.

should be interpreted based only on *p*-values. Research findings are defined here as any relationship reaching formal statistical significance, e.g., effective interventions, informative predictors, risk factors, or associations. "Negative" research is also very useful. "Negative" is actually a misnomer, and the misinterpretation is widespread. However, here we will target relationships that investigators claim exist, rather than null findings.

As has been shown previously, the probability that a research finding is indeed true depends on the prior probability of it being true (before doing the study), the statistical power of the study, and the level of statistical significance [10,11]. Consider a 2 × 2 table in which research findings are compared against the gold standard of true relationships in a scientific field. In a research field both true and false hypotheses can be made about the presence of relationships. Let R be the ratio of the number of "true relationships" to "no relationships" among those tested in the field. R is characteristic of the field and can vary a lot depending on whether the field targets highly likely relationships or searches for only one or a few true relationships among thousands and millions of hypotheses that may be postulated. Let us also consider, for computational simplicity, circumscribed fields where either there is only one true relationship (among many that can be hypothesized) or the power is similar to find any of the several existing true relationships. The pre-study probability of a relationship being true is $R/(R + 1)$. The probability of a study finding a true relationship reflects the power $1 - \beta$ (one minus the Type II error rate). The probability of claiming a relationship when none truly exists reflects the Type I error rate, α. Assuming that c relationships are being probed in the field, the expected values of the 2 × 2 table are given in Table 1. After a research finding has been claimed based on achieving formal statistical significance, the post-study probability that it is true is the positive predictive value, PPV. The PPV is also the complementary probability of what Wacholder et al. have called the false positive report probability [10]. According to the 2 × 2 table, one gets $PPV = (1 - \beta)R/(R - \beta R + \alpha)$. A research finding is thus

Citation: Ioannidis JPA (2005) Why most published research findings are false. PLoS Med 2(8): e124.

Abbreviation: PPV, positive predictive value

John P. A. Ioannidis is in the Department of Hygiene and Epidemiology, University of Ioannina School of Medicine, Ioannina, Greece, and Institute for Clinical Research and Health Policy Studies, Department of Medicine, Tufts-New England Medical Center, Tufts University School of Medicine, Boston, Massachusetts, United States of America. E-mail: jioannid@cc.uoi.gr

Competing Interests: The author has declared that no competing interests exist.

DOI: 10.1371/journal.pmed.0020124

Science is broken?

Unreliable research

Trouble at the lab

The Economist

Scientists like to think of science as self-correcting. To an alarming degree, it is not

THE WEEK

Big Science is broken

Pascal-Emmanuel Gobry

https://theweek.com/articles/618141/big-science-broken

SCIENCE

Science Is Broken. How Much Should We Fix It?

More rigor in research could stamp out false positive results. It might also do more harm than good.

By DANIEL ENGBER

SLATE
THE WORKIEST WORKISTS OF ALL

MAY 05, 2017 • 5:56 AM

Reproducibility is not the norm

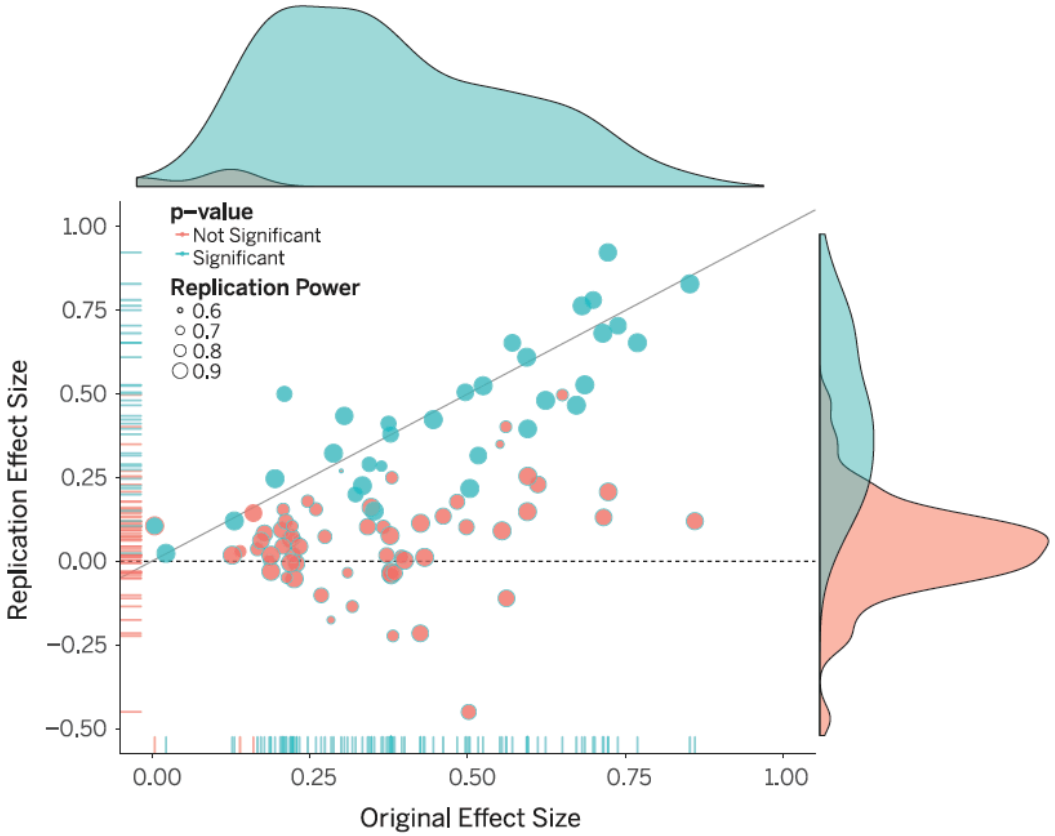
RESEARCH ARTICLE SUMMARY

PSYCHOLOGY

Estimating the reproducibility of psychological science (2015)

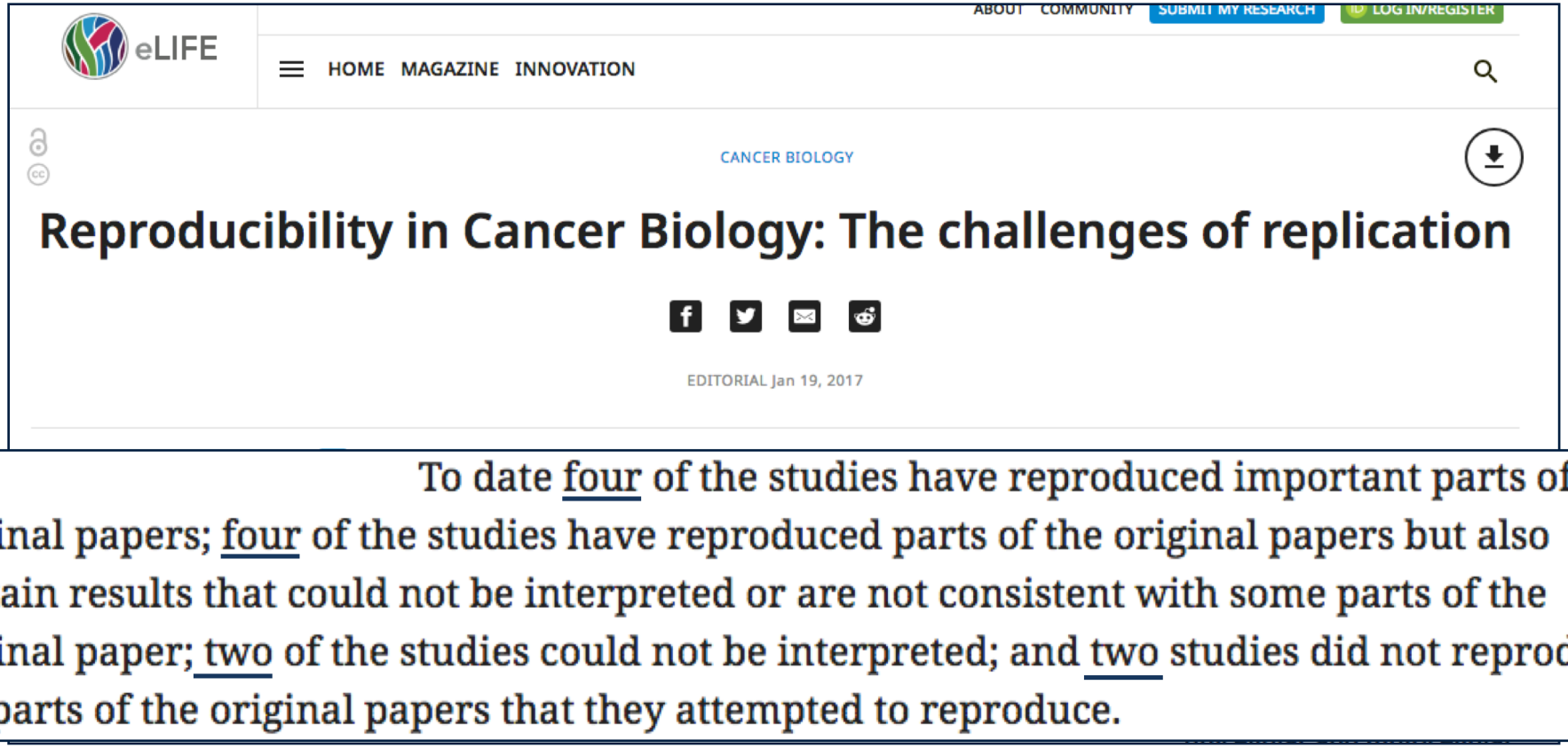
Open Science Collaboration*

- **100 studies** published in **3 psychology journals**
- Used high-powered designs and original materials
- **36%** of studies were able to be reproduced



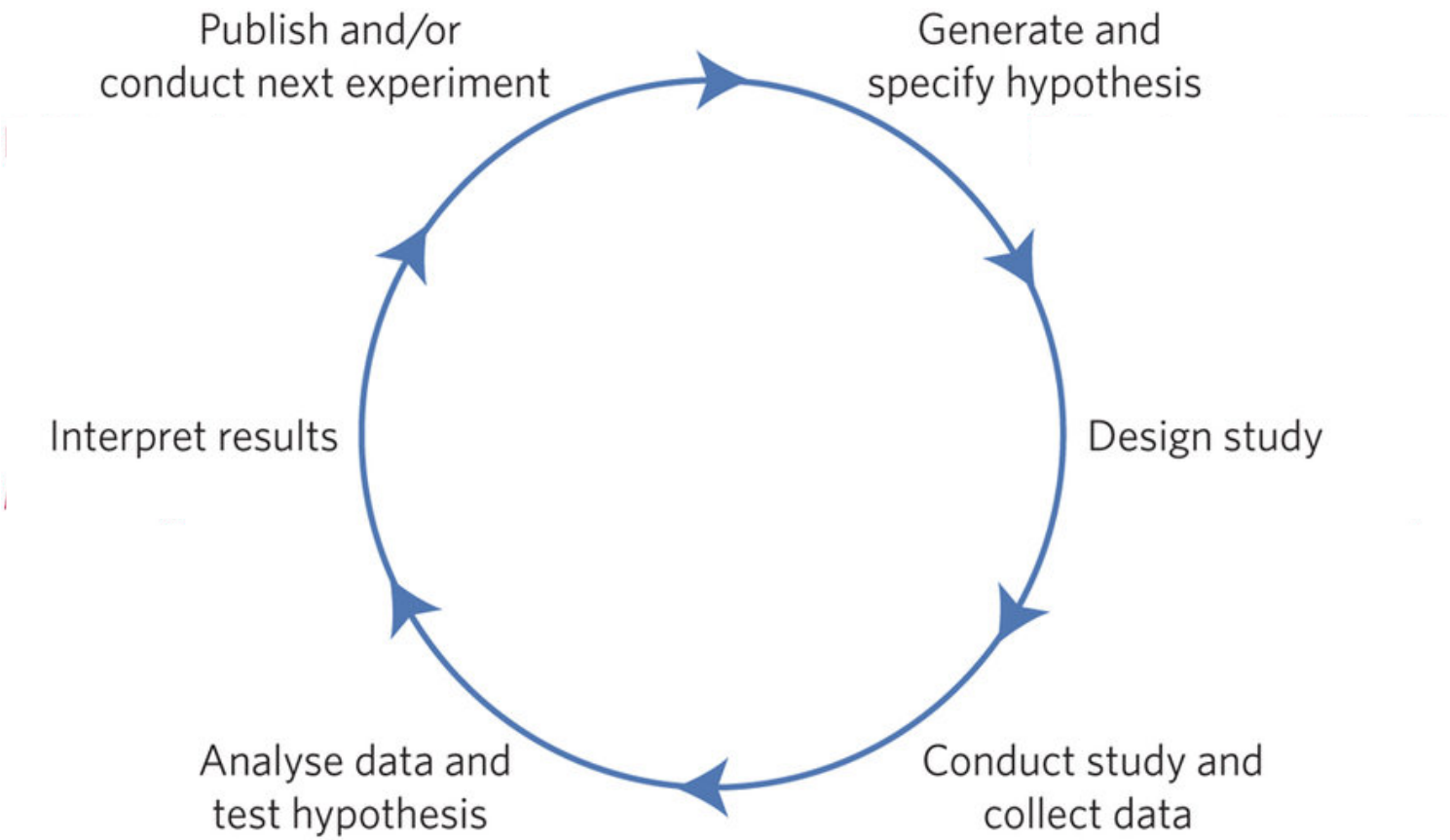
Original study effect size versus replication effect size (correlation coefficients). Diagonal line represents replication effect size equal to original effect size. Dotted line represents replication effect size of 0. Points below the dotted line were effects in the opposite direction of the original. Density plots are separated by significant (blue) and nonsignificant (red) effects.

