
Reproducibility, Replicability, and Open Science

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Learning Objectives

By the end of this class, you will be able to:

- ❖ define the "reproducibility crisis" and describe some of the causes
 - ❖ contrast "replicability" and "reproducibility" (NASEM)
 - ❖ describe open practices for improving reproducibility
 - ❖ identify next steps in making your own research more open
-

The "Reproducibility Crisis"

Open access, freely available online

Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

The
Economist

Menu

Weekly edition

Search

Sign in

Briefing

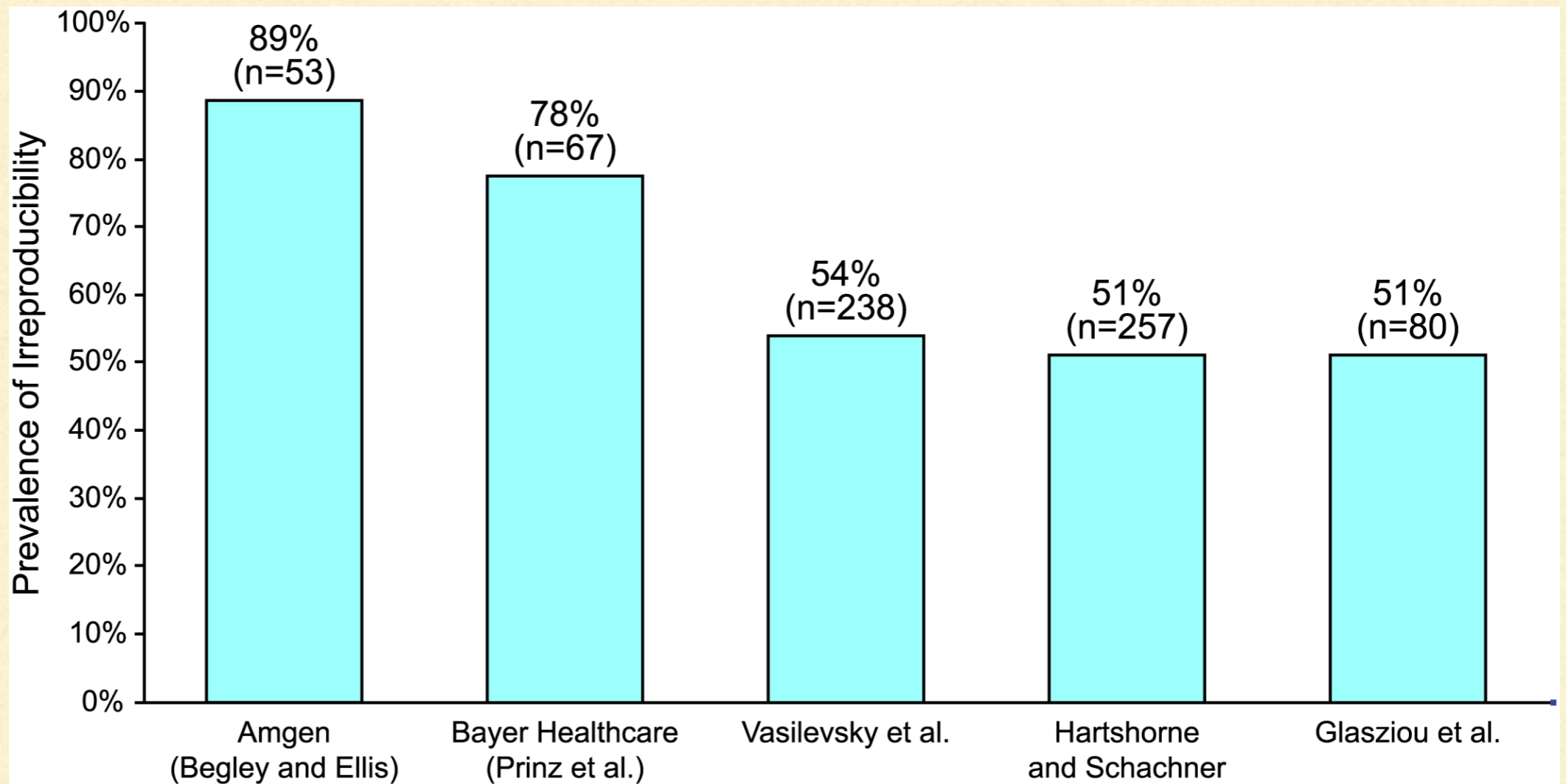
Oct 19th 2013 edition >

Unreliable research

Trouble at the lab


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

Are research results reproducible?



*note axis
(higher = more
irreproducible)*

The Economics of Reproducibility in Preclinical Research

Leonard P. Freedman , Iain M. Cockburn, Timothy S. Simcoe

Published: June 9, 2015 • <https://doi.org/10.1371/journal.pbio.1002165>

Estimating the reproducibility of psychological science

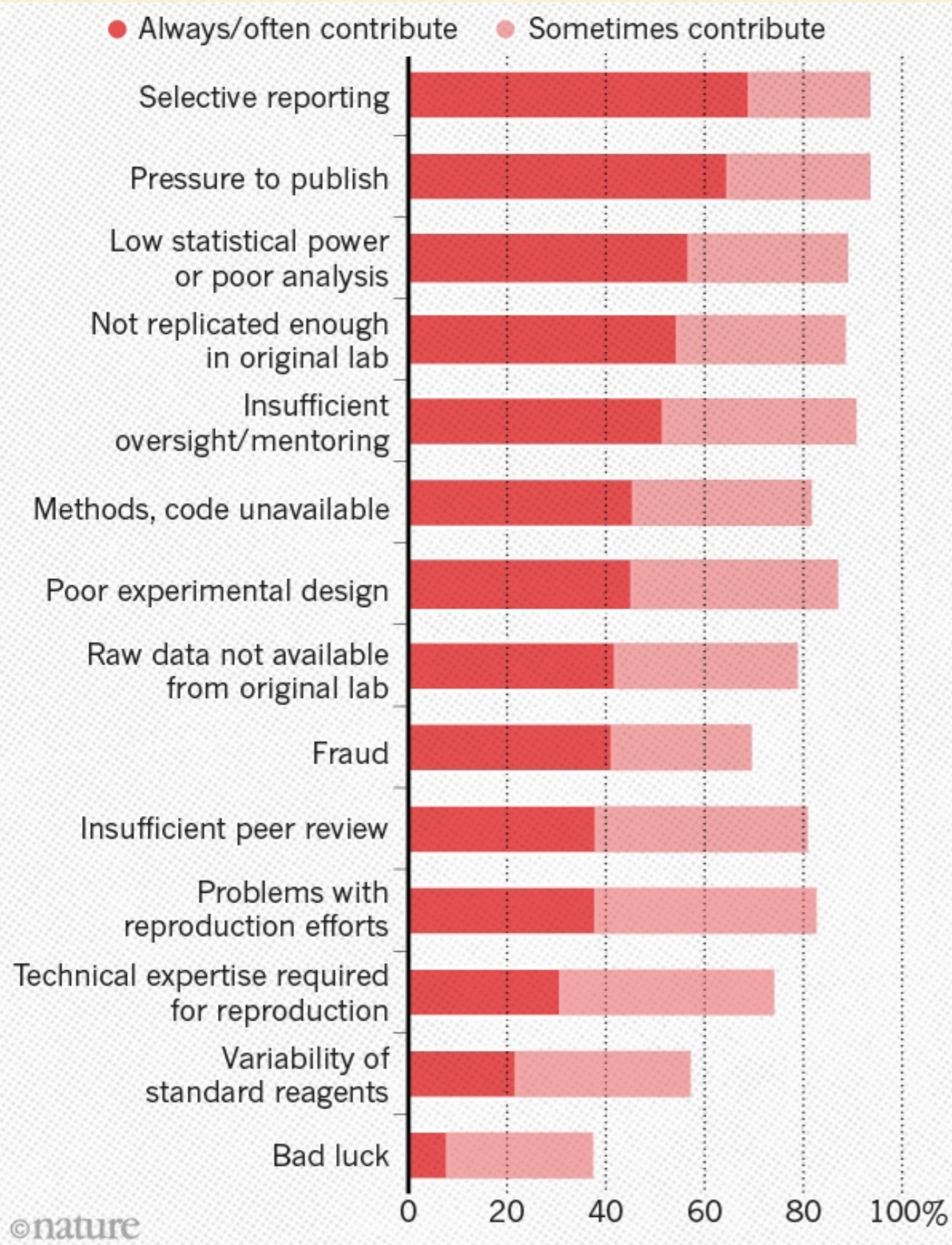
Open Science Collaboration*

270 authors worked to replicate 100 studies:

- ❖ statistically significant p-values:
 - ◆ original **97%**; replication **36%**
- ❖ effect sizes:
 - ◆ original **0.403 ± 0.188**
 - ◆ replication **0.197 ± 0.257**

What do you think are some of the causes?
(zoom poll)

What factors contribute to irreproducible research?

