How to make science more trustworthy by improving transparency and reproducibility

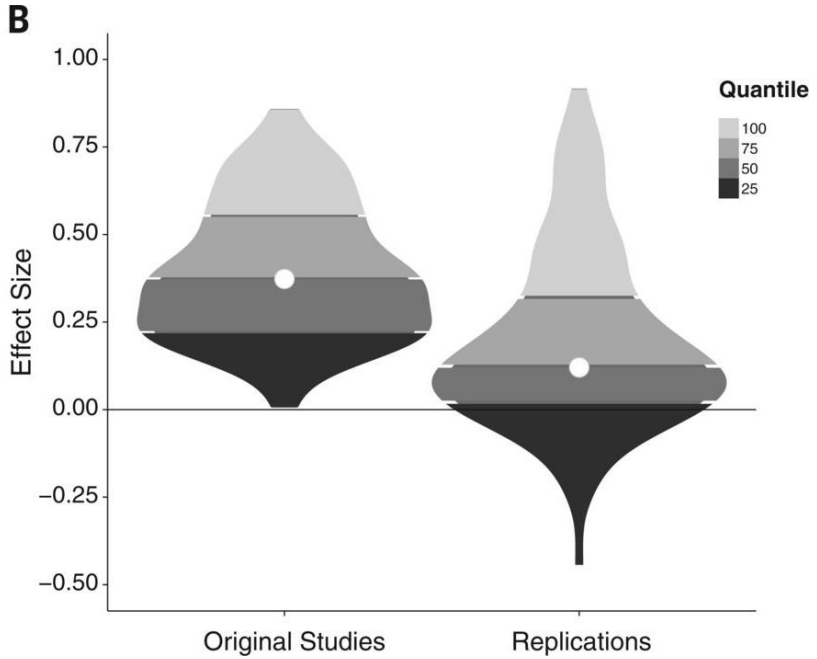
Gustav Nilsonne

@GustavNilsonne

> We need less research, better research, and research done for the right reasons.
>
> Doug Altman, 1994

Reproducibility Project: Psychology

- Aimed to empirically investigate the reproducibility of psychological science in a large-scale effort
- 97/100 original studies reported significant positive effects
- Actual vs expected positive findings: 35/89 (36%)
- Mean effect size was halved from $r = 0.40$ to $r = 0.20$