Reproducibility is not the norm



To date four of the studies have reproduced important parts of the original papers; four of the studies have reproduced parts of the original papers but also contain results that could not be interpreted or are not consistent with some parts of the original paper; two of the studies could not be interpreted; and two studies did not reproduce the parts of the original papers that they attempted to reproduce.

Sources of the problem



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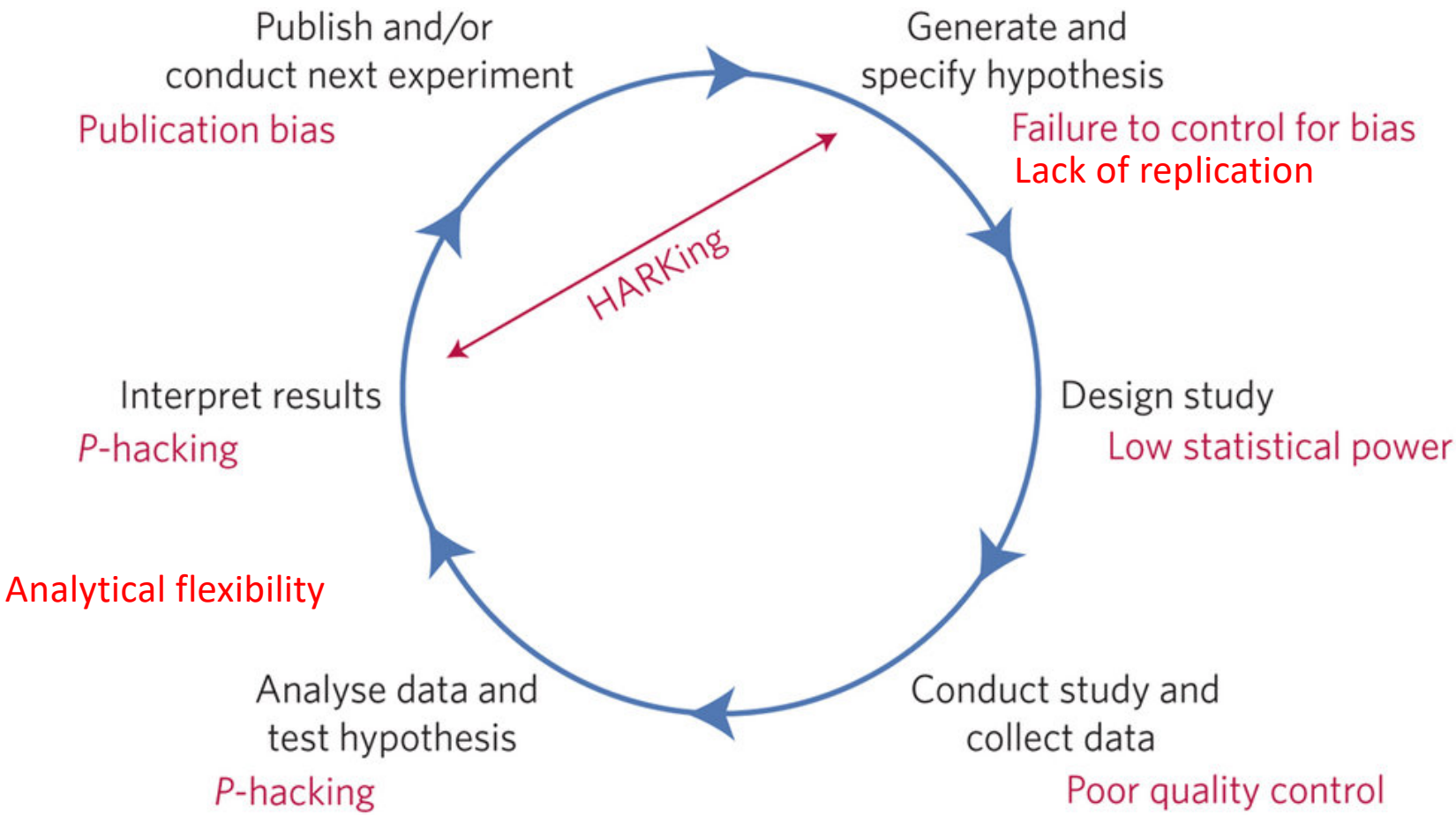
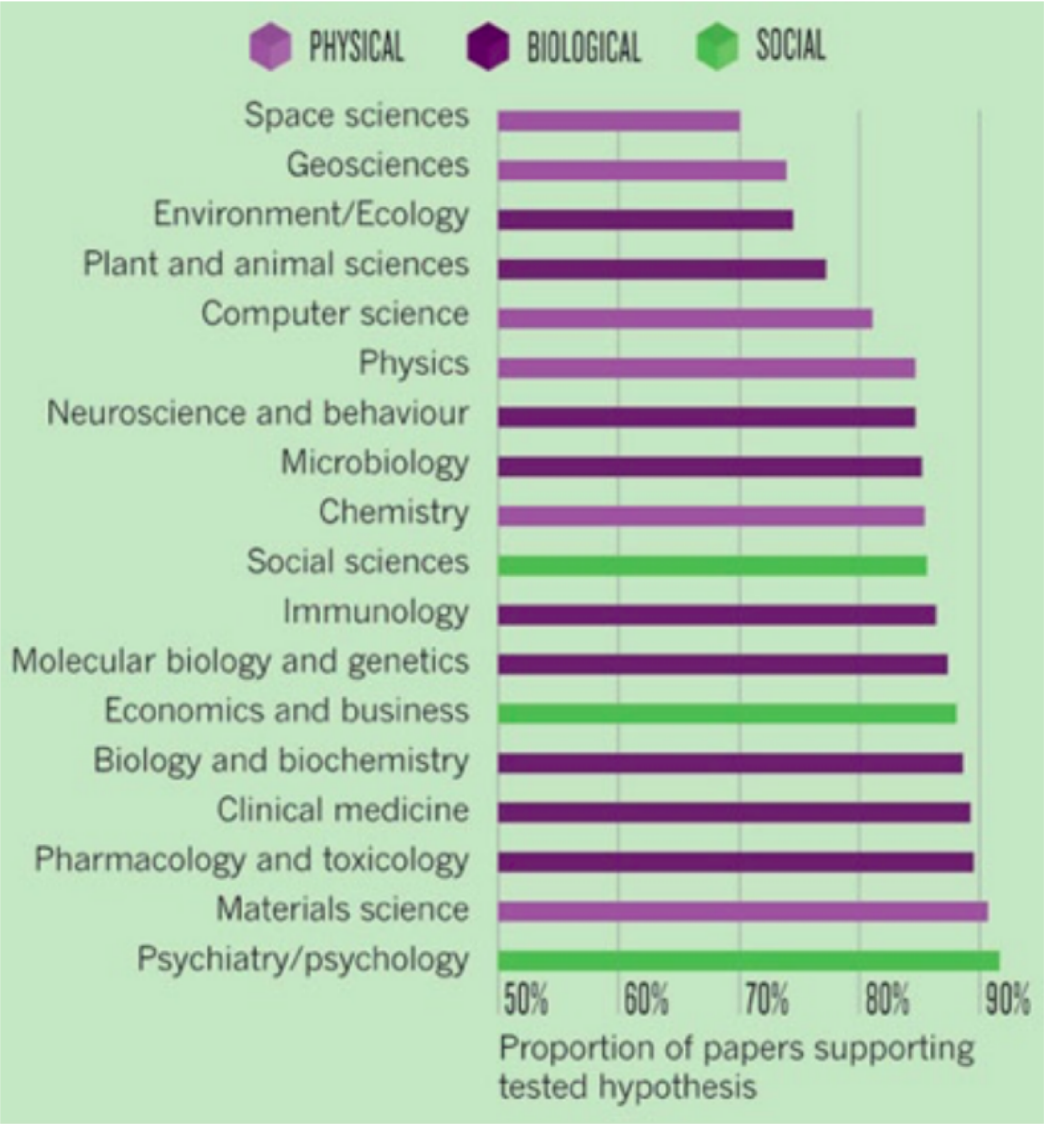


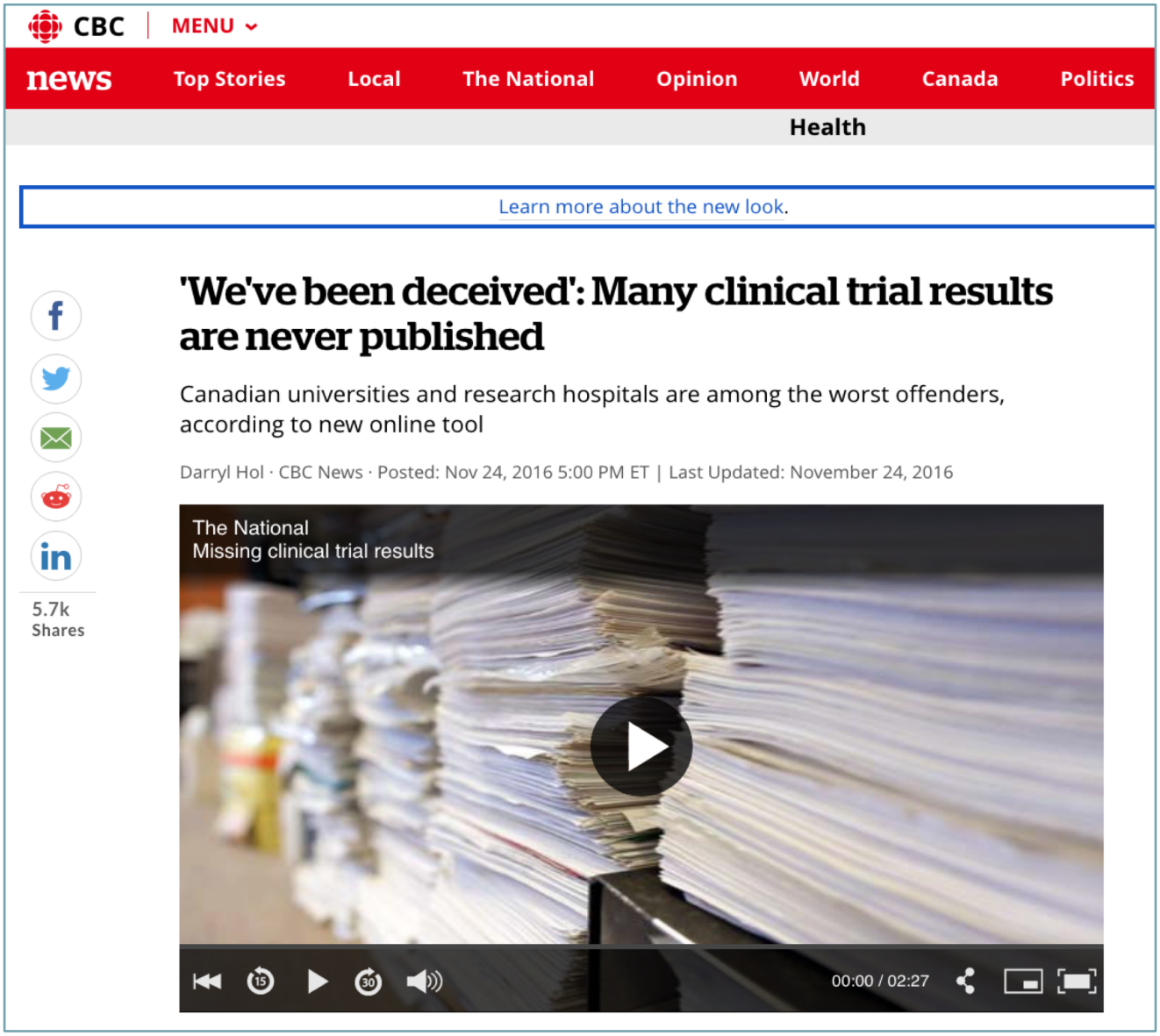
Publication bias: positive results

Positive Results by Discipline



Fanelli D (2010) "Positive" Results Increase Down the Hierarchy of the Sciences. PLOS ONE 5(4): e10068. CC-BY doi:10.1371/journal.pone.0010068