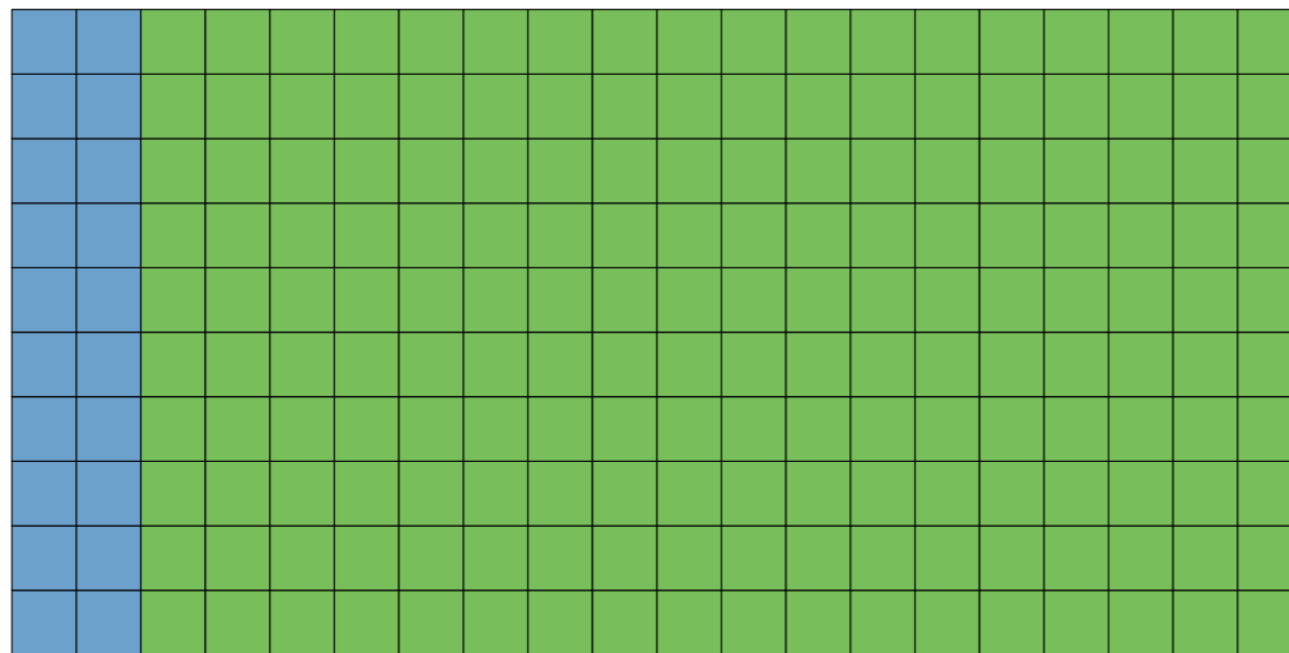


- ❖ Baker 2016. "1,500 scientists lift the lid on reproducibility"
- ❖ <https://www.nature.com/articles/533452a>

a) Publication Bias

- ❖ Journals prioritize novel findings that contain positive results.
 - ◆ experiments which show null effects or that do not reach statistical significance are difficult to publish.
 - ◆ replications of previous experiments, whether confirmatory or contradictory, are difficult to publish.
-

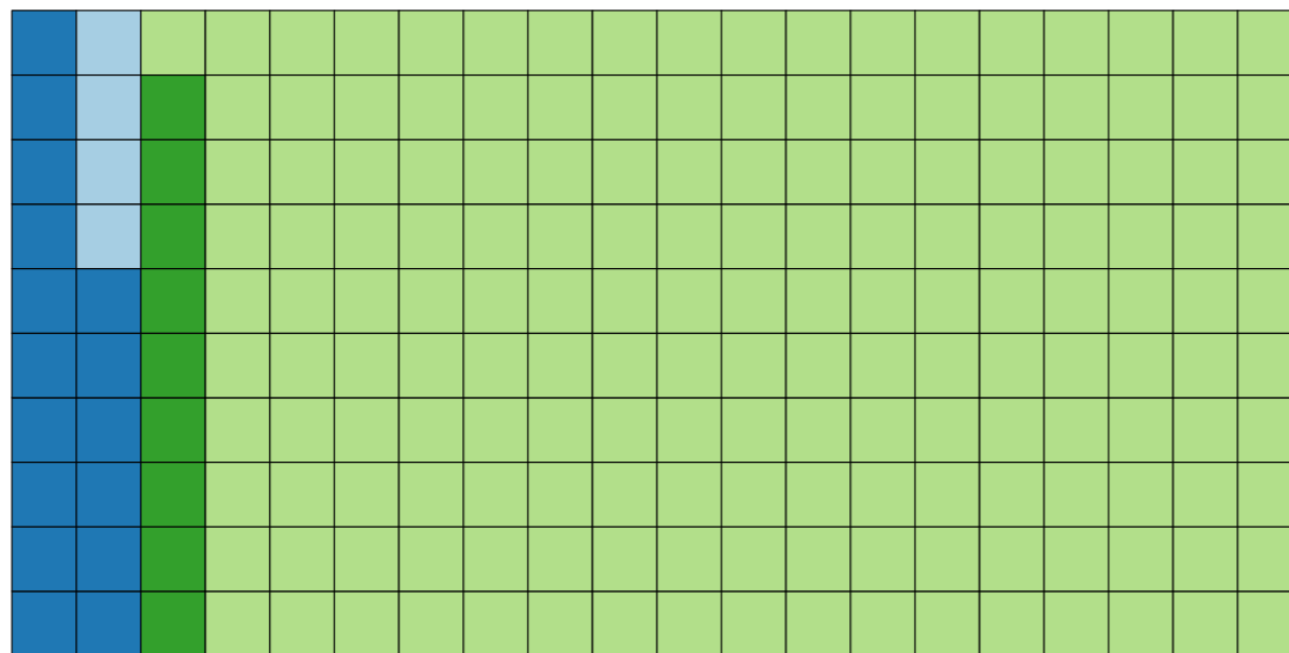
- ❖ Start with 200 hypotheses that are interesting enough to test.
- ❖ Assume 10% are true:
 - ◆ 20 true hypotheses, 180 false hypotheses



labels

- True Hypotheses
- False Hypotheses

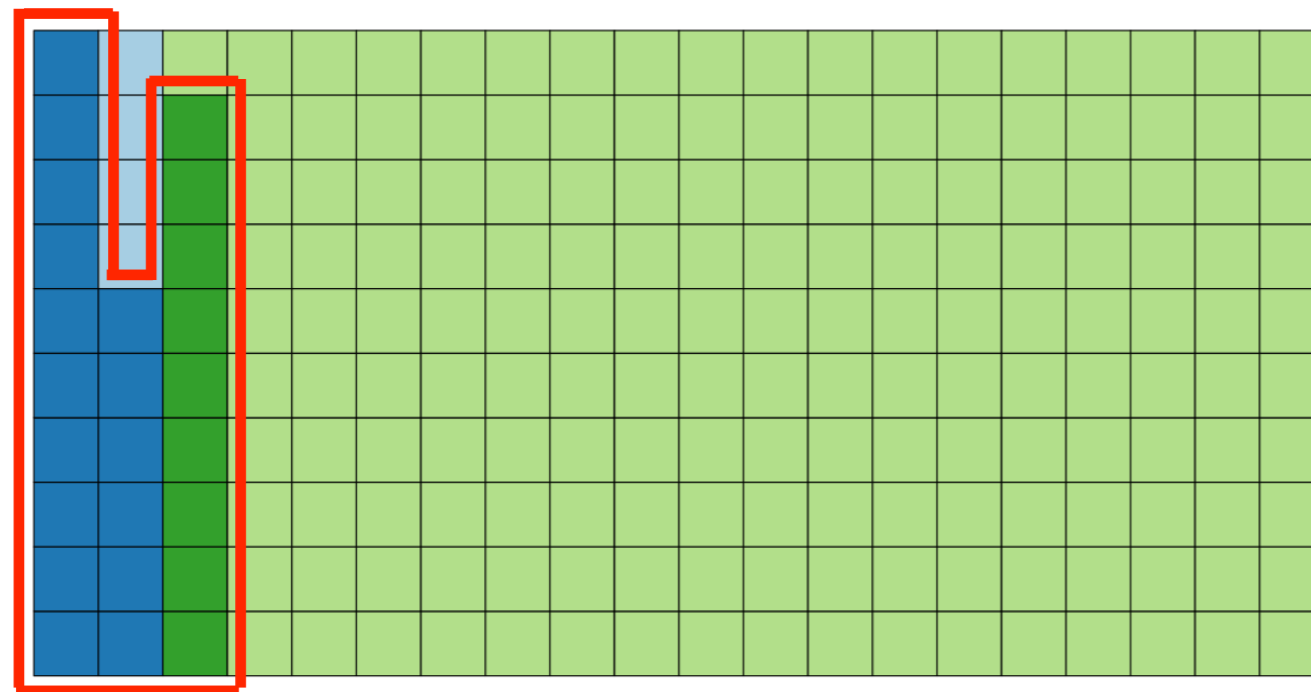
- ❖ Assume power = 80%, **16 of the 20** true hypotheses yield statistically significant results.
- ❖ Assume alpha = 0.05, **9 of the 180** false hypotheses yield statistically significant results