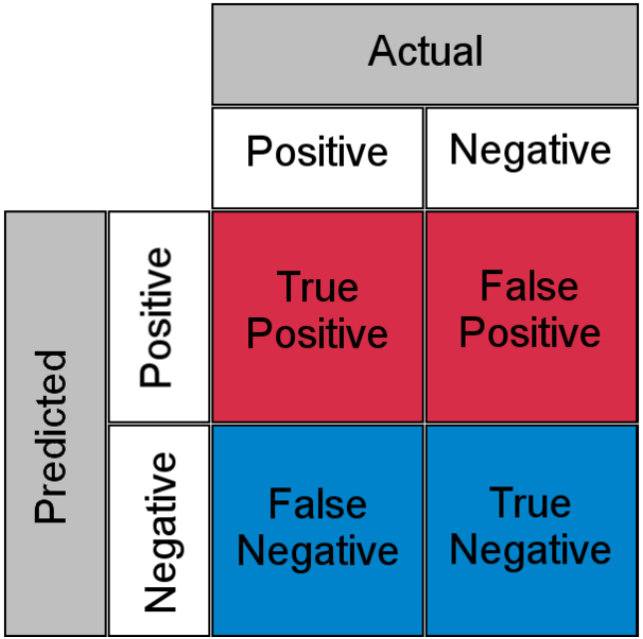


Open Science Collaboration, 2015

Possible reasons for failed replications

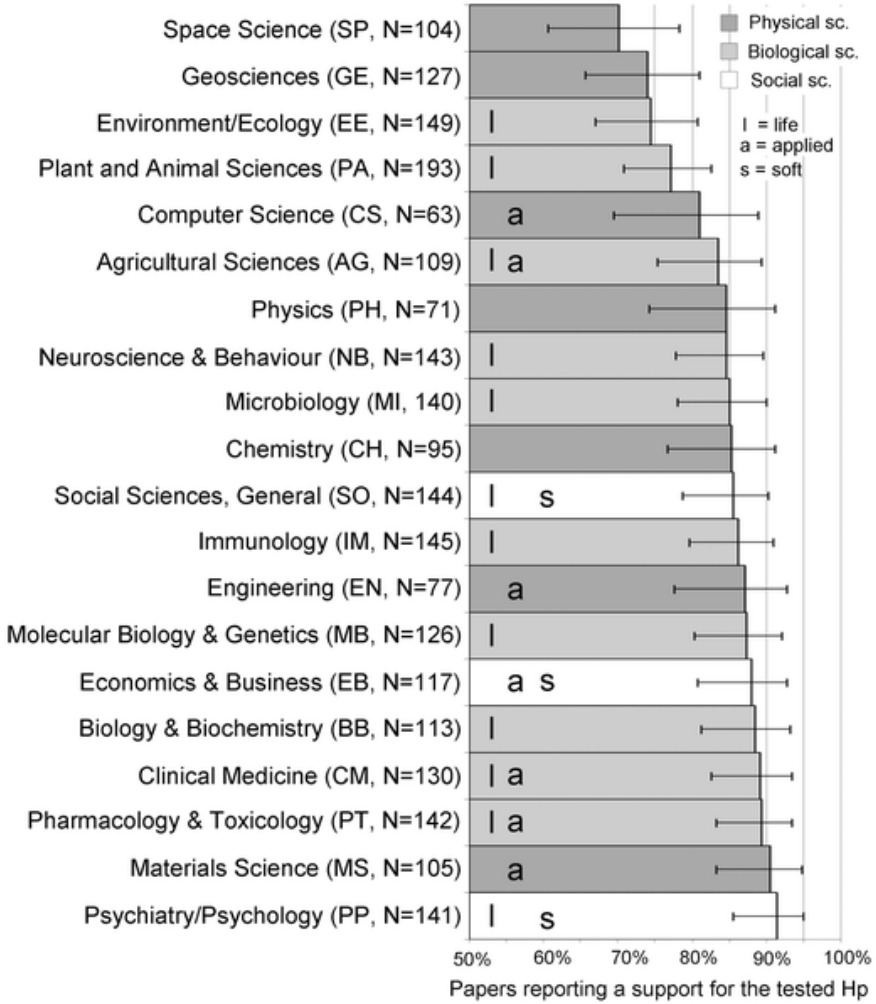
- Hidden moderators
- False negative replications due to chance
- False positive original findings due to chance
- False positive original findings due to biases

Positive and negative findings in a hypothesis testing framework



- The probability of detecting a true positive effect in a study, if it exists, is the **statistical power**
- The proportion of positive effects that exist among studied hypotheses is called the **prior probability**
- The **proportion of observed true positive effects** is given by the **statistical power** multiplied by the **prior probability**

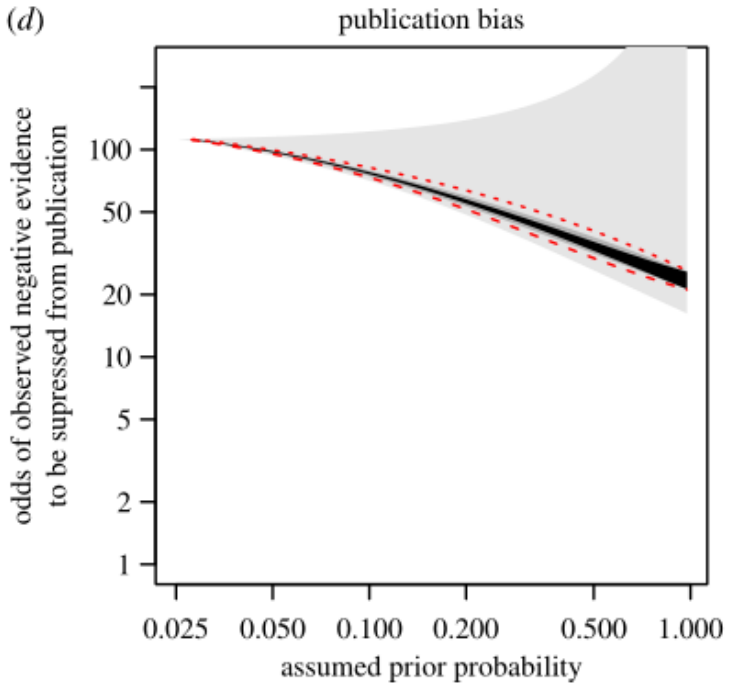
Share of positive findings by field



Fanelli, 2010

Publication bias: a simulation

- We have estimated based on assumptions of 36% replicability and 90% positive findings that negative results were observed 50-100 times before one negative result was published
- Under such circumstances, any field will generate a literature dominated by positive findings