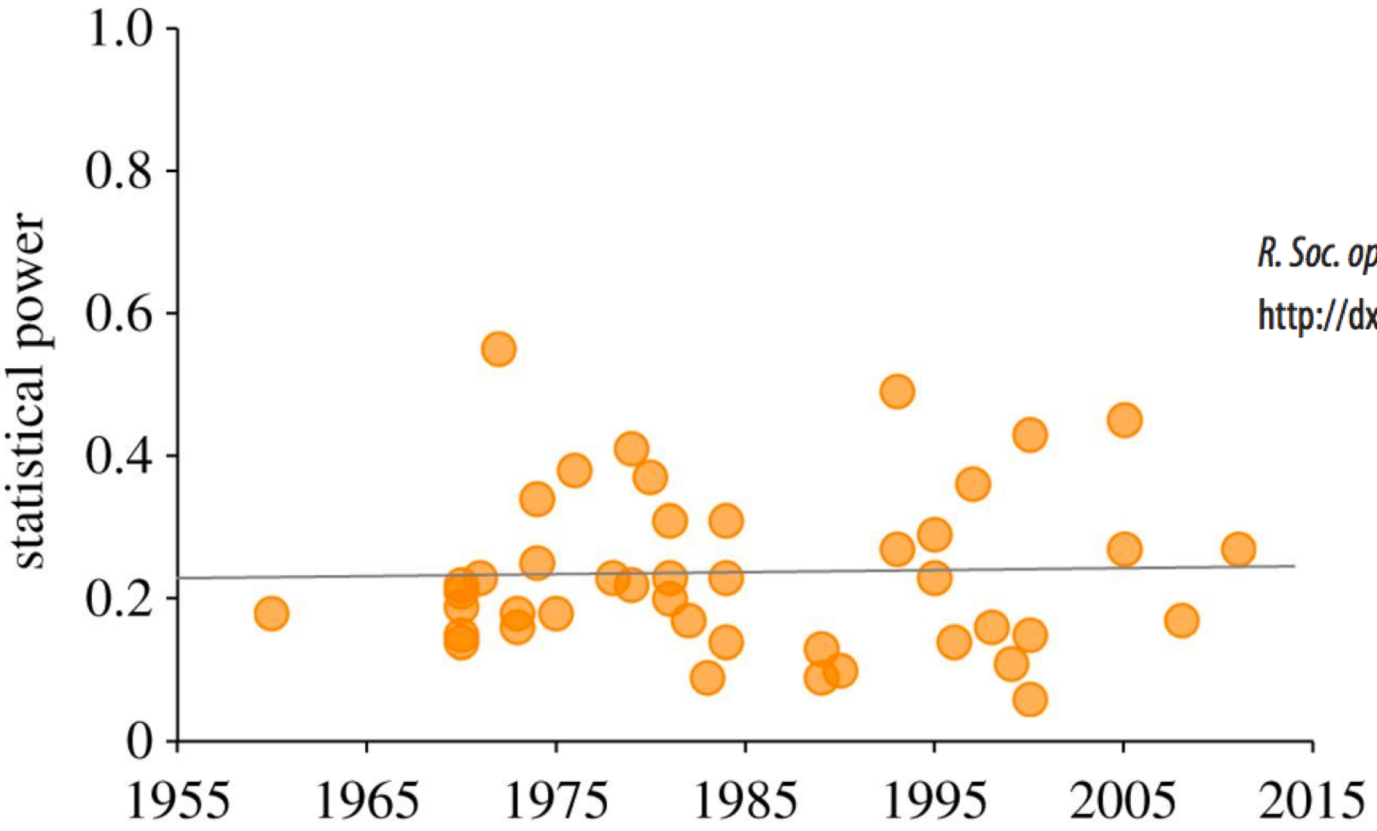
Publication bias: file drawer



Publication bias: file drawer

University or Institution	Proportion of registered trials missing results (%)
U. Health Network	76.3
U. of Calgary	75.8
U. of British Columbia	**72.4**
Queen's University	70.2
U. of Manitoba	67.2
U. of Alberta	66.7
U. of Toronto	65.5
Ottawa Hospital Research Institute	63.8
Hospital for Sick Children	62.1
	69.9

Low power



R. Soc. open sci. **3**: 160384.
http://dx.doi.org/10.1098/rsos.160384

Average statistical power from 44 reviews of papers published in journals in the social and behavioural sciences between 1960 and 2011. Data are power to detect small effect sizes (d=0.2), assuming a false-positive rate of α=0.05, and indicate both very low power (mean=0.24) but also no increase over time (R^2=0.00097).

Low power

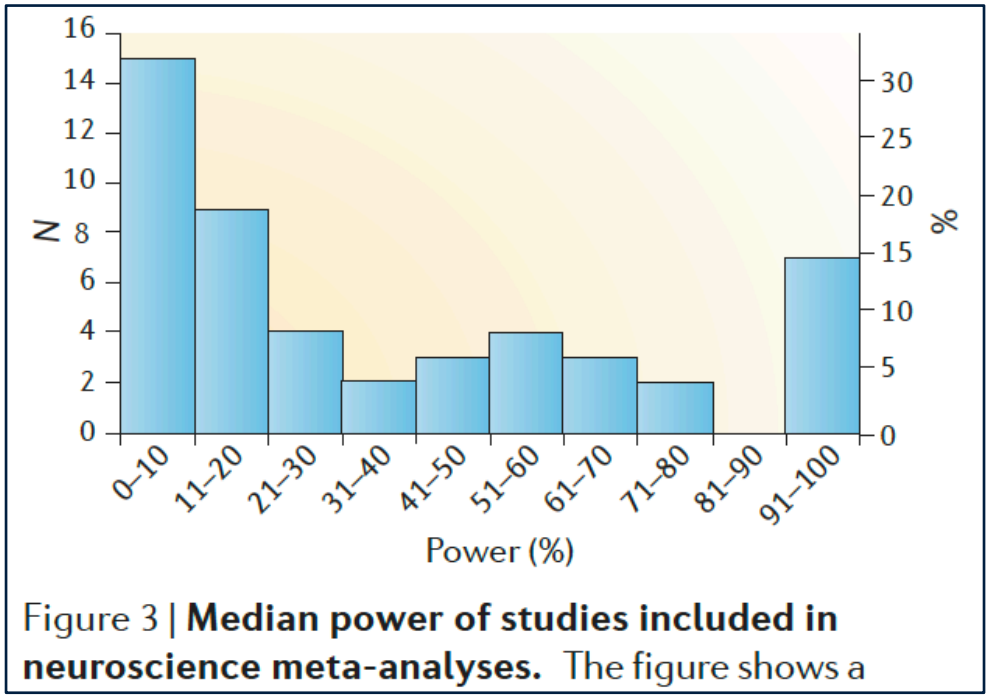


Figure 3 | **Median power of studies included in neuroscience meta-analyses.** The figure shows a

N = 49 studies

Power failure: why small sample size undermines the reliability of neuroscience

Katherine S. Button[1,2], John P. A. Ioannidis[3], Claire Mokrysz[1], Brian A. Nosek[4], Jonathan Flint[5], Emma S. J. Robinson[6] and Marcus R. Munafò[1]

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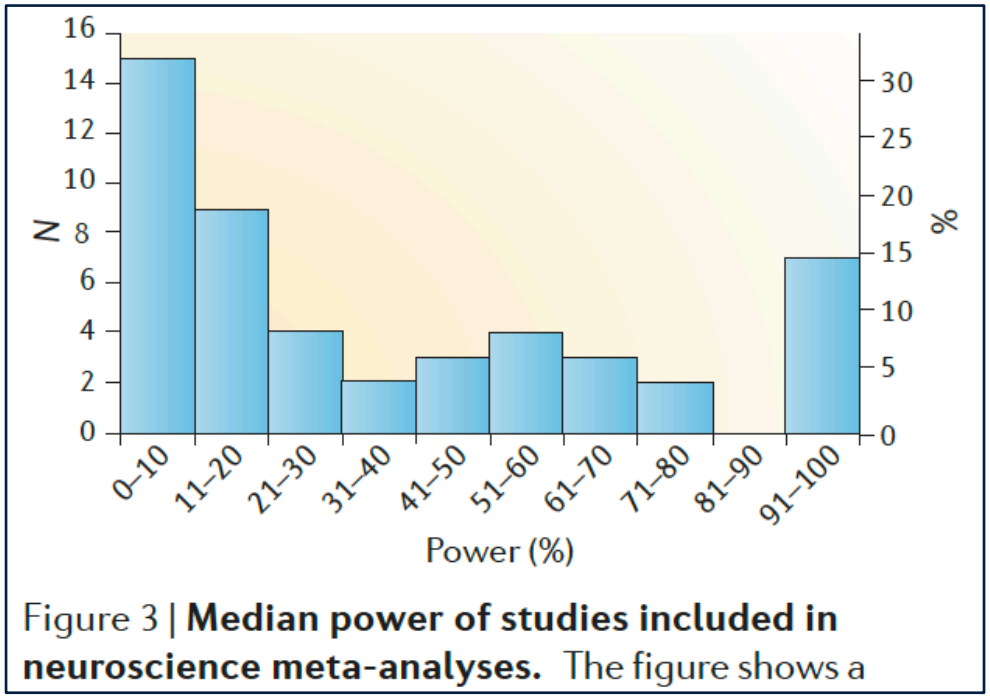

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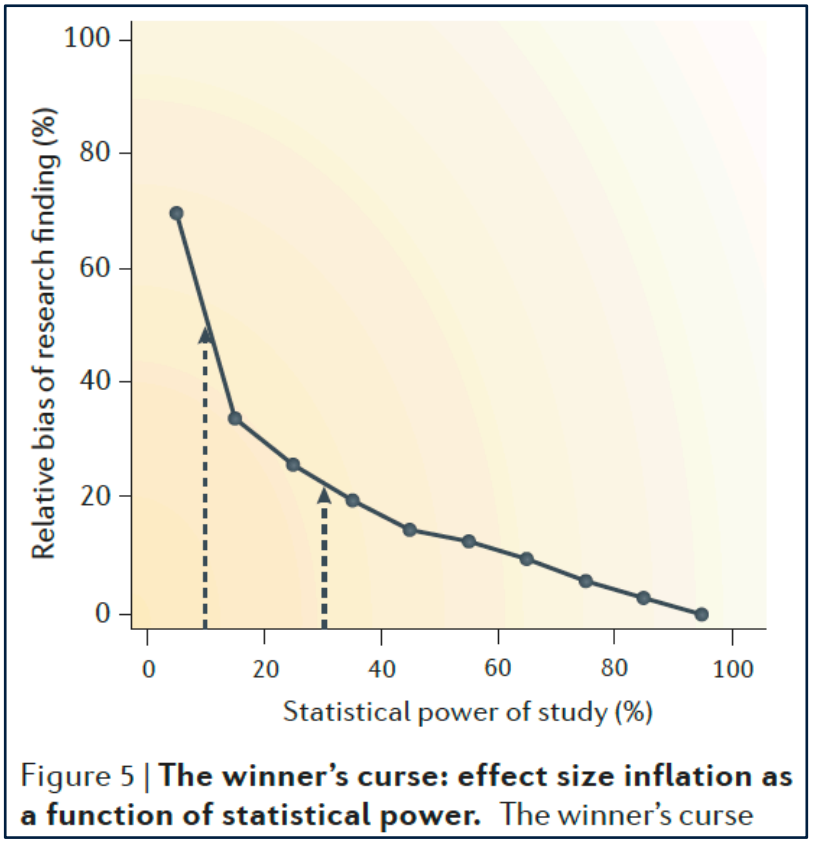

Figure 5 | **The winner's curse: effect size inflation as a function of statistical power.** The winner's curse

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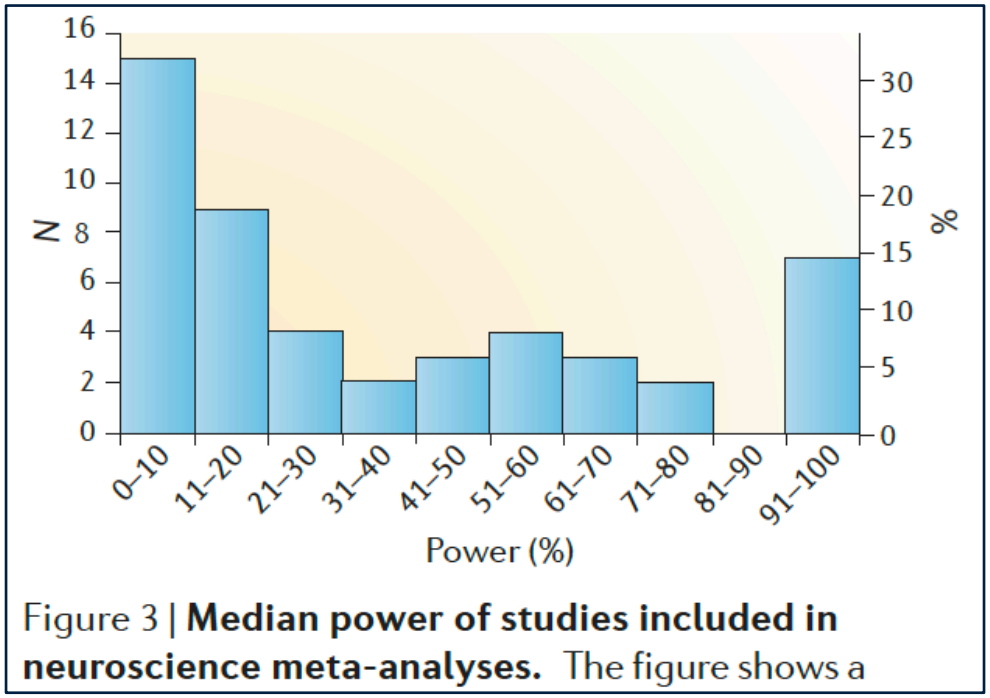

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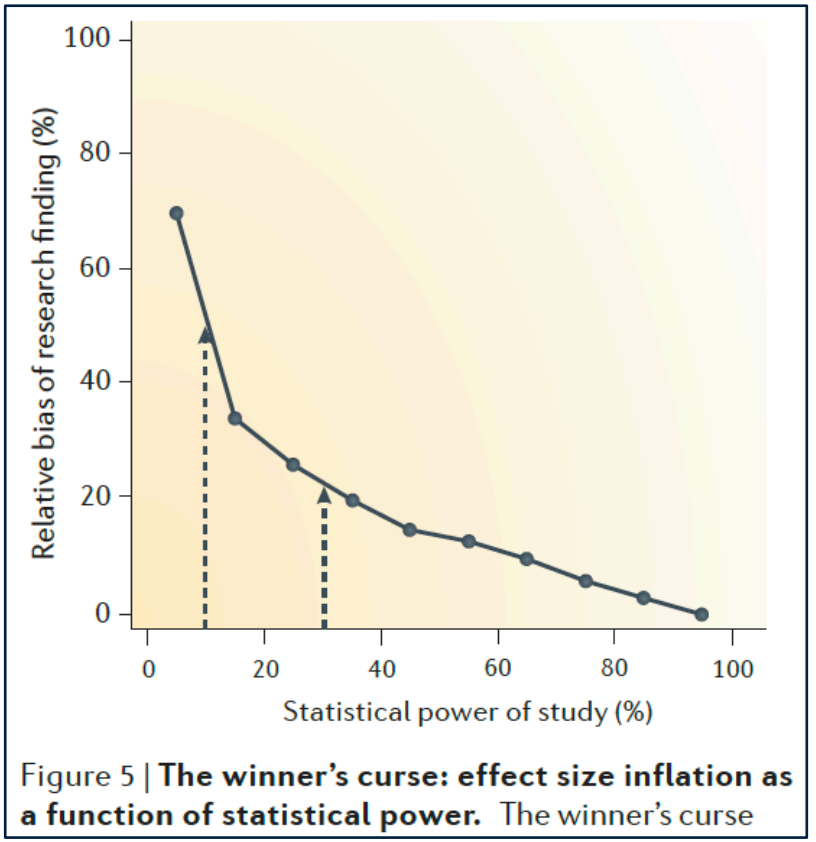

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Low power studies are prone to inflated effect sizes (even if no true effect is present)!

Low power

Type “M” error:

Quantifies the proportion by which the critical value must exceed the effect size in order to achieve statistical significance

Researcher degrees of freedom

All data processing and analytical choices made after seeing and interacting with your data

Results become data dependent, and no longer adhere to the original hypothesis testing model

Researcher degrees of freedom

- Should more data be collected?
- Should I exclude this ”outlier”? Is it an ”outlier”?
- These extra variables I measured, should they be used?
- This analysis seems to behave better than the other…
- Which variable should I use as my main dependent variable?
- How should I treat this covariate?

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- How should I treat this covariate?

Often feel very reasonable and logical in the moment, but…

Inflates false-positive rates and *P*-values become uninformative

Researcher degrees of freedom

Table 1. Likelihood of Obtaining a False-Positive Result

	Significance level		
Researcher degrees of freedom	$p < .1$	$p < .05$	$p < .01$
Situation A: two dependent variables ($r = .50$)	17.8%	9.5%	2.2%
Situation B: addition of 10 more observations per cell	14.5%	7.7%	1.6%
Situation C: controlling for gender or interaction of gender with treatment	21.6%	11.7%	2.7%
Situation D: dropping (or not dropping) one of three conditions	23.2%	12.6%	2.8%
Combine Situations A and B	26.0%	14.4%	3.3%
Combine Situations A, B, and C	50.9%	30.9%	8.4%
Combine Situations A, B, C, and D	81.5%	60.7%	21.5%

Joseph P. Simmons[1], Leif D. Nelson[2], and Uri Simonsohn[1]
[1]The Wharton School, University of Pennsylvania, and [2]Haas School of Business, University of California, Berkeley

Psychological Science
22(11) 1359–1366

Inaccessible data

META-RESEARCH ARTICLE
PLOS Biology | https://doi.org/10.1371/journal.pbio.2006930 November 20, 2018

Reproducible research practices, transparency, and open access data in the biomedical literature, 2015–2017

Joshua D. Wallach[1,2], Kevin W. Boyack[3], John P. A. Ioannidis[4,5,6,7,8]*

N = 149 randomly selected articles

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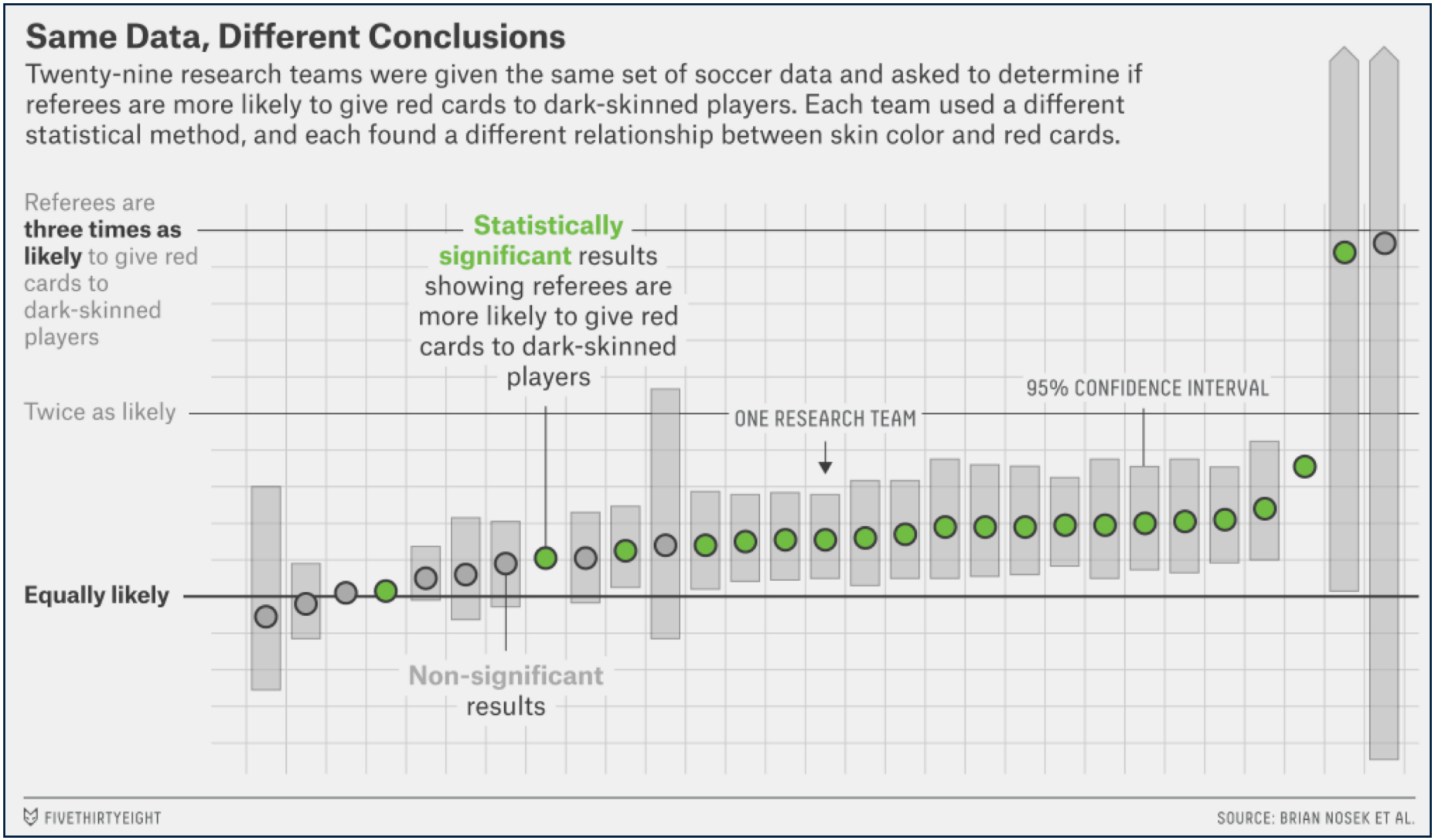
N = 149 randomly selected articles

Among the 104 articles with empirical data in which protocols or data sharing would be pertinent, **19** (18.3% [11.6% to 27.3%]) discussed publicly available data; only one (1.0% [0.1% to 6.0%]) included a link to a full study protocol.

Analytical flexibility



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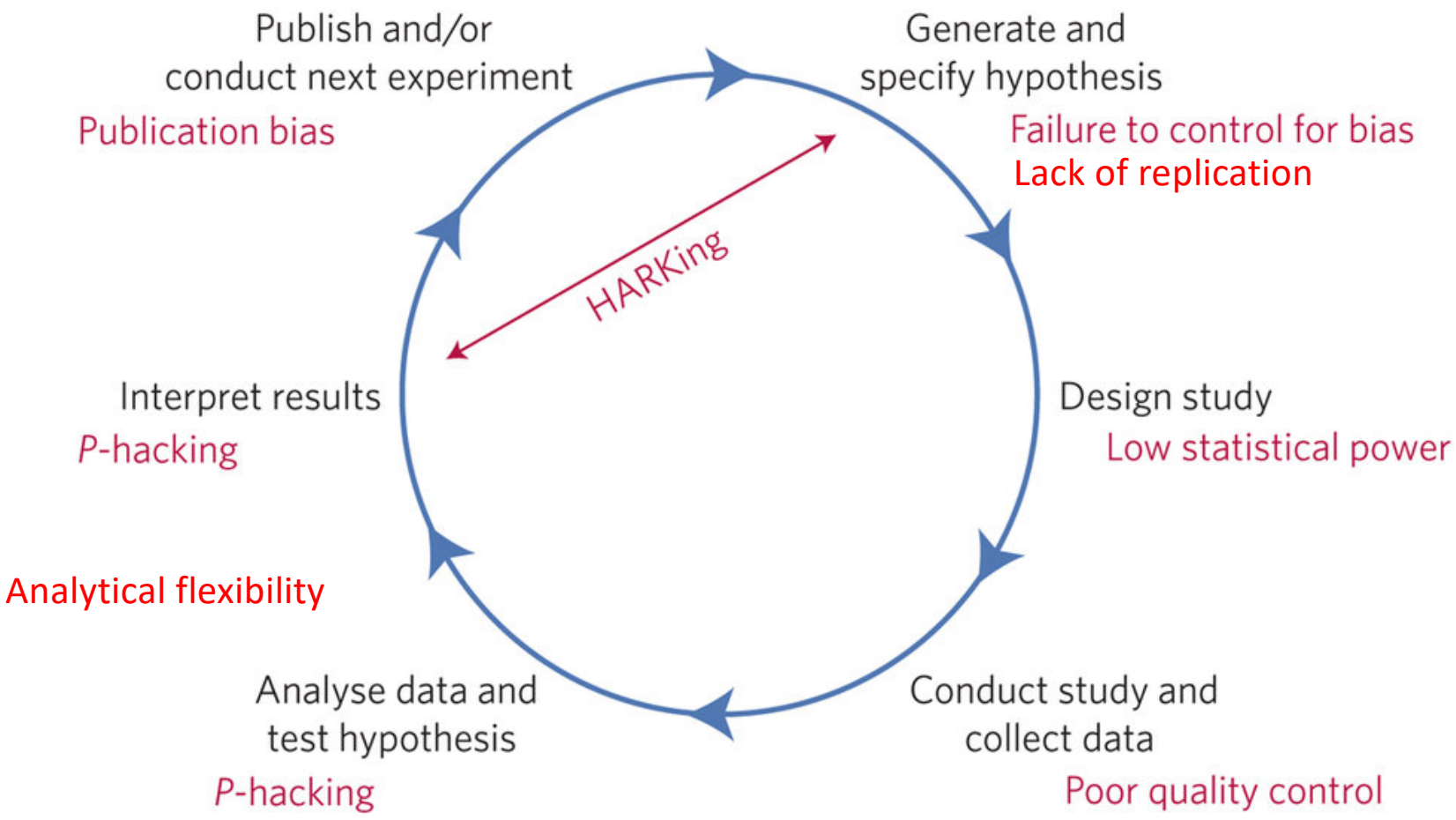
Sources of the problem



Moving Sport and Exercise Science Forward
doi:10.31236/osf.io/fxe7a

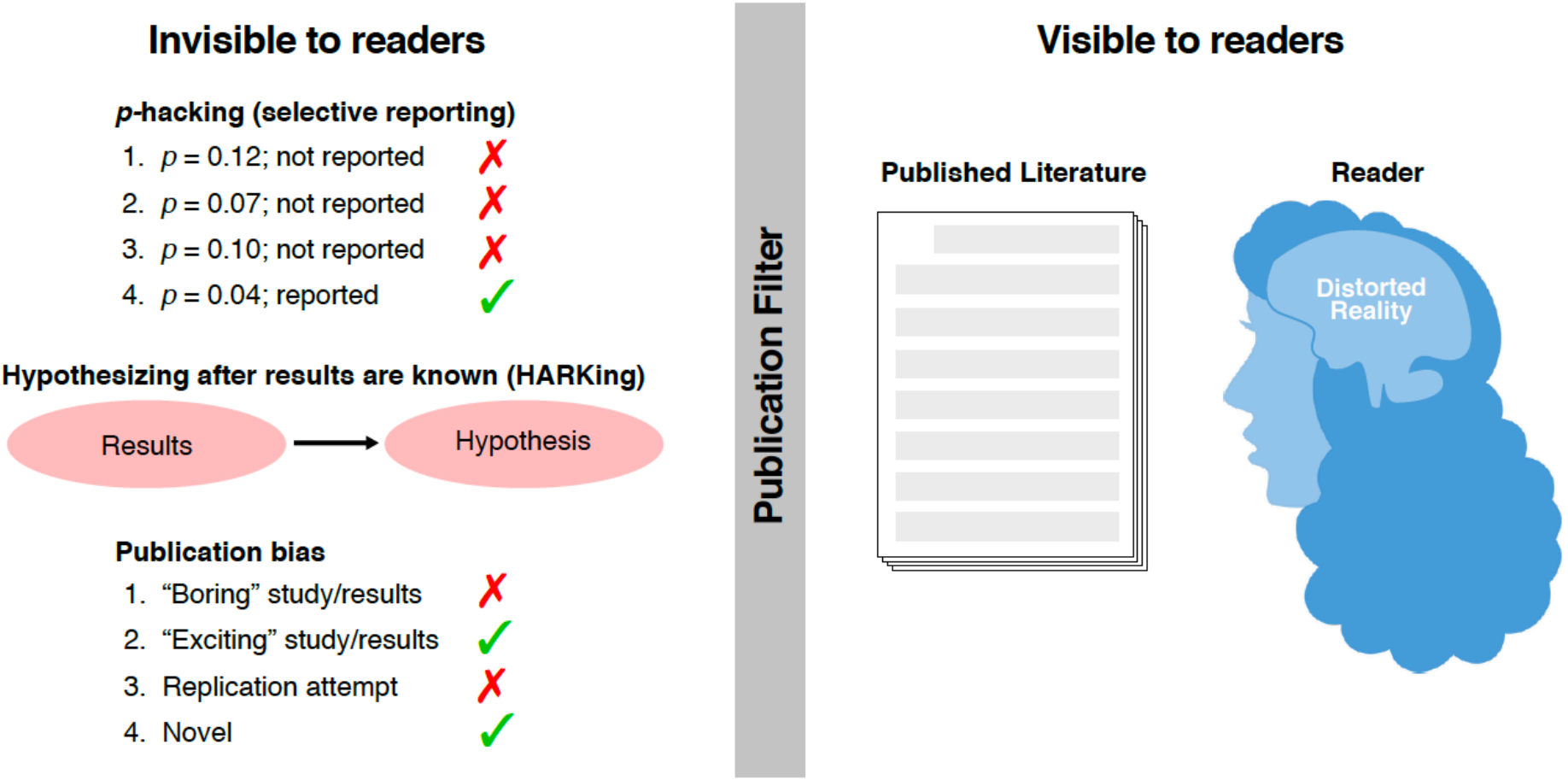


Figure 1: *Researchers' Distorted View of Reality.*
Researchers carry out numerous studies and perform many statistical tests, but not all of them are reported or published. Moreover, those results that are reported are not necessarily hypothesized *a priori*. These biases act as a filter, which distorts the findings present in the publish literature, providing readers (researchers) with a distorted view of reality.

A solution: practice Open Science

The workflow is key

Vast majority of the scientific workflow is obscured*

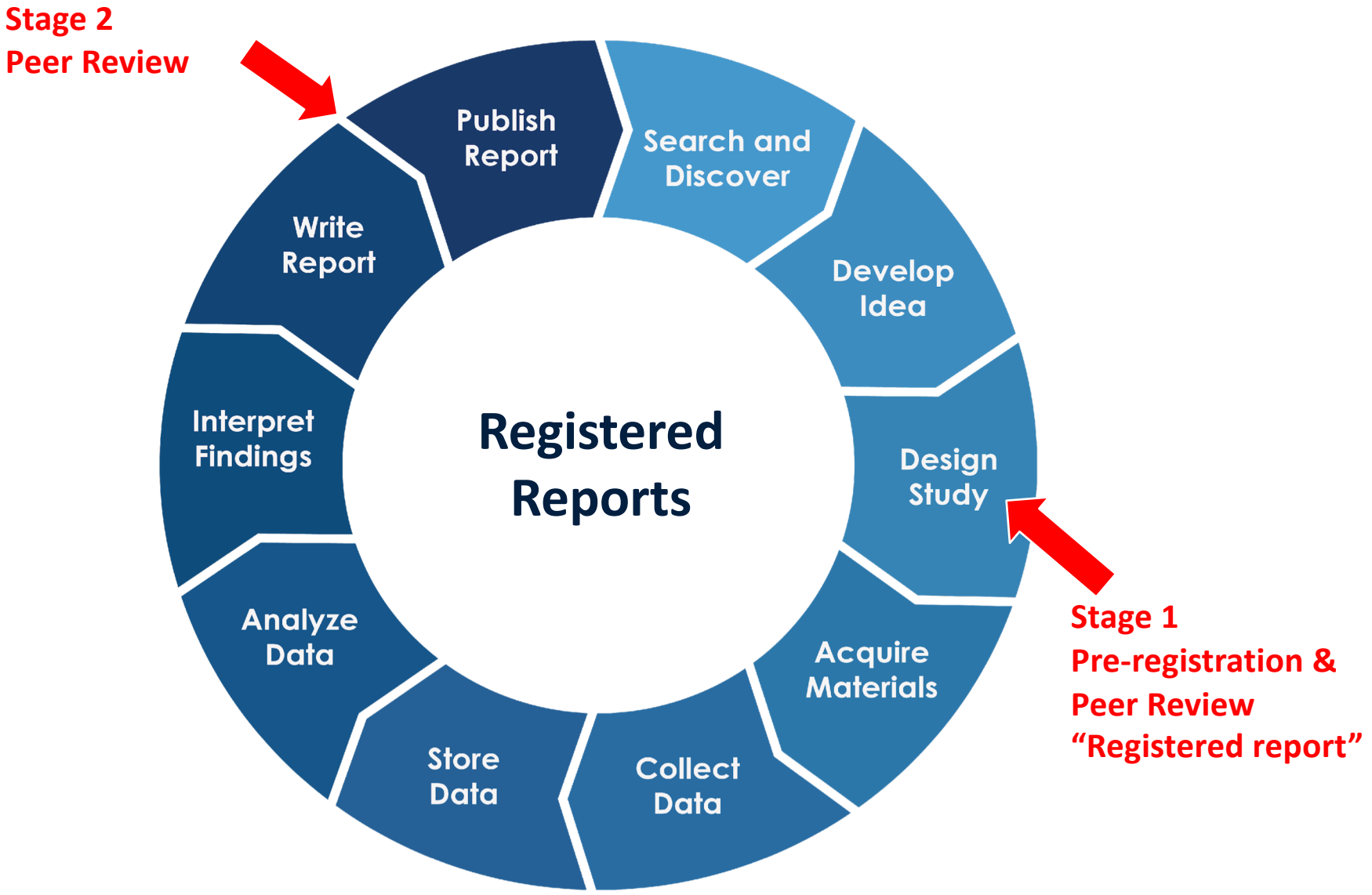
As a result:

- Hard to reproduce others' work
- Hard to reproduce our own work!
- Difficult to accumulate unpublished knowledge, or to use published results for additional analyses (e.g. meta-analyses)

* Some scientific disciplines (e.g. physics) better than others

Typical workflow

Ideal workflow



Ideal workflow

Stage 2
Peer Review

Decreases researcher d.f.
Holds you accountable to yourself and others

Stage 1
Pre-registration &
Peer Review
"Registered report"

Ideal workflow

Stage 2
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Stage 1
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If registration made public:
Helps replication attempts
Decreases the file drawer effect

Ideal workflow

Stage 2
Peer Review

207 journals have some form of RR adoption!