labels

- True Positives
- False Negatives
- False Positives
- True Negatives

- ❖ If only statistically significant results are published:
 - ✦ **16 out of 25** publications have true effects
 - ✦ **9 out of 25** publications are from false positives



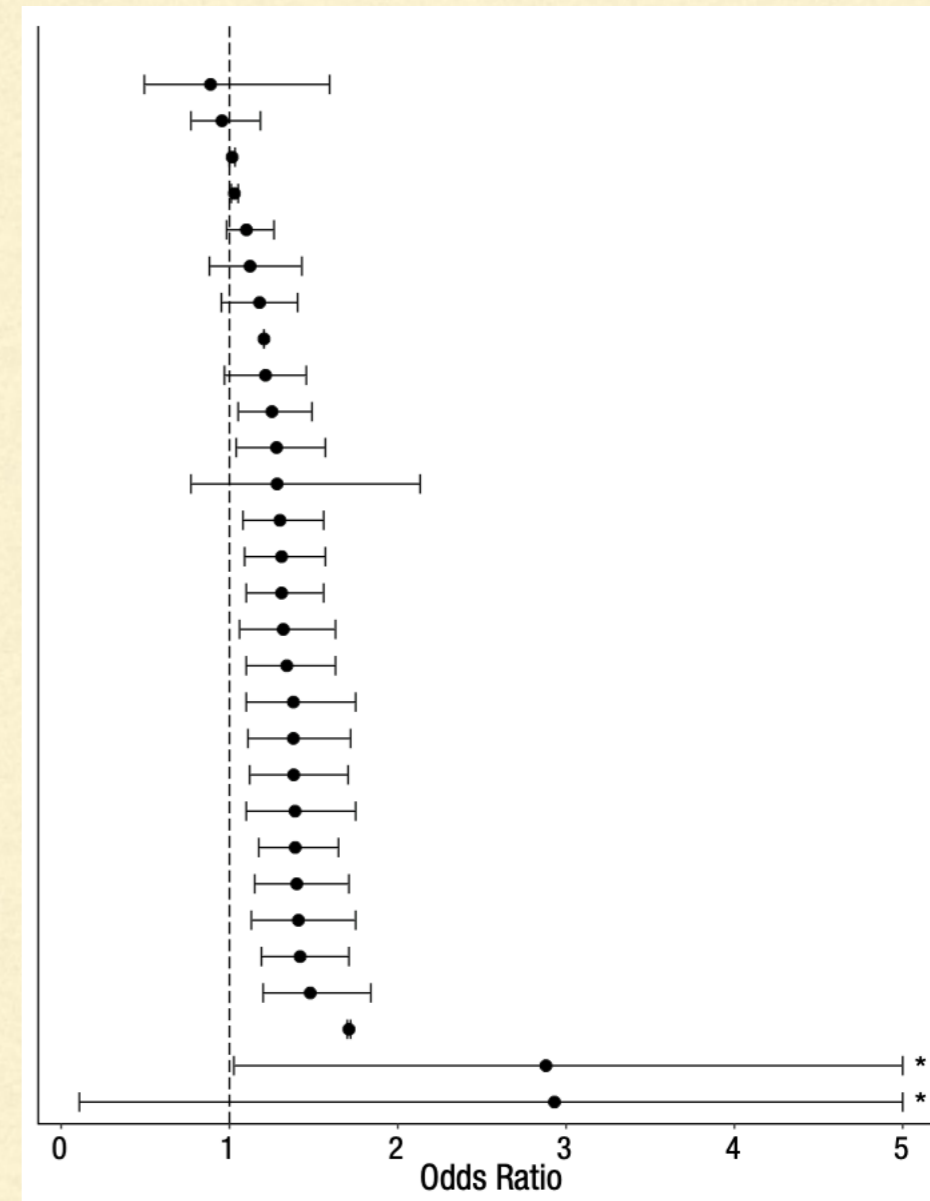
labels

- True Positives
- False Negatives
- False Positives
- True Negatives

36% of the statistically significant results are false positives!

b) Researcher Degrees of Freedom

- ❖ Researchers have many options when deciding how to process and analyze data.
- ❖ "Many Analysts" (Silberzahn et al. 2018)
 - ◆ Are soccer referees more likely to give red cards to dark-skin-toned players vs. light-skin-toned players?
 - ◆ 29 teams of analysts



Questionable Research Practices

- ❖ **p-hacking** - adjusting methodology (e.g. collecting more data, changing experimental design, trying different analysis methods) to achieve a specific result (usually statistically significant in a desired direction)
 - ❖ **HARKing** - "Hypothesizing After Results are Known", presenting a hypothesis that is chosen after data collection/analysis as though the hypothesis were selected ahead of time
 - ❖ *Note: p-hacking and HARKing are not mutually exclusive!*
 - ❖ *Note: similar activities, reported honestly as exploratory research may be ok!*
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Reproducibility vs. Replicability

as used by NASEM (and others)

	DATA	ANALYSIS	RESULTS
reproducibility	same	same	same
replicability	different	same (usually)	same

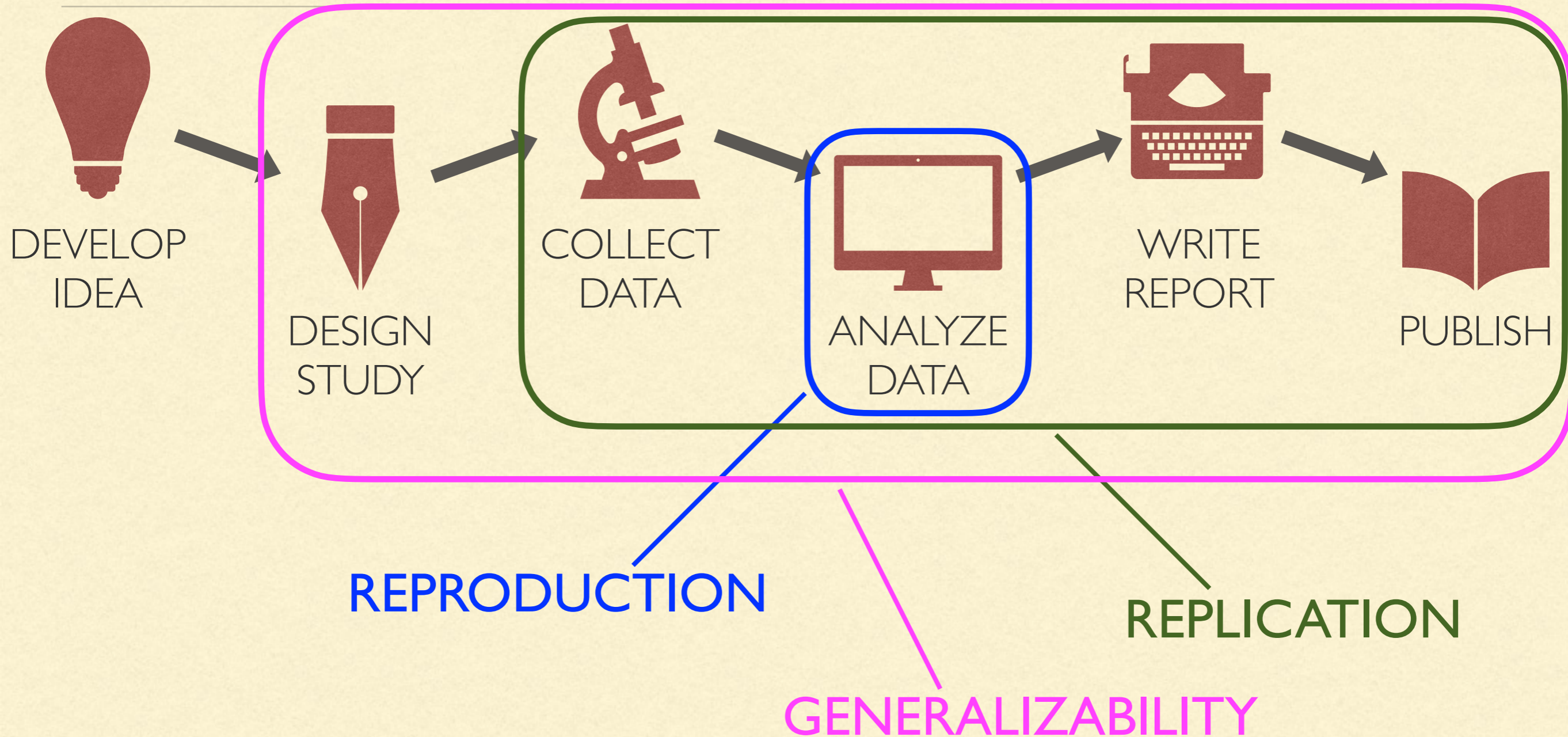
ASA 2017. "Recommendations to Funding Agencies for Supporting Reproducible Research"