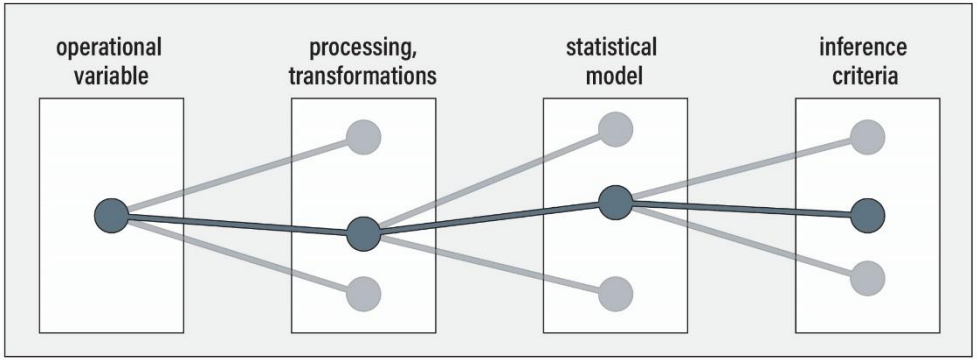


Ingre & Nilsonne, 2018

Analytical flexibility

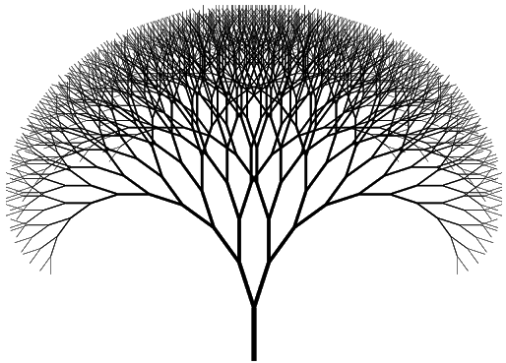
- Data analysis requires many decisions
- The **analytical space** can be defined as the set of justifiable ways to analyse a dataset with respect to a hypothesis
- Undisclosed exploration of the analysis space can give a biased view

  → ”Researcher degrees of freedom”, ”forking paths”, ”*p*-hacking”



Exploring the multiverse

- Multiverse: conducting all the analyses that could reasonably be conducted on a certain dataset with a certain hypothesis
- Benefits
  - → Shows variability of results due to analytical choices
  - → Shows dependency of results on particular choices
- Limitations
  - → Size and scope of the multiverse are arbitrary
  - → Specifications may be more or less well justified

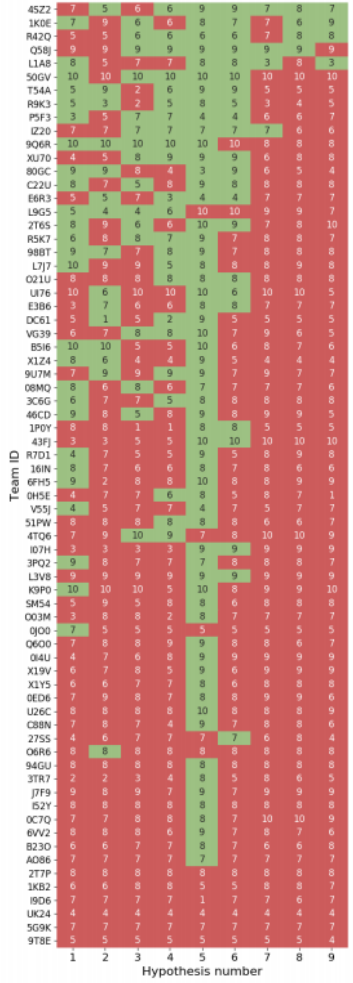


Multi-analyst studies

- Many groups independently analyse the same data with the same hypotheses
- Typical aims: to estimate how much of the analytical space is traversed under naturalistic circumstances, and how much results vary as a consequence
- Can be used to ”stake out boundaries” of a multiverse analysis

