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Open Science Across Disciplines and the Research Process

Dr. David Philip Morgan, Open Science Officer, Research Data Management Consultant
University Library, University of Mannheim, Open Science Office, Research Data Centre

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1. **Broad overview of Open Science and Open Science Practices**

2. **Open Science in Context across disciplines, Open Science Grants**

3. **Open Science as a continuum**

Definition for Open Science

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"An **umbrella term** reflecting the idea that **scientific knowledge** of all kinds, where appropriate, should be **openly accessible, transparent, rigorous, reproducible, replicable, accumulative, and inclusive**, all which are considered fundamental features of the scientific endeavour. Open science consists of principles and behaviors that promote **transparent, credible, reproducible, and accessible science**."

Source: https://forrt.org/glossary/english/open_science/ (last updated on Jul 19, 2024)

Making research openly accessible and reusable

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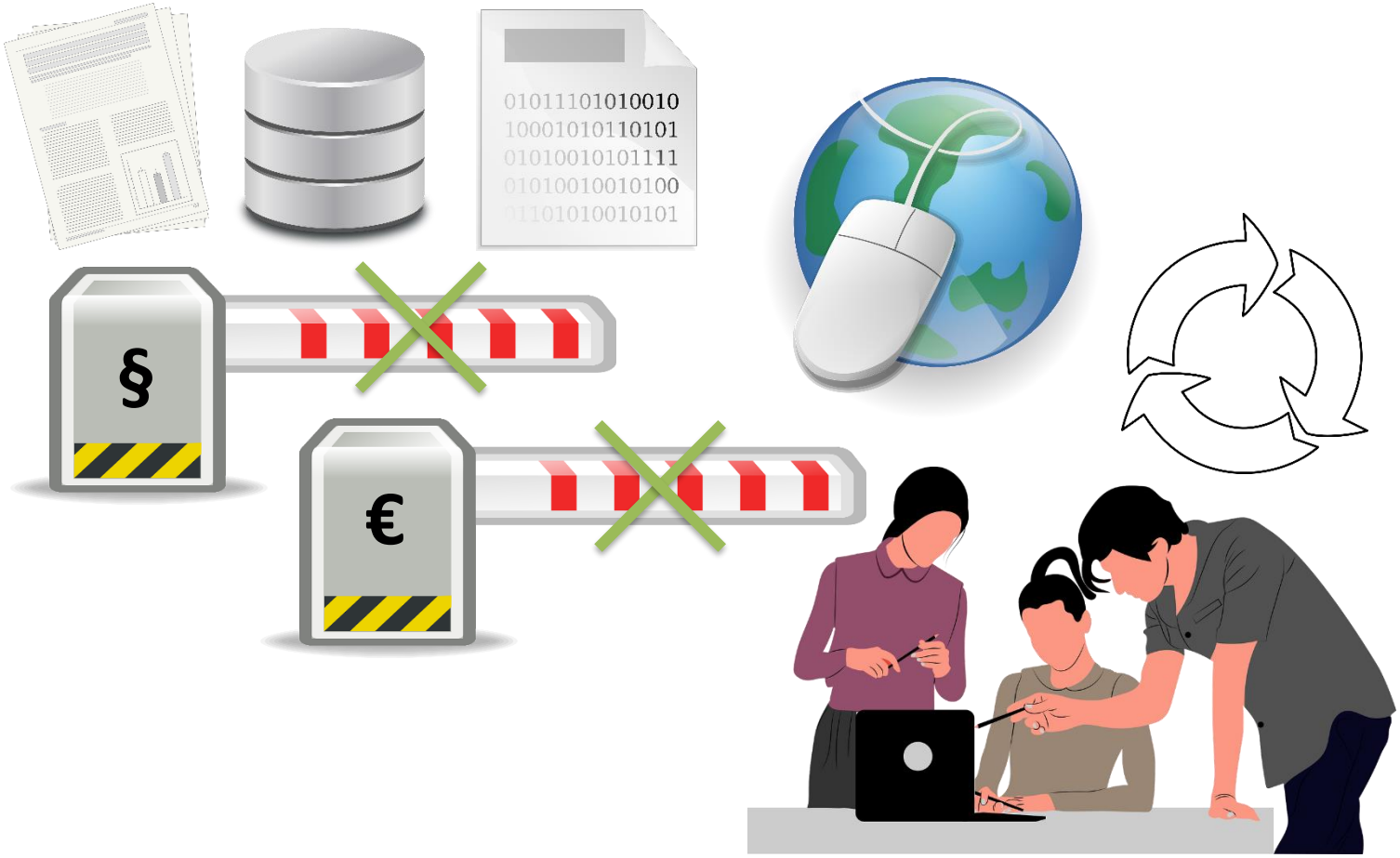