Replicability vs. Reproducibility

- ❖ (replication)
 - ❖ "If we repeat the experiment, will the new data and results be consistent with the findings of the original paper?"

 - ❖ (reproducible result)
 - ❖ "If we use the published data and methods, can we reproduce the results/analysis/figures?"
-

Research Process



What are some ways of addressing irreproducibility / irreplicability?

Scenario

(adapted from one by Melissa Rethlefsen)

- ❖ Quinn has just joined Darcy's lab, and will be continuing a line of research started by Jamie, a former lab member who has started a job outside academia.
 - ❖ Quinn begins by replicating Jamie's experiments, in order to become familiar with the protocol. Quinn is unable to locate Jamie lab notebook, which may have been taken with them or lost.
 - ❖ Whereas Jamie's initial results show a significant effect, the new data collected by Quinn does not.
 - ❖ Darcy is preparing to publish Jamie's research, which will be an important paper in Darcy's tenure packet.
-

What should Quinn do?

- ❖ Try additional ways of processing the data and/or performing the analyses.
 - ❖ Contact Jamie to ask for the original lab journal(s) and/or more information about conducting the experiments.
 - ❖ Rerun the experiments and collect more data.
 - ❖ Intervene with the paper submission, because the results are not reproducible.
 - ❖ Other.
-

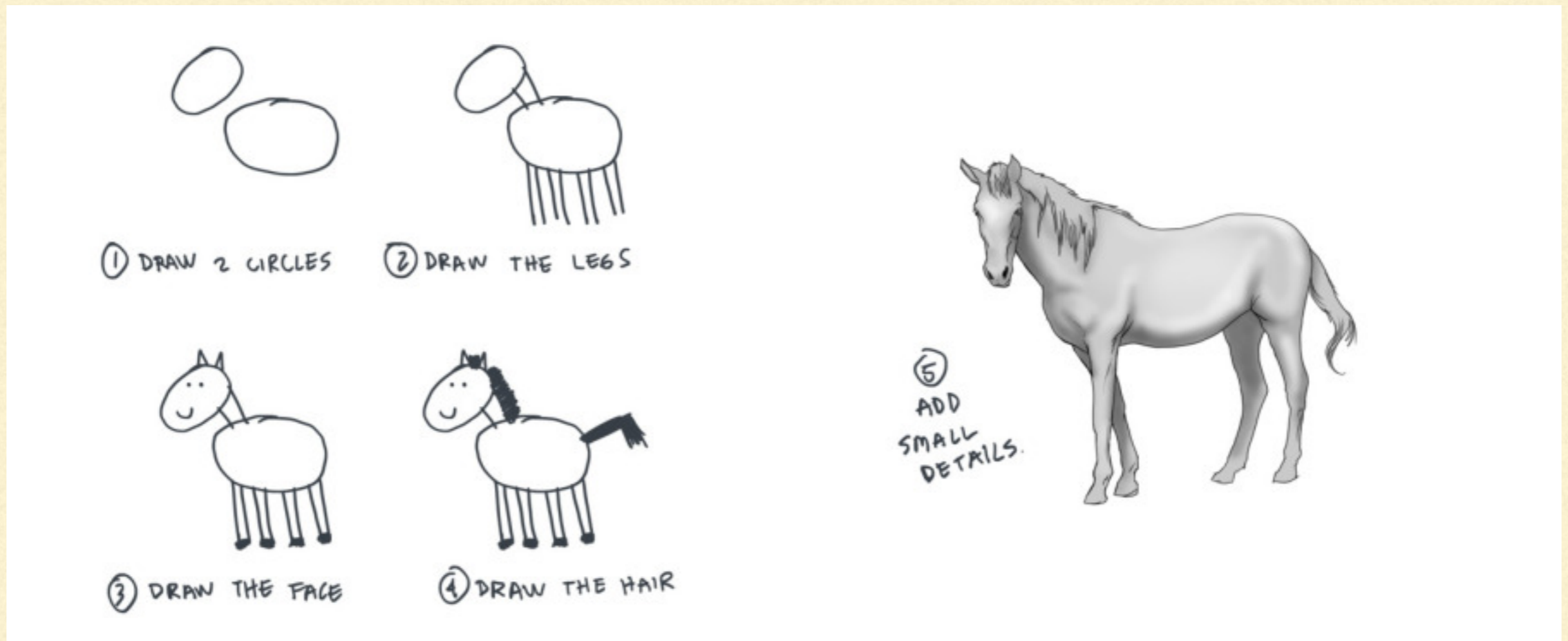
(breakout rooms)

Scenario Discussion

- ❖ There is no perfect solution!
 - ◆ There are multiple actions - you don't have to do them all at the same time.
 - ❖ Increasing openness and transparency at various stages of research can prevent some problems from occurring or make it easier to resolve other problems.
 - ◆ Openness alone is incomplete; research is complex!
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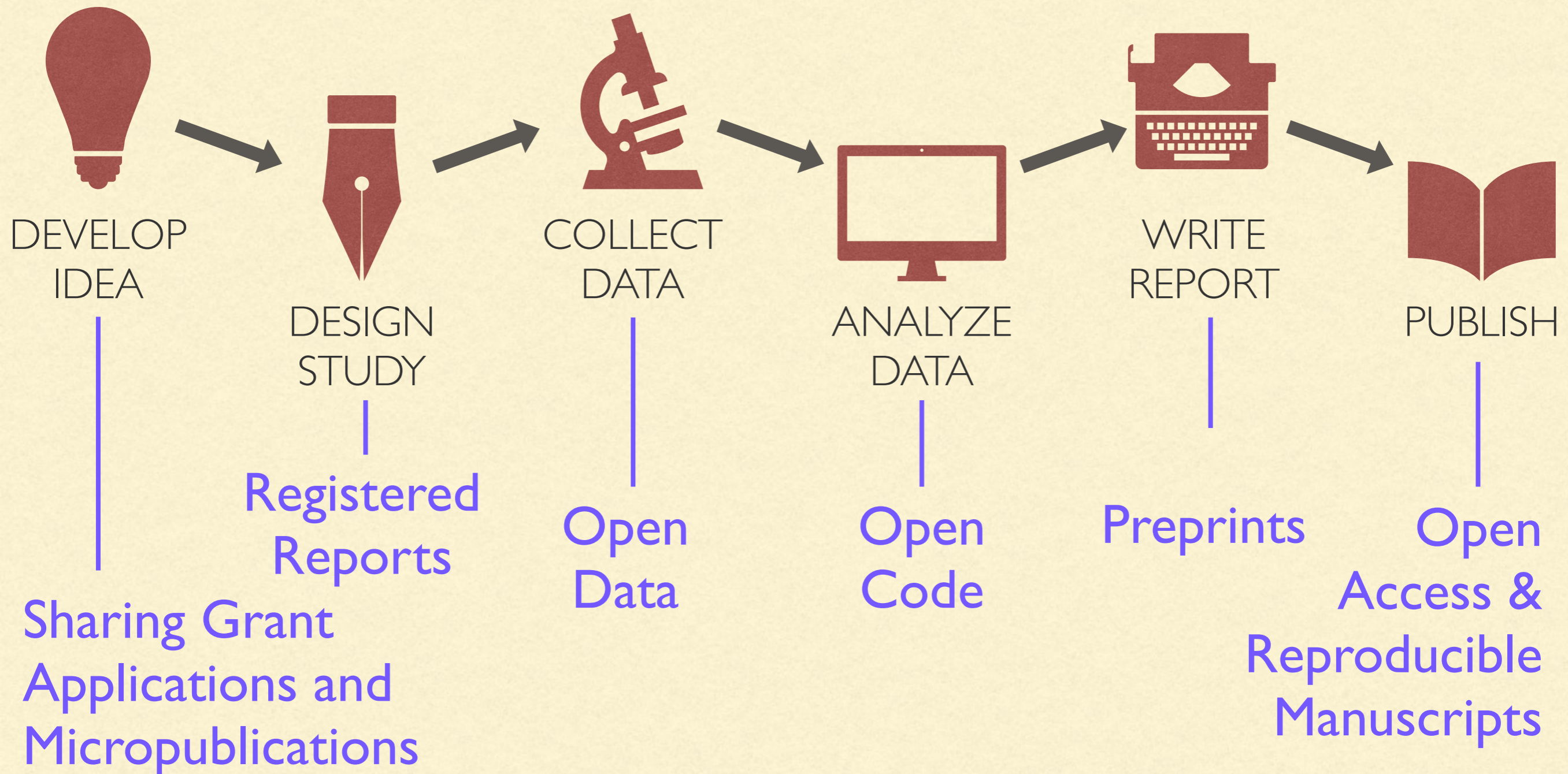
Openness as a path to
reproducibility

Reproducing methods from a published paper



Oktop, Van. "HOW TO: DRAW A HORSE" Van Oktop. 2012-01-05.
Web. 2020-01-27 <https://oktop.tumblr.com/post/15352780846>

Openness in the Research Process

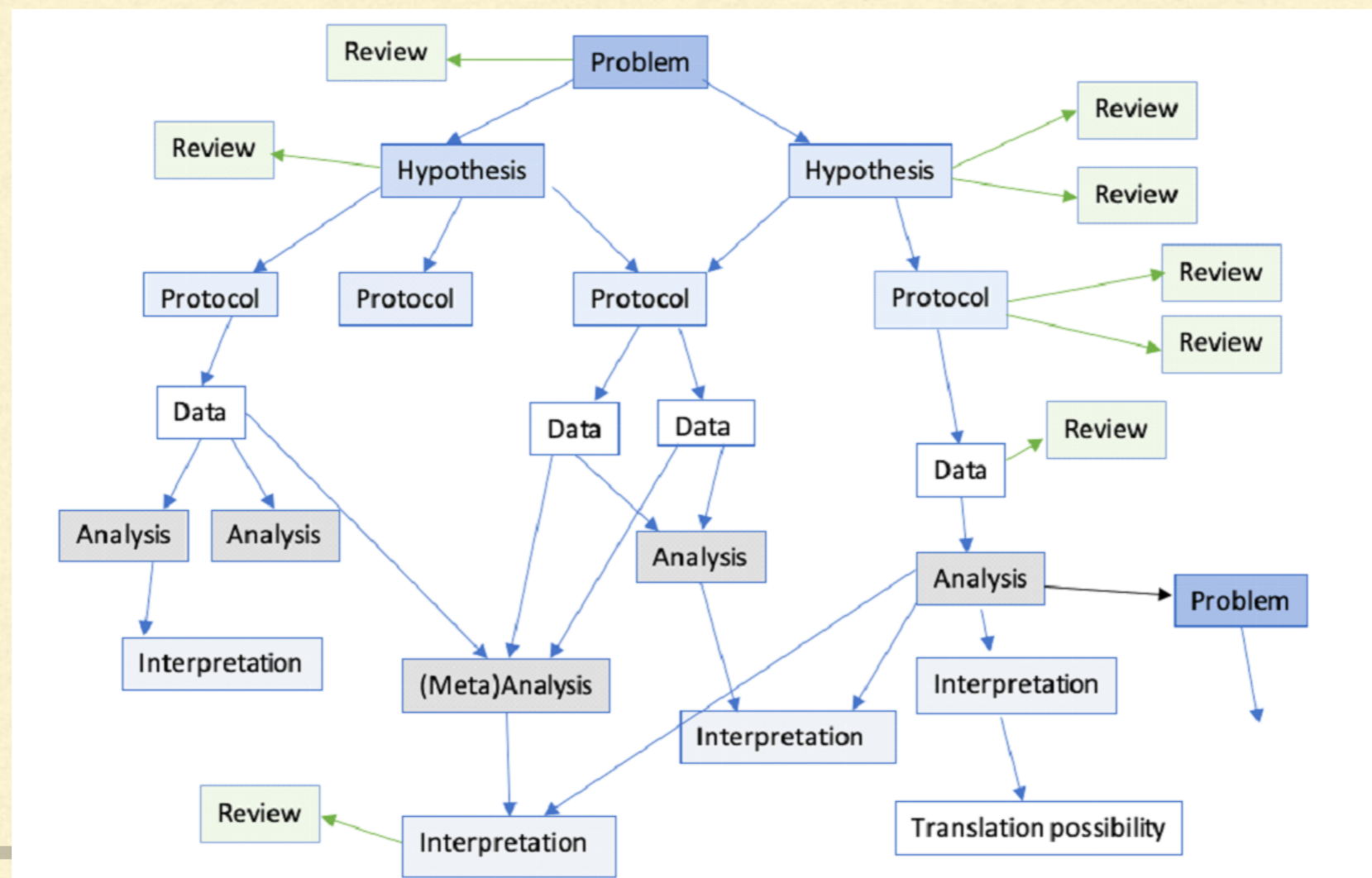


Sharing grant applications

- ❖ funders, institutional repositories, other platforms (e.g. <https://ogrants.org>)
 - ❖ Enable researchers to openly share grant and fellowship applications (funded and unfunded)
 - ❖ Demystify the process for new researchers, first-gen, those without access to institutional knowledge and support, etc.
-

Publish hypotheses, ideas, etc.

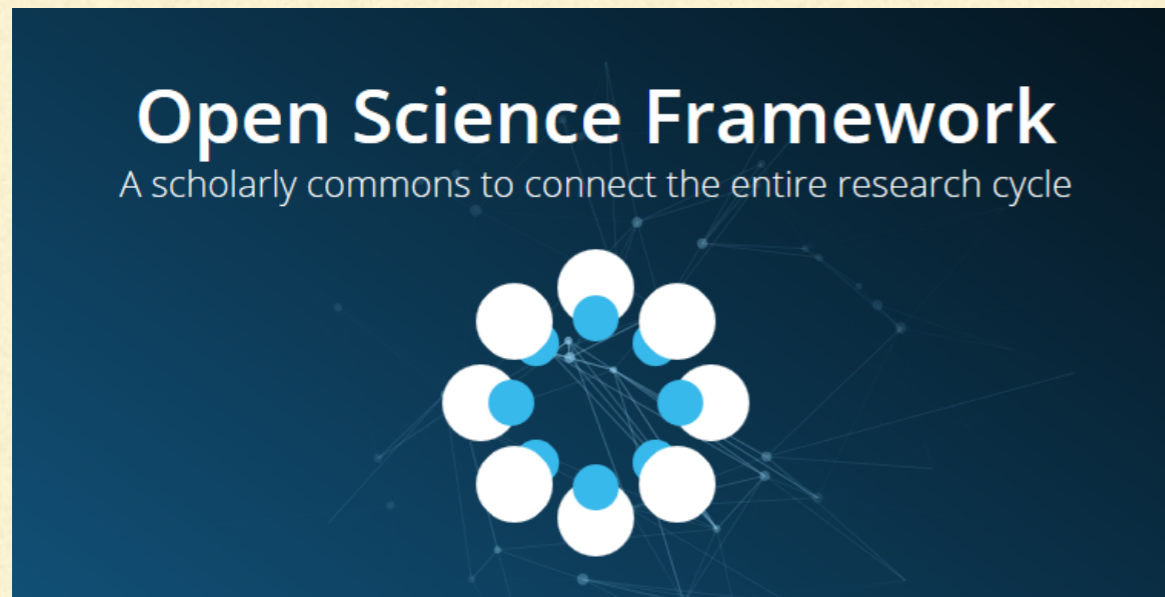
- ❖ <https://science-octopus.org/>
- ❖ <https://libscie.org/hypergraph/>



Registered Reports

- ❖ 2-stage process:
 - ◆ study design and analysis plan is peer-reviewed prior to data collection → journal provisionally accepts if the methodology is followed
 - ◆ peer review occurs without regard to impact
 - ❖ standard practice for clinical trials – clinicaltrials.gov
 - ❖ protocols in other fields can be registered at osf.io/rr/
-

Data and Code Sharing

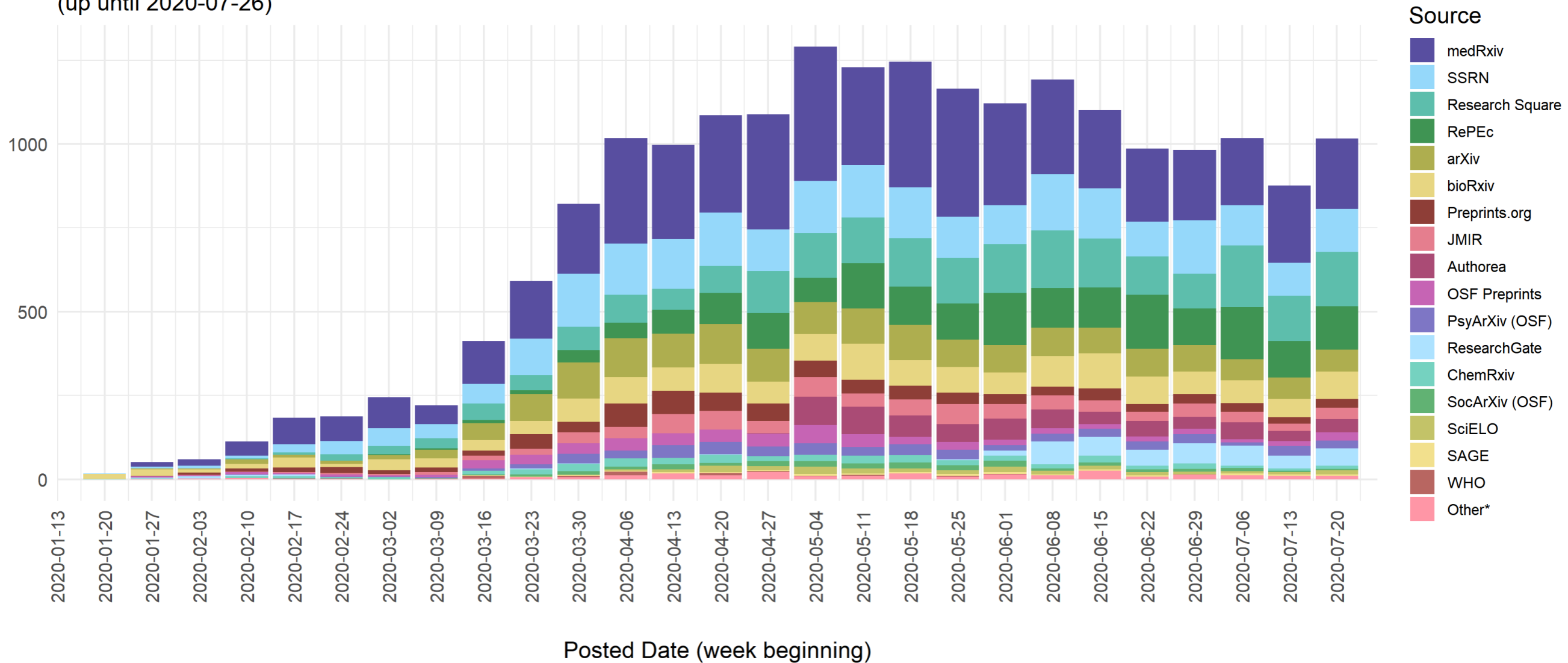


**UF Research Vault
(ResVault)**



Preprints

COVID-19 preprints per week
(up until 2020-07-26)

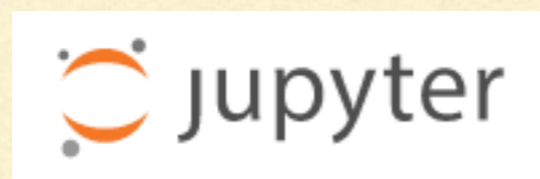
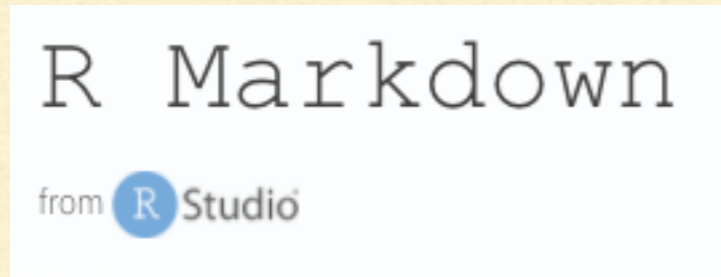


* 'Other' refers to preprint repositories containing <40 total relevant preprints. These include: AfricArXiv (OSF), AgriXiv (OSF), BioHackrXiv (OSF), EarthArXiv (OSF), EcoEvoRxiv (OSF), EdArXiv (OSF), engrXiv (OSF), Figshare, Frenxiv (OSF), INA-Rxiv (OSF), IndiaRxiv (OSF), LawArXiv (OSF), MediArXiv (OSF), NutriXiv (OSF), ScienceOpen, SportRxiv (OSF), Techrxiv (IEEE), Zenodo.

Open Access Publishing

- ❖ Papers are available for anyone to read.
 - ❖ Usually requires authors/funders to pay an Article Processing Charge (in lieu of journal subscription)
 - ❖ UF has discounts on APCs for some publishers/journals (sometimes free!)
 - ◆ <https://guides.uflib.ufl.edu/openaccess/uinvests>
 - ◆ (sorry, no more open access fund!)
-

Reproducible Manuscripts

The eLife logo, featuring a colorful circular icon with a grid of dots and the text "eLife" in a bold, black, sans-serif font.

HOME MAGAZINE INNOVATION

This is a [Reproducible document](#). See the [original article](#) or [source](#).

Replication Study: Transcriptional amplification in tumor cells with elevated c-Myc

L Michelle Lewis, Meredith C Edwards, Zachary R Meyers, C Conover Talbot Jr, Haiping Hao, David Blum, Reproducibility Project: Cancer Biology

noise-phenomena compendium

[launch binder](#) [build passing](#) DOI [10.5281/zenodo.1219780](https://doi.org/10.5281/zenodo.1219780)

A compendium of code, data, and author's manuscript accompanying the publication:

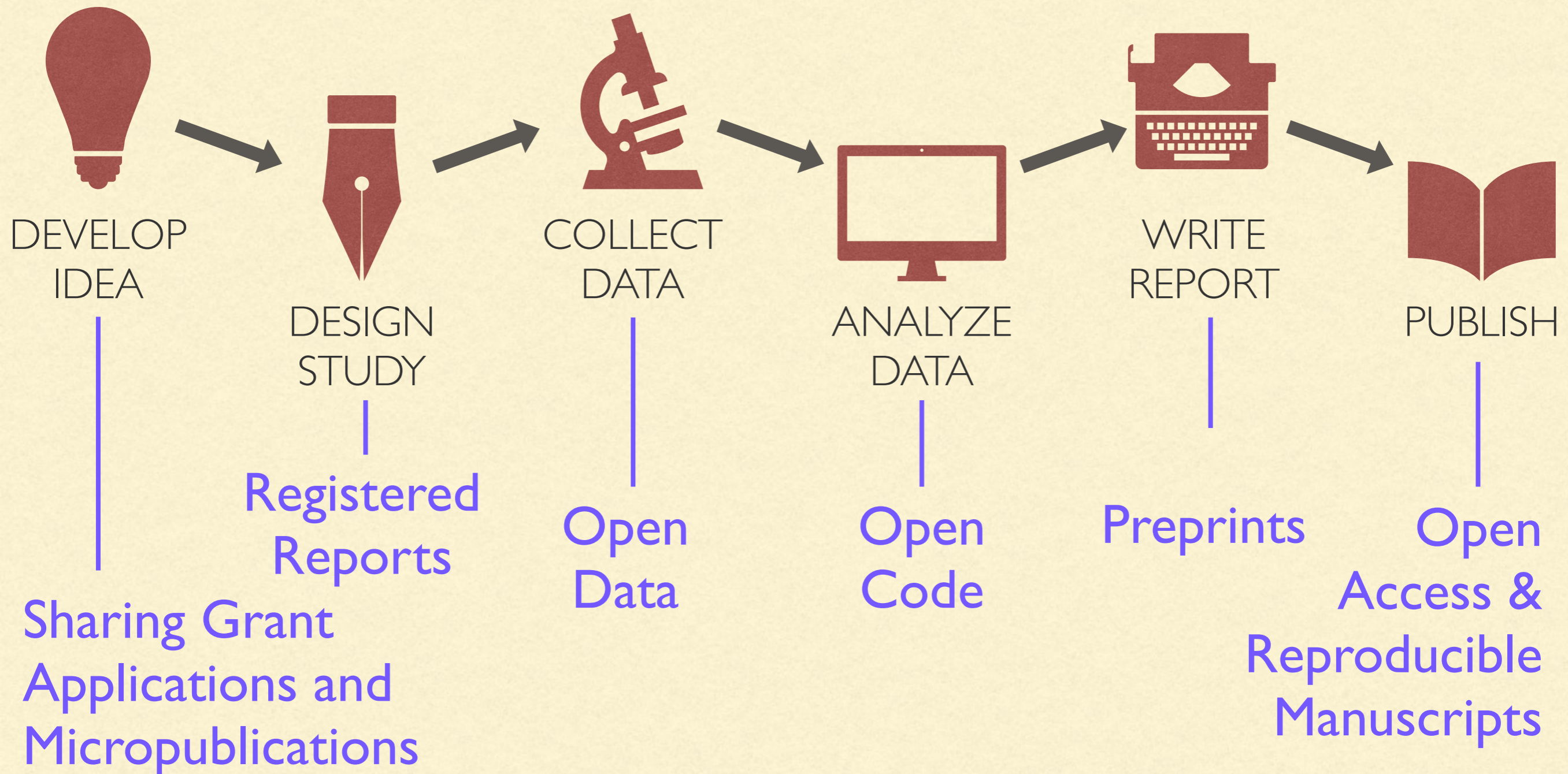
🔗 Carl Boettiger . *From noise to knowledge: how randomness generates novel phenomena and reveals information*. Published in *Ecology Letters*, 22 May 2018 <https://doi.org/10.1111/ele.13085>

Overview

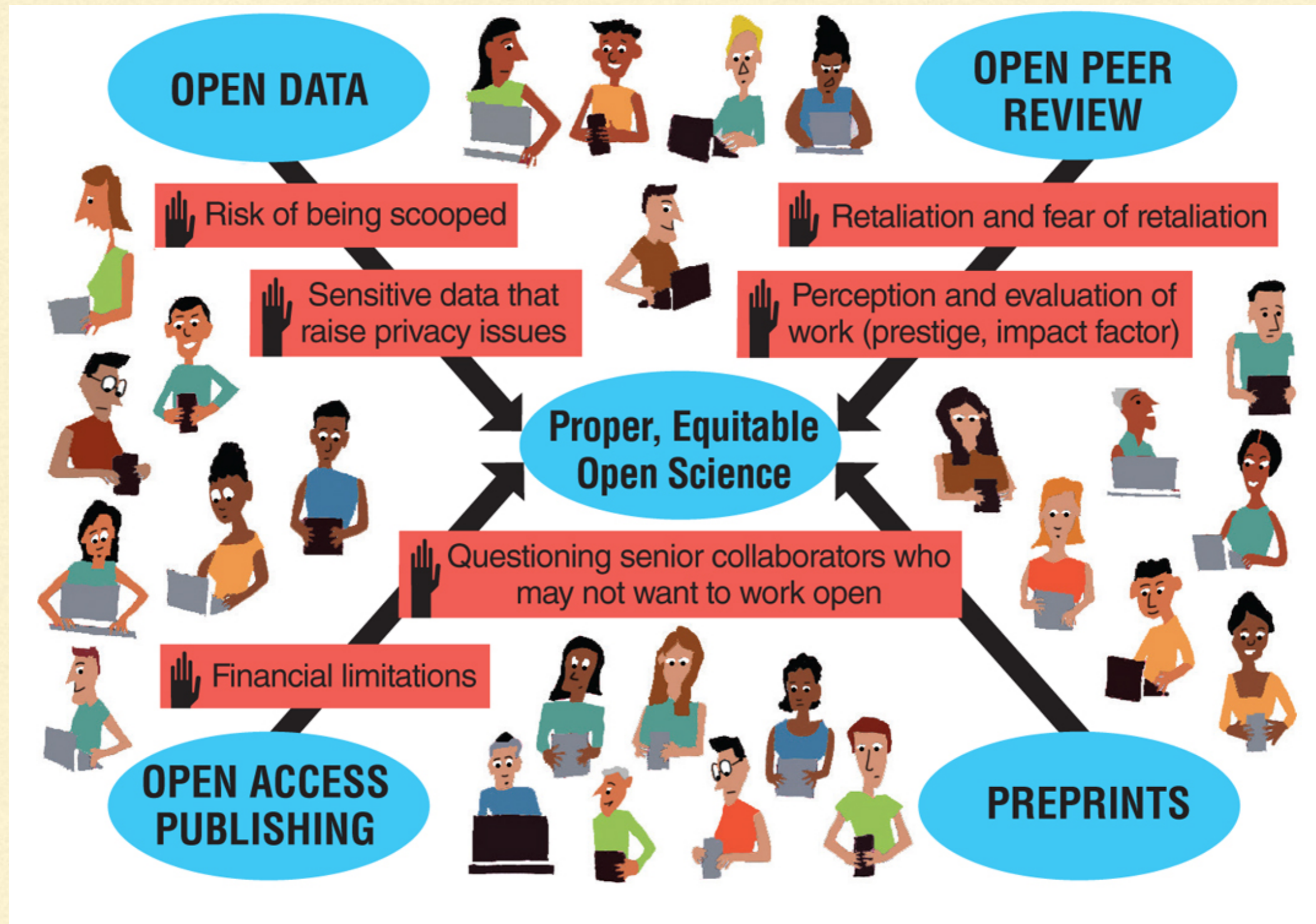
This repository is organized as a reproducible research compendium. Click the [launch binder](#) button above to explore in an [interactive RStudio session](#). Binder uses rocker-project.org Docker images to ensure a consistent and reproducible computational environment. These Docker images can also be used locally.



Openness in the Research Process



What's next?



Bahlai, Bartlett, Burgio, Fournier, Keiser, Poisot, Stack Whitney 2019. "Open Science Isn't Always Open to All Scientists". *American Scientist* 107. DOI: 10.1511/2019.107.2.78

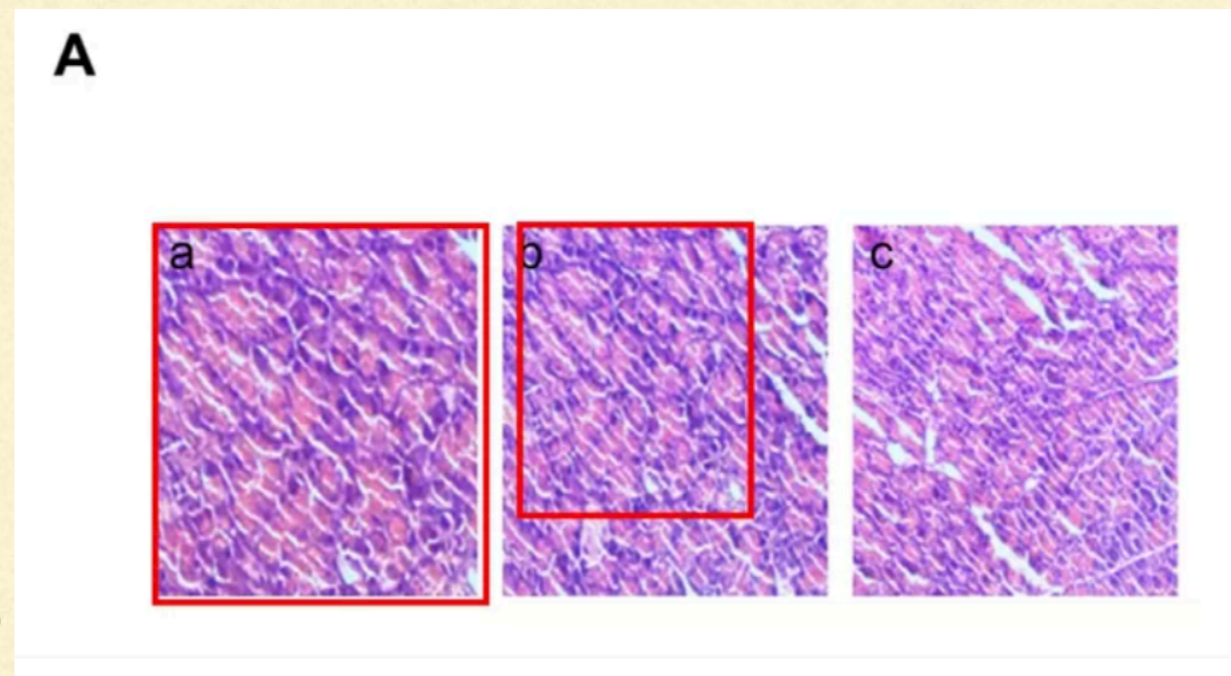
NEWS | 27 May 2021

Scientific image sleuth faces legal action for criticizing research papers

Researchers say the complaint filed against Elisabeth Bik could have a 'chilling effect' on scholarly criticism.

<https://www.nature.com/articles/d41586-021-01430-z>

recent example from <https://pubpeer.com/publications/78B9CF77368453B0CB4627E90D1EA9>



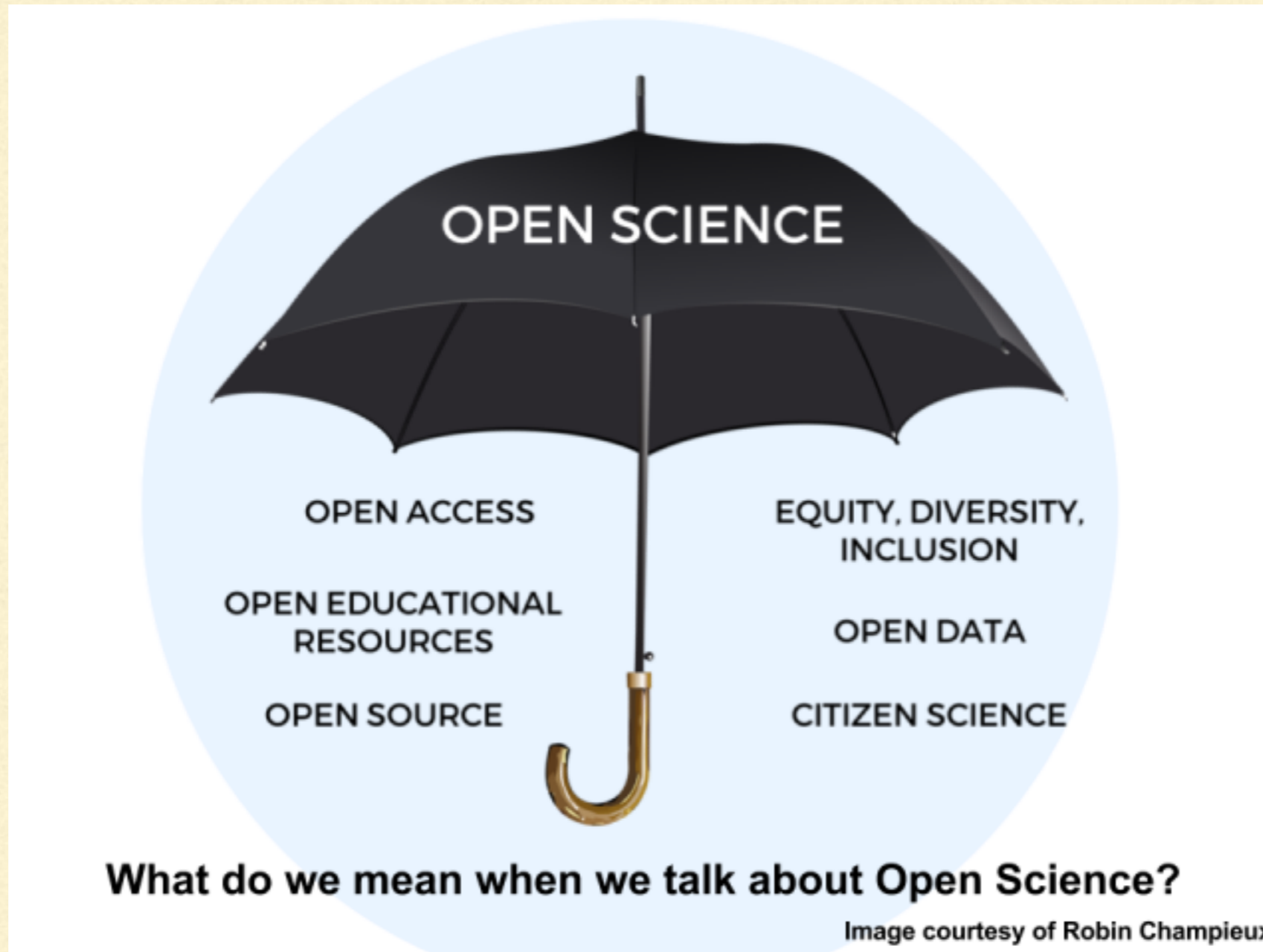
How to Get Started?

- ❖ UF Libraries Academic Research Consulting & Services
 - ◆ guidance on data management, open access, research metrics, research integrity, reproducibility, etc.
 - ◆ <https://arcs.uflib.ufl.edu/>
 - ❖ ReproducibiliTea (UF Chapter) - meetings to start in Fall 2021
 - ◆ Reproducibility and Open Science Journal club
 - ◆ <https://uf-repro.github.io/>
-

Rigor and Reproducibility Seminar Series

UF Interdisciplinary T32 in Movement Disorders and
Neurorestoration

- ❖ <https://uf-repro.github.io/movementdisorders-seminar/seminars>
 - ❖ includes links to recordings
-



SURVEY

https://ufl.qualtrics.com/jfe/form/SV_1WVLQUcrykr7YFM

If You Suspect Research Misconduct...

Research Misconduct means fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.

Questionable Research Practices are reports of careless, irregular, or contentious research practices, as well as authorship disputes, may not meet the standard for research misconduct but may be a research integrity violation.

Make a **confidential report** to the UF Research Integrity Officer (RIO)

Cassandra C. Farley
(352) 273-3052 | cfarley@ufl.edu

You may also report anonymously
UF Compliance Hotline: 877-556-5356



Still not sure if it is Misconduct or a QRP? The RIO can help you better understand the situation. You can speak in hypotheticals as you consider making an official allegation.



Open Access Publishing Costs

- ❖ Article Processing Charge (APC) for Nature Communications, Nature Publishing Group's flagship OA journal:
 - ◆ £3,790 / \$5,380 / €4,380
 - ❖ APC waivers for low-income countries*
 - ◆ *defined by the World Bank
 - ◆ what about researchers in non-profits, volunteer groups, graduated students?
-

The Perils of Open Data

- ❖ publication on rare Chinese cave geckos led to poaching and local extinction:
 - ◆ Ngo et al. 2016. "First population assessment of two cryptic Tiger Geckos (*Goniurosaurus*) from northern Vietnam: Implications for conservation". *Amphibian & Reptile Conservation* 10: 34-45.
 - ❖ software for medical data on GitHub leaked patient data:
 - ◆ Evans & Taylor 2020. "Protected health information breaches on GitHub". Zenodo. DOI: 10.5281/zenodo.3823418
-

5 Schools of Thought

- ❖ **democratic:** make knowledge freely available for everyone
- ❖ **pragmatic:** open up the process of knowledge creation
- ❖ **infrastructure:** create openly available platforms, tools, and services
- ❖ **public:** make science accessible to the community
- ❖ **measurement:** develop alternative metrics for measuring impact

Fecher & Friesike 2014. "Open Science: One Term, Five Schools of Thought" in *Opening Science*, pp 17-47. DOI: 10.1007/978-3-319-00026-8_2