Decreases researcher d.f.
Holds you accountable to yourself and others

Stage 1
Pre-registration &
Peer Review
"Registered report"

If registration made public:
Helps replication attempts
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Ideal workflow

See here for list of current journals offering some form of registered report

Example registered reports

ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Registered report

Check for updates

Cite this article: Przybylski AK, Weinstein N. 2019 Violent video game engagement is not associated with adolescents' aggressive behaviour: evidence from a registered report. *R. Soc. open sci.* **6**: 171474.
http://dx.doi.org/10.1098/rsos.171474

Violent video game engagement is not associated with adolescents' aggressive behaviour: evidence from a registered report

Andrew K. Przybylski[1,2] and Netta Weinstein[3]

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[2]Department of Experimental Psychology, University of Oxford, Oxford, UK
[3]School of Psychology, Cardiff University, Cardiff, UK

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Example registered reports

Reproducibility project: Cancer Biology

Estimating the reproducibility of psychological science

All contributing studies include registered reports.

Open science lite

Central to most definitions of open science:

- Research workflow is transparent, open, and thoroughly documented from the start
- Annotated scripts are shared
- The data themselves are open*

* This is not strictly necessary to ensure reproducibility

Open science lite

Central to most definitions of open science:

- Research workflow is transparent, open, and thoroughly documented from the start
- Annotated scripts are shared
- The data themselves are shared

On their own, these features go a long way towards ensuring reproducibility of research.

Open science lite

Central to most definitions of open science:

- Research workflow is transparent, open, and thoroughly documented from the start
- Annotated scripts are shared
- The data themselves are shared or at least accessible

On their own, these features go a long way towards ensuring reproducibility of research.

Even better:

- Pre-register study (different from full registered report)

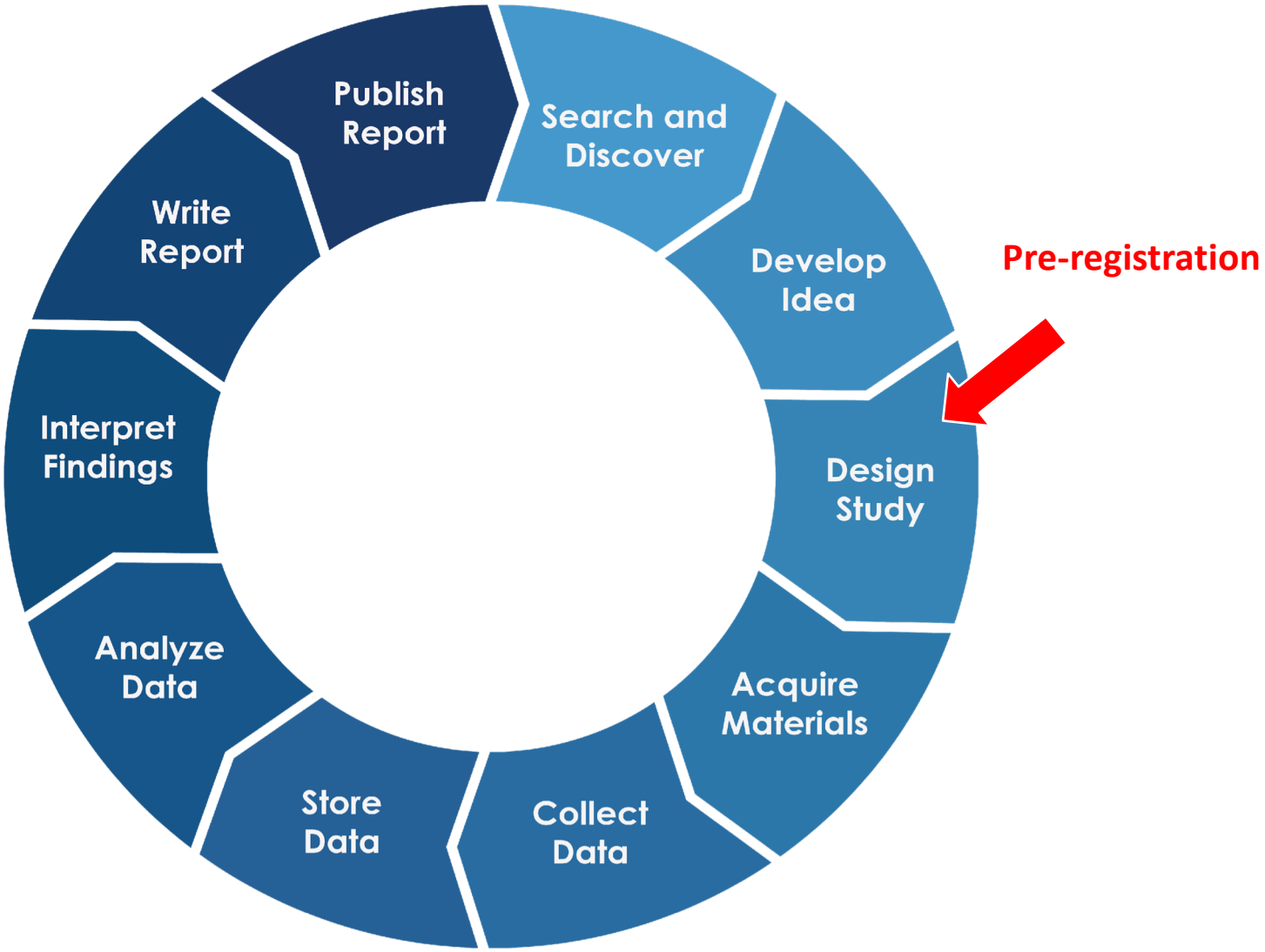
Pre-registration

Documenting your research plan in a read-only public repository before you conduct the study

At a minimum, a pre-registration should include the "what" of a study:

- Research question
- **Target population and sample size based on power analyses or, better, estimates of Type M error**
- General design
- Variables to be measured / dataset you'll be using

Workflow for the masses



Pre-registration

Helps reduce publication bias, specifically the “file drawer effect”, by increasing discoverability of unpublished studies.

Helps you as a researcher plan ahead more carefully, and fosters greater awareness of pitfalls associated with researcher degrees of freedom.

Focuses attention on effect sizes and reducing type M errors

What good is Open Science to me personally?

POINT OF VIEW
McKiernan *et al.* eLife 2016;5:e16800. DOI: 10.7554/eLife.16800

How open science helps researchers succeed

Abstract Open access, open data, open source and other open scholarship practices are growing in popularity and necessity. However, widespread adoption of these practices has not yet been achieved. One reason is that researchers are uncertain about how sharing their work will affect their careers. We review literature demonstrating that open research is associated with increases in citations, media attention, potential collaborators, job opportunities and funding opportunities. These findings are evidence that open research practices bring significant benefits to researchers relative to more traditional closed practices.

DOI: 10.7554/eLife.16800.001

ERIN C MCKIERNAN*, PHILIP E BOURNE, C TITUS BROWN, STUART BUCK, AMYE KENALL, JENNIFER LIN, DAMON MCDOUGALL, BRIAN A NOSEK, KARTHIK RAM, COURTNEY K SODERBERG, JEFFREY R SPIES, KAITLIN THANEY, ANDREW UPDEGROVE, KARA H WOO AND TAL YARKONI

Benefits of adopting Open Science

Improves Efficiency

- Saves time and $$
- Re-use methods / code
- Avoids duplication while enabling replication
- Facilitates meta-analyses
- Promotes accurate discovery

Benefits of adopting Open Science

- Funding agencies (e.g. Tri-Council) are increasingly demanding aspects of OS (e.g. open data, open access)
- OS practices are increasingly being favoured at academic institutions
- Many aspects of OS will eventually be required

Tools that can help

- Open Science Framework (https://osf.io)
- Scripting (e.g. using R instead of Excel! R Markdown)
- Git / Github (see lesson here)
- Data management plan tools e.g. here

Scripting using R / R Markdown, Python etc…

Open Science Framework

https://people.ok.ubc.ca/jpither/modules/biol202_home.html

Starter Tutorials

- Tutorial 00: Preparing and formatting assignments for submission
- Tutorial 01: Visualizing and describing a single variable
- Tutorial 02: Visualizing associations between two variables
- Tutorial 03: Calculating descriptive statistics for a numeric variable grouped by a categorical variable
- Tutorial 04: Sampling, Estimation, and Uncertainty
- Tutorial 05: Random trials
- Tutorial 06: Hypothesis_testing
- Tutorial 07: Estimating proportions
- Tutorial 08: Binomial distribution and binomial test
- Tutorial 09: Goodness of fit tests
- Tutorial 10: Odds Ratio
- Tutorial 11: Contingency Analysis
- Tutorial 12: The normal distribution
- Tutorial 13: Comparing one mean to a hypothesized value
- Tutorial 14: Comparing two means
- Tutorial 15: Comparing means among more than two groups using ANOVA
- Tutorial 16: Correlation analysis
- Tutorial 17: Regression analysis
- Markdown files for the tutorials
- Extra tutorials
- Master list of functions by lab

BIOL202: Introduction to Biostatistics

This page was last updated on September 17, 2019.

It is continually being updated, so be sure to refresh the page in your browser each time you visit!

You should download copies of these helpful **cheatsheets** and have them on hand:

- RStudio cheatsheet
- R Markdown cheatsheet

These cheat sheets deal with packages that will increasingly be used in the tutorials:

- ggplot2 cheatsheet
- dplyr cheatsheet

Starter Tutorials

These tutorials teach you the fundamentals of R and R Markdown, and should be completed prior to attempting any subsequent tutorials.

Introduction to R & RStudio

- What is R and RStudio?
- Installing R and RStudio
- How do I code in R?
- What are "packages"?
- Additional resources for learning R and RStudio

Reproducible R with R Markdown **Updated**: Friday Sept 7, 3pm: I clarified instructions on creating new projects in RStudio

- Creating a reproducible lab report
- What is R Markdown?
- Workflow: create a project and R Markdown document
- More R Markdown information

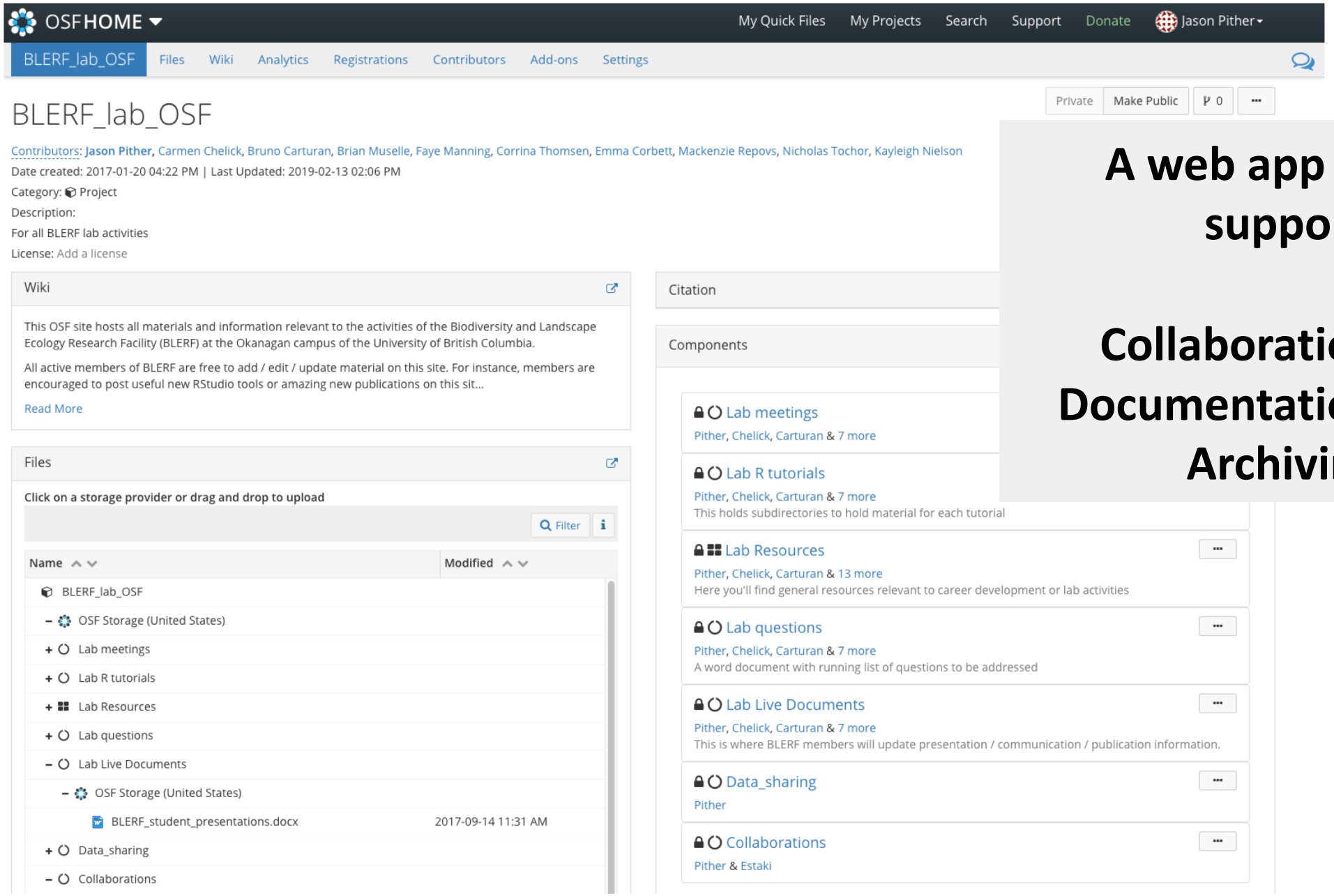
Importing data into R **Work in progress**

Tutorial 00: Preparing and formatting assignments for submission

This tutorial provides instructions on how to prepare your assignments for submission.

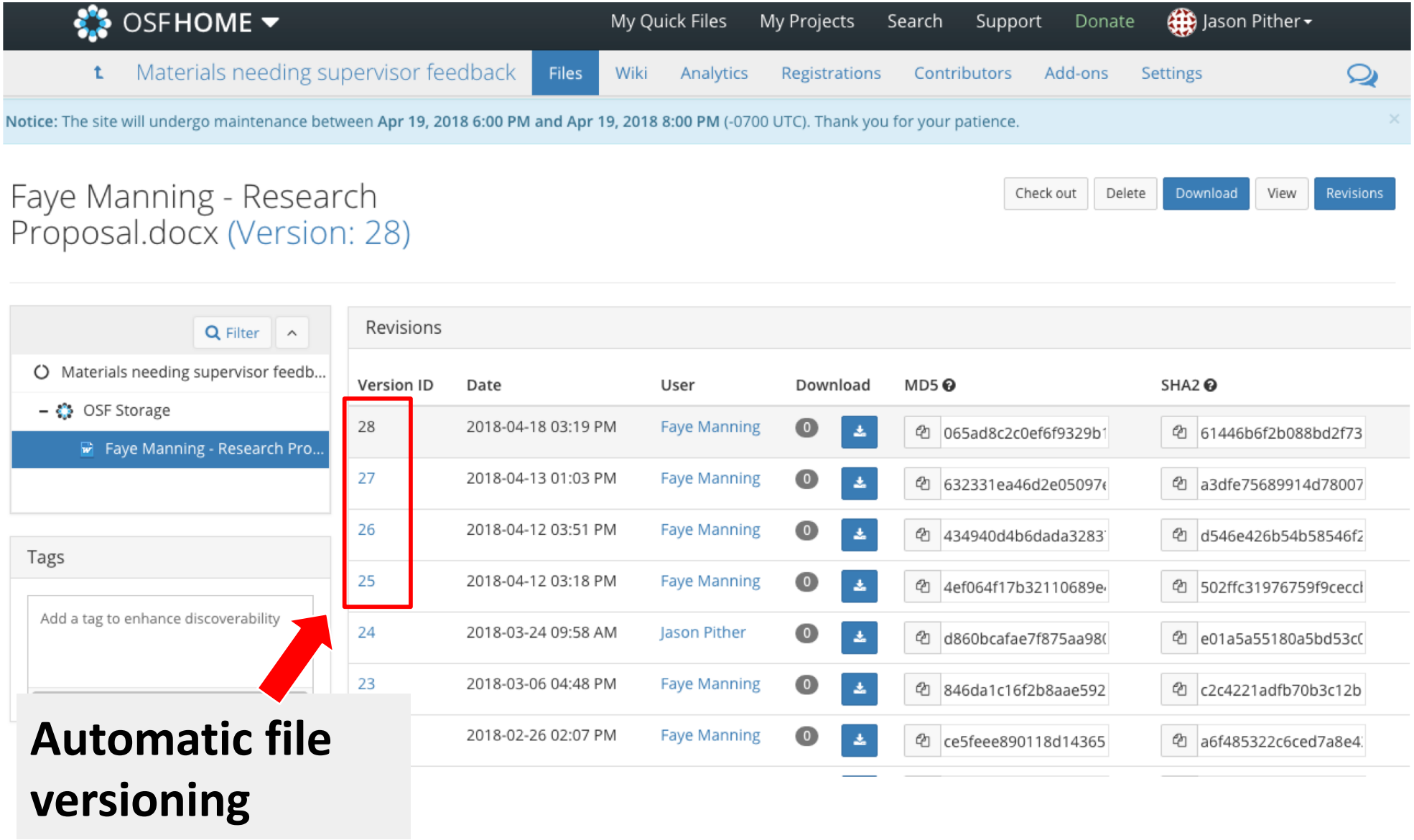
Tutorial 01: Visualizing and describing a single variable

Learn with simulated data!



A web app to support:

Collaboration
Documentation
Archiving



Automatic file versioning

Wiki

This is a public repository containing all information and data relevant to the following article that has been accepted for publication at the **New Phytologist**:

Belowground biotic interactions moderated the post-glacial range dynamics of trees

Jason Pither, Brian J. Pickles, Suzanne W. Simard, Alejandro Ordonez, John W. Williams

Citation osf.io/vuhe8

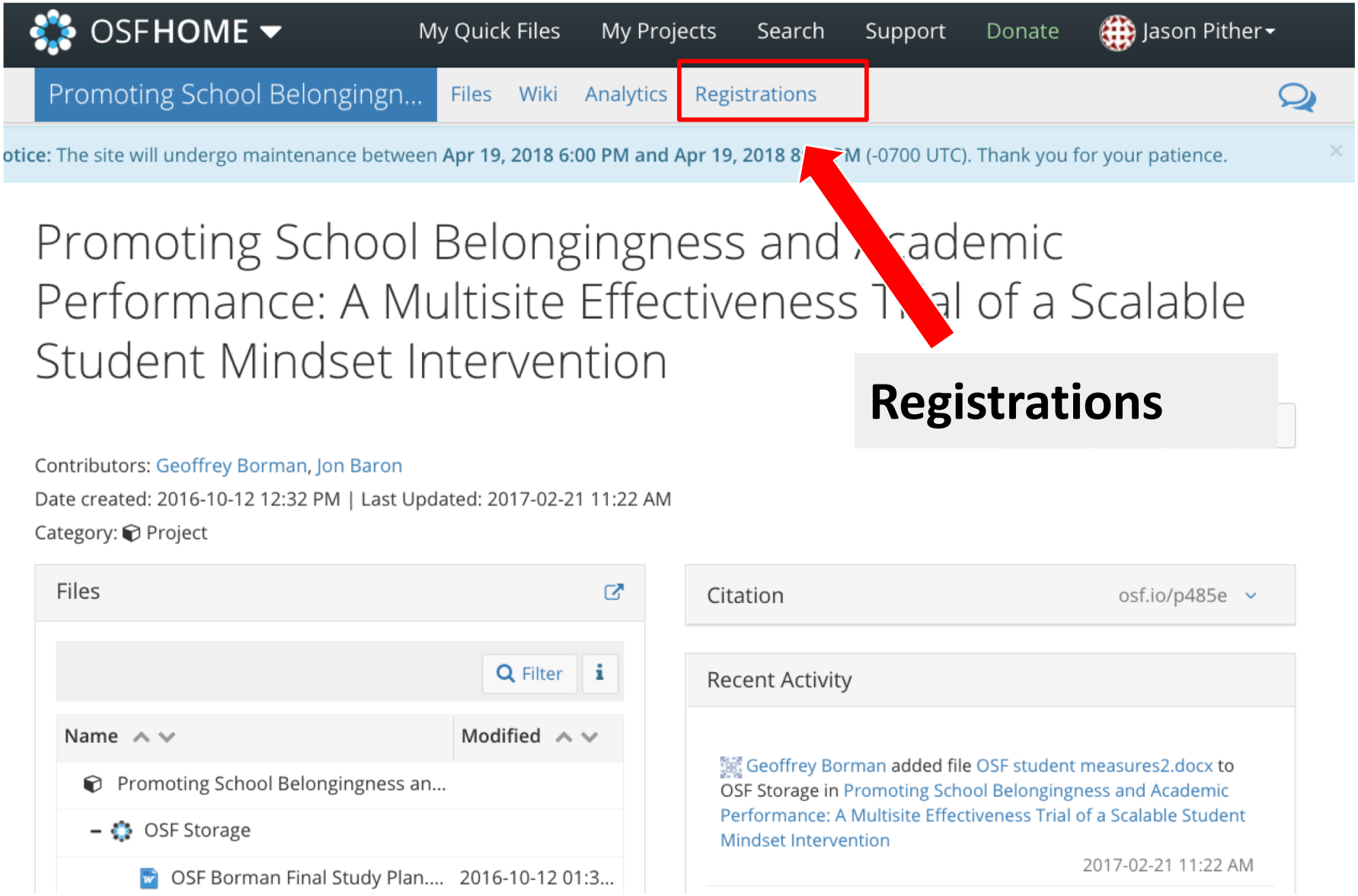
APA

Pither, J., & Pickles, B. J. (2018, April 12). Belowground biotic interactions moderated the post-glacial range dynamics of trees. http://doi.org/10.17605/OSF.IO/VUHE8

MLA

Pit[illegible], Jason, and Brian J Pickles. "Belowground Biotic I[illegible]ractions Moderated the Post-Glacial Range Dynamics of [illegible]ees." Open Science Framework, 12 Apr. 2018. Web.