The Neuroimaging Analysis Replication and Prediction Study (NARPS)

- Aimed to assess variability in functional magnetic resonance imaging (fMRI) research
- Teams were asked to freely analyze the data with their usual analysis pipeline and report a binary decision for 9 hypotheses
- 70 teams reported results
- No two teams used the same analysis pipeline



Preprint: https://www.biorxiv.org/content/10.1101/843193v1

Conclusions from NARPS

- Considerable variation observed in methods and results
- Recommendations and suggestions
  - → Share raw data and results (unthresholded maps)
  - → Preregister analysis pipelines
  - → Share analysis code
  - → Use multiple pipelines (”multiverse analysis”)

Further multi-analyst projects

- Guidance for multi-analyst studies: 50 experts contributed in a consensus procedure to develop a set of recommendations and a reporting guideline (Aczel et al. 2021)
- EEGManyPipelines: a multi-analyst project for electroencephalography (EEG) data. ~170 independent teams have reported results, analysis phase now ongoing.
- Multi100: Data and hypotheses from 100 papers in social/behavioural sciences will be reanalysed by 5 analysts each
- Further multi-analyst projects in RCT:s and medical registry research forthcoming

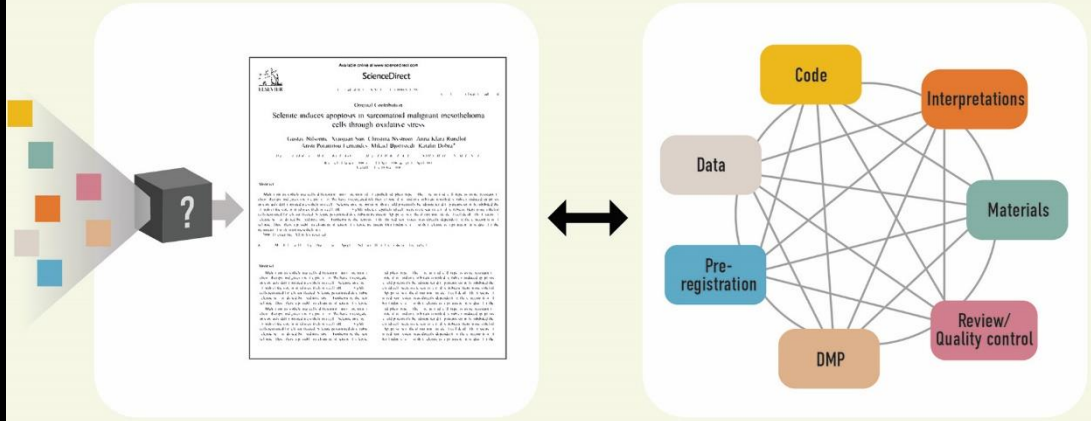
Some research practices for increased reproducibility

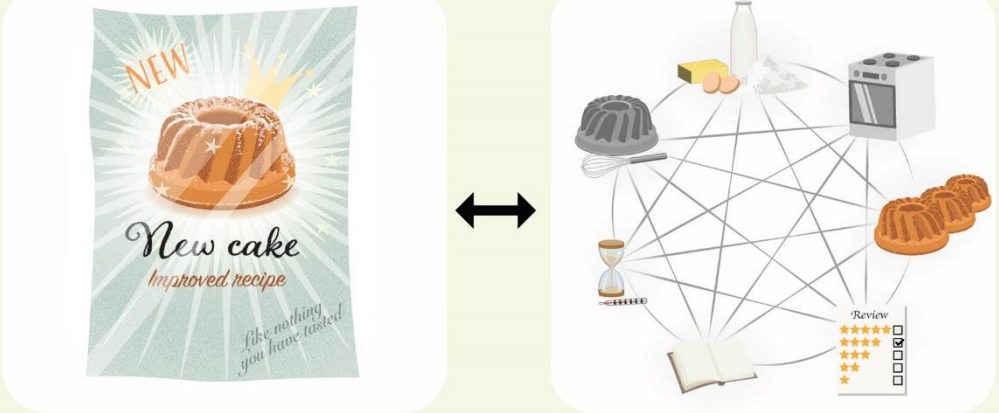
- Error mitigating practices: standards, code copiloting etc
- Preregistration
- Open digital research objects: papers, data, materials, code
- Reporting multiple analytical strategies
- Replication research