Open Access & Open Data

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Open access means unrestricted access to research information, **free of charge for readers**. It means that anyone interested can read, print, save, distribute or automatically evaluate open access publications **without financial, legal or technical restrictions**. (retrieved from https://www.bib.uni-mannheim.de/en/teaching-and-research/publishing-and-open-access/)

"**Open data** refers to data that is freely available and readily accessible for use by others without restriction, "Open data and content can be freely used, modified, and shared by anyone for any purpose" (retrieved from https://opendefinition.org/)."

Open Science Badges by the Open Science Framework (Centre for Open Science) are licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. Source: https://osf.io/tvyxz/overview

Definition for Open Science

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"An umbrella term reflecting the idea that scientific knowledge of all kinds, where appropriate, should be openly accessible, **transparent**, rigorous, **reproducible**, **replicable**, accumulative, and inclusive, all which are considered fundamental features of the scientific endeavor. Open science consists of principles and behaviors that promote transparent, credible, reproducible, and accessible science."

Source: https://forrt.org/glossary/english/open_science/ (last updated on Jul 19, 2024)

Making research transparent and replicable

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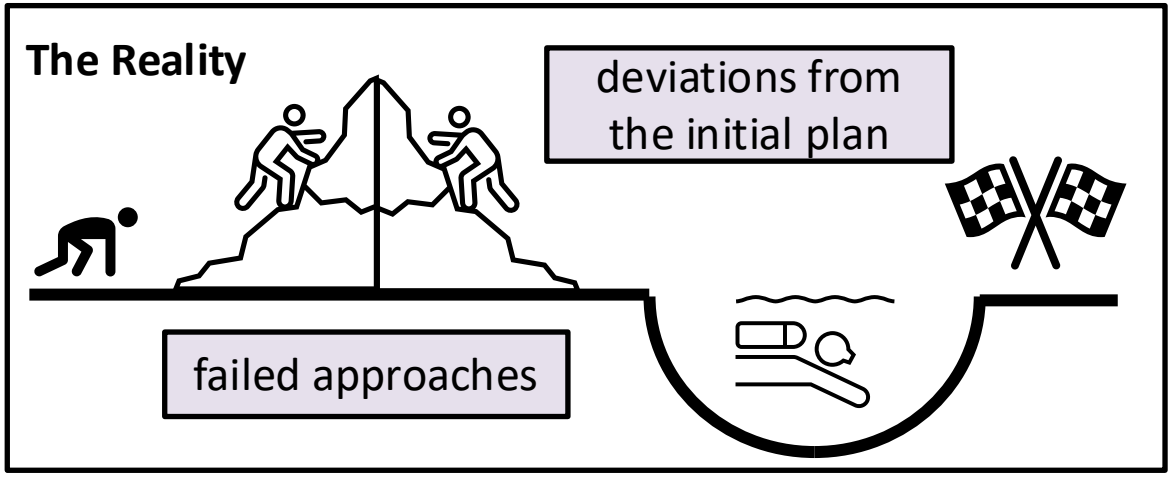