Persistent citable identifiers


OSFHOME
My Quick Files
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Jason Pither
Promoting School Belongingn...
Files
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Registrations
otice: The site will undergo maintenance between Apr 19, 2018 6:00 PM and Apr 19, 2018 8
M (-0700 UTC). Thank you for your patience.
Promoting School Belongingness and Academic Performance: A Multisite Effectiveness Trial of a Scalable Student Mindset Intervention
Registrations
Contributors: Geoffrey Borman, Jon Baron
Date created: 2016-10-12 12:32 PM | Last Updated: 2017-02-21 11:22 AM
Category: Project
Files
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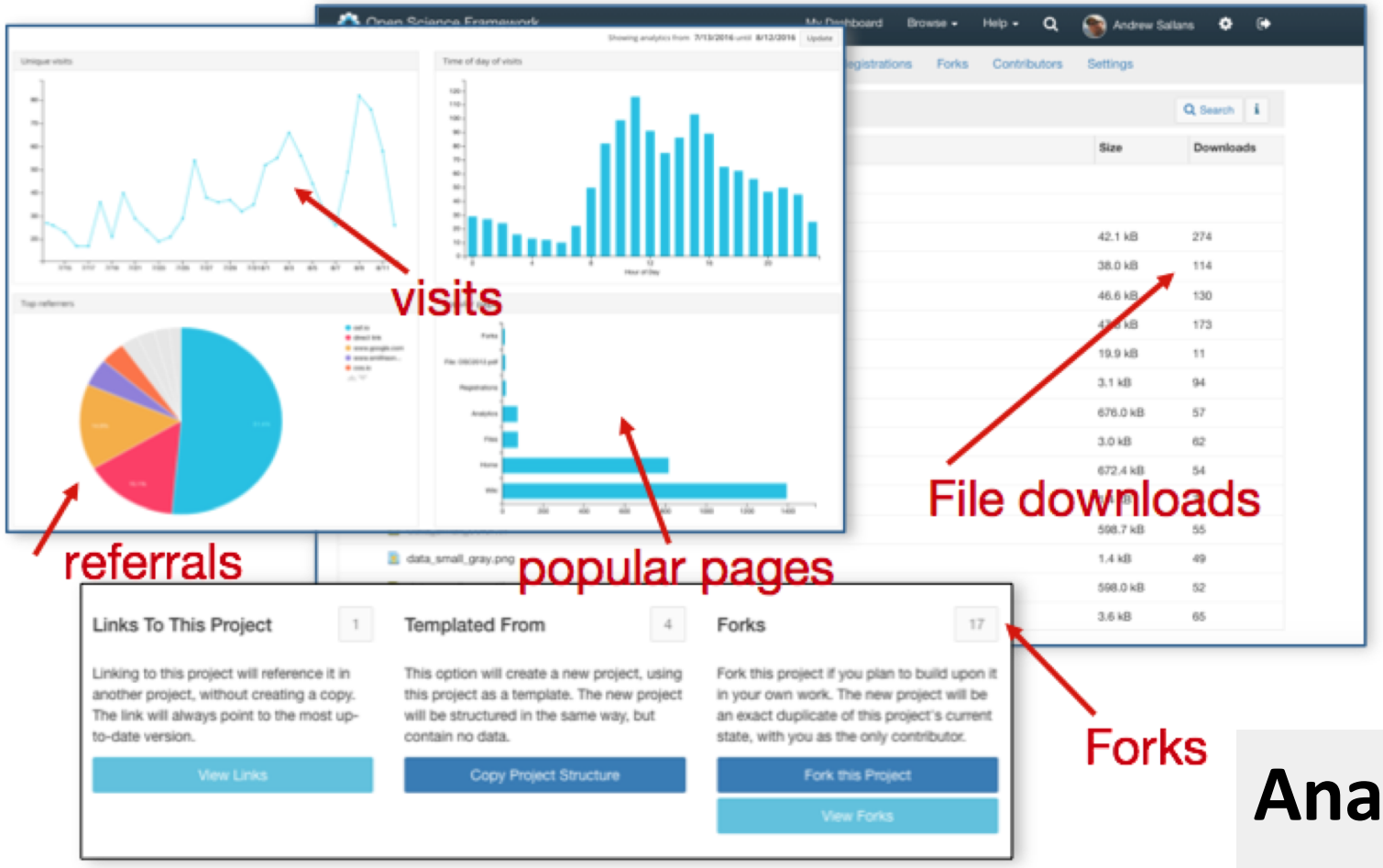
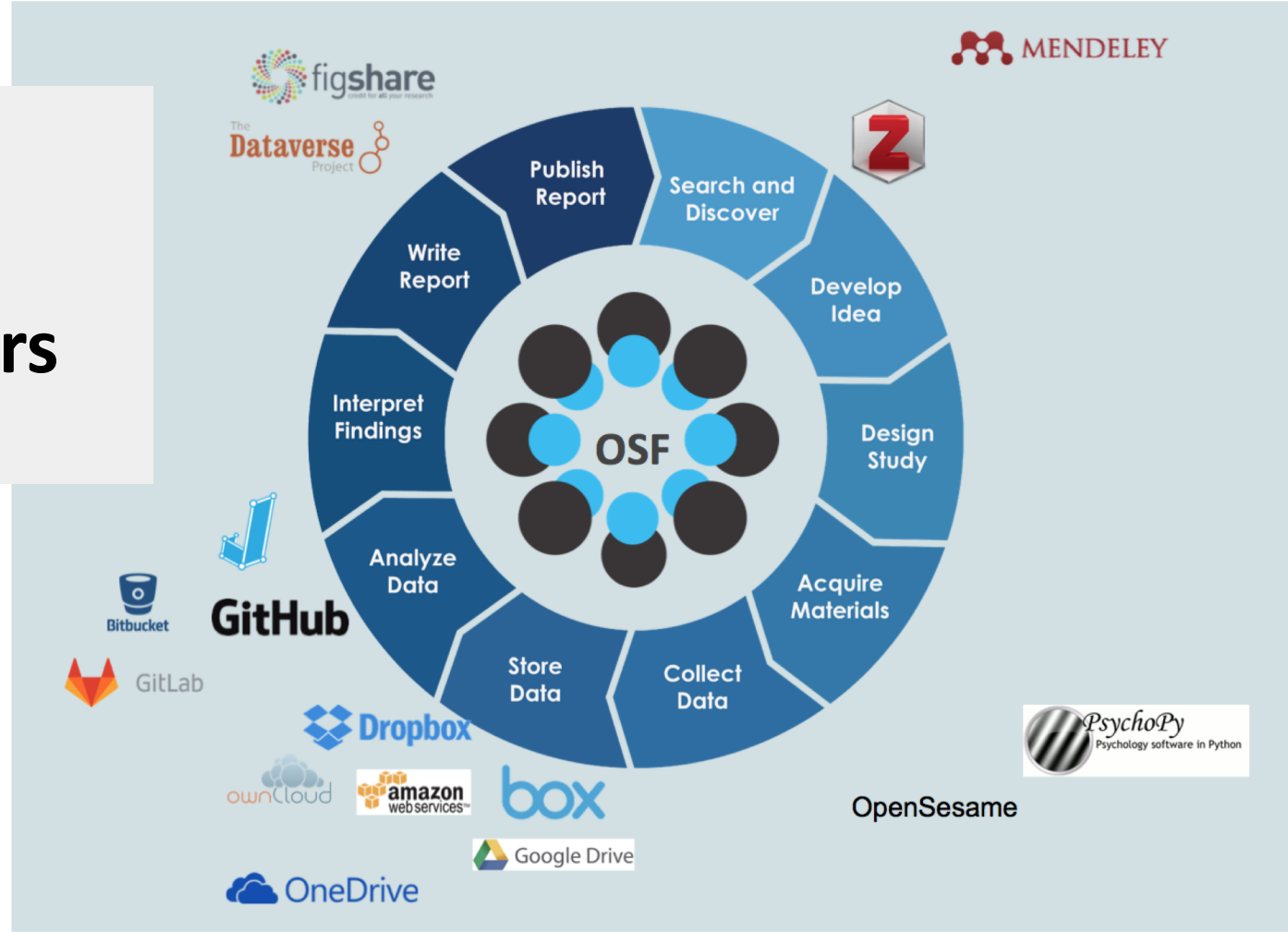
Promoting School Belongingness an...
OSF Storage
OSF Borman Final Study Plan.... 2016-10-12 01:3...
Citation
osf.io/p485e
Recent Activity
Geoffrey Borman added file OSF student measures2.docx to OSF Storage in Promoting School Belongingness and Academic Performance: A Multisite Effectiveness Trial of a Scalable Student Mindset Intervention
2017-02-21 11:22 AM


visits
referrals
popular pages
File downloads
Forks
Links To This Project
Templated From
Forks
Linking to this project will reference it in another project, without creating a copy. The link will always point to the most up-to-date version.
This option will create a new project, using this project as a template. The new project will be structured in the same way, but contain no data.
Fork this project if you plan to build upon it in your own work. The new project will be an exact duplicate of this project's current state, with you as the only contributor.
View Links
Copy Project Structure
Fork this Project
View Forks

Analytics

Connects services researchers use



Preprint services enhance research visibility

Open Science @

Excellence fund strategic initiative:

FOSTERING OPEN SCIENCE AT UBC

This project targets research support and educational initiatives at the undergraduate and graduate levels in order to integrate Open Science practices. Open Science represents an approach to research that emphasizes reproducibility, transparency and accessibility. This project has two strategic goals: first, to establish the expertise and infrastructure required to foster the practice of Open Science among willing members of the entire UBC research community at both campuses. Secondly, to ensure that the core tenets of Open Science are of second nature to graduates of UBC's undergraduate and graduate programs.

Related strategy(ies): Strategy 8: Student Research, Strategy 9: Knowledge Exchange, Strategy 10: Research Culture, Strategy 12: Program Redesign and Strategy 14: Practical Learning
Project sponsor: Provost and Vice-President Academic UBCV; Provost and Vice-Principal Academic UBCO; Associate Vice-President Research & Vice-Principal Research
Target end date: Winter 2020
Progress: On track

UBC-wide initiatives

- Funded by UBC Excellence Fund: strategic initiative
- Promoting best practices in OS throughout UBC community
- Library and Advanced Research Computing developing sustainable infrastructure and expertise to support Open Science and **OSF**
- Establishment of OSF Institutions for UBC (coming soon!)
- Providing regular workshops, seminars, outreach at both campuses
- Developing instructional material for credit - BIOLOGY
- Engaging with Faculty Association and administration to encourage collaborative policy development
- openscience.ubc.ca

Organize and increase visibility of your institutional research.

OSF Institutions is a scholarly web tool that enhances transparency, fosters collaboration, and increases the visibility of research outputs at leading research institutions. The Center for Open Science partners with these institutions to create central hubs for research projects on a branded, dedicated OSF page.

OSF INSTITUTIONS

Single sign-on authentication creates a seamless and integrated framework that accommodates custom research workflows and streamlines institutional data management. You can focus your efforts on generating and sharing research, not on building and maintaining research infrastructure.

Key Benefits for Your Institution

- Collaborate at all levels of a project within the institution as well as outside collaborators
- Conveniently share and make whole projects or just parts of them public, and retain security and privacy for project elements that are not shareable because of ethical or proprietary considerations
- Archive and cite projects easily
- Connect 3rd party tools and services & eliminate silos or redundancy
- Provide visibility for ongoing and unpublished research across the entire institution
- Gain insight and data on research collaboration throughout your organization
- Evaluate impact of research investment beyond citations

Get Started Now

At UBC's Okanagan campus

Pilot project underway

Integrating best practices in Open Science into the Biology undergraduate program. Starting with small steps...

- Developing and deploying introductory instructional material regarding OS (currently in 1st year BIOL)
- Uploading / archiving digital photos of lab book notes to Canvas
- Teaching R Markdown in 2nd year core Biostats course (BIOL202)
- Encouraging use of Markdown for upper-year lab assignments
- Encouraging instructors to reward transparency and honesty

Longer-term goal

- Accreditation for undergrads and grads

Acknowledgments

- Dr. Eric Eich (Vice-Provost and AVP Academic Affairs)
- Heather Berringer (Chief Librarian, Okanagan campus)
- Sharon Hanna (UBCO librarian helping with OS initiatives)
- Centre for Open Science (https://osf.io)
- Wade Klaver (UBC ARC)
- Carmen Chelick and Brian Muselle (MSc Biology students)
- Department of Biology (Okanagan campus)
- Steve Cundy and UBC's Advanced Research Computing team
- UBC Excellence Fund

Extra slides

Discussion points:

- Early career researchers
- Promotion & Tenure
- How to effect change
- Lab practices
- Exploratory vs confirmatory data analysis
- Open Access publications
- eLife interactive articles