Scientific publishing

Journal article as artefact

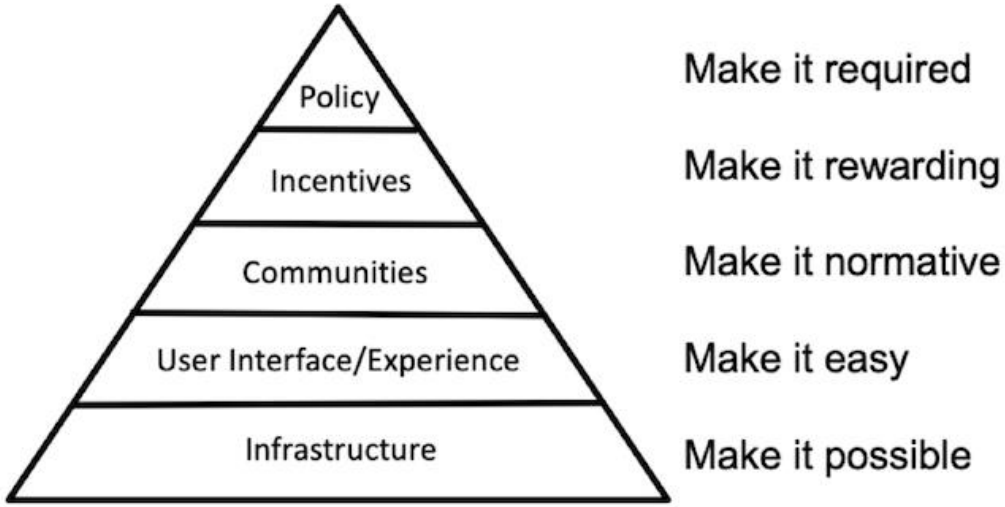
Interoperable digital research objects





https://doi.org/10.53962/hbfx-kmg3

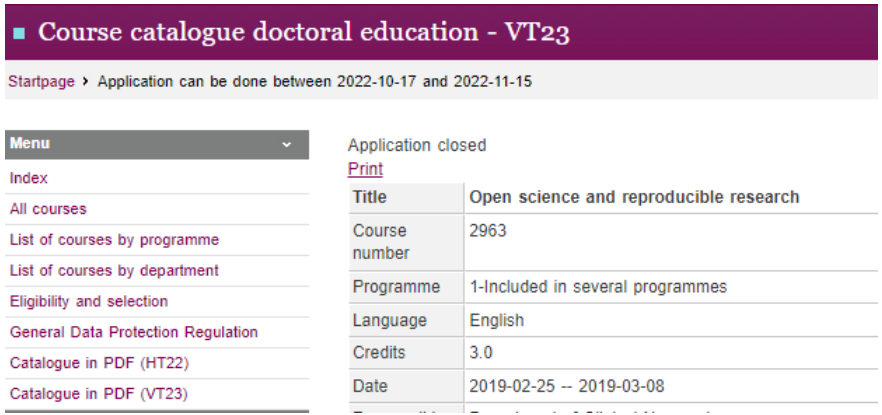
A theory of change



Nosek, 2019

How to make your research more reproducible

- Be the change that you want to see
- Learn the skills that you wish to practice
- Find your community



Course catalogue doctoral education - VT23

Startpage › Application can be done between 2022-10-17 and 2022-11-15

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- Eligibility and selection
- General Data Protection Regulation
- Catalogue in PDF (HT22)
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Application closed

Print

Title	Open science and reproducible research
Course number	2963
Programme	1-Included in several programmes
Language	English
Credits	3.0
Date	2019-02-25 -- 2019-03-08

OSCS Open Science Community Sweden

RN SE Swedish Reproducibility Network

Thank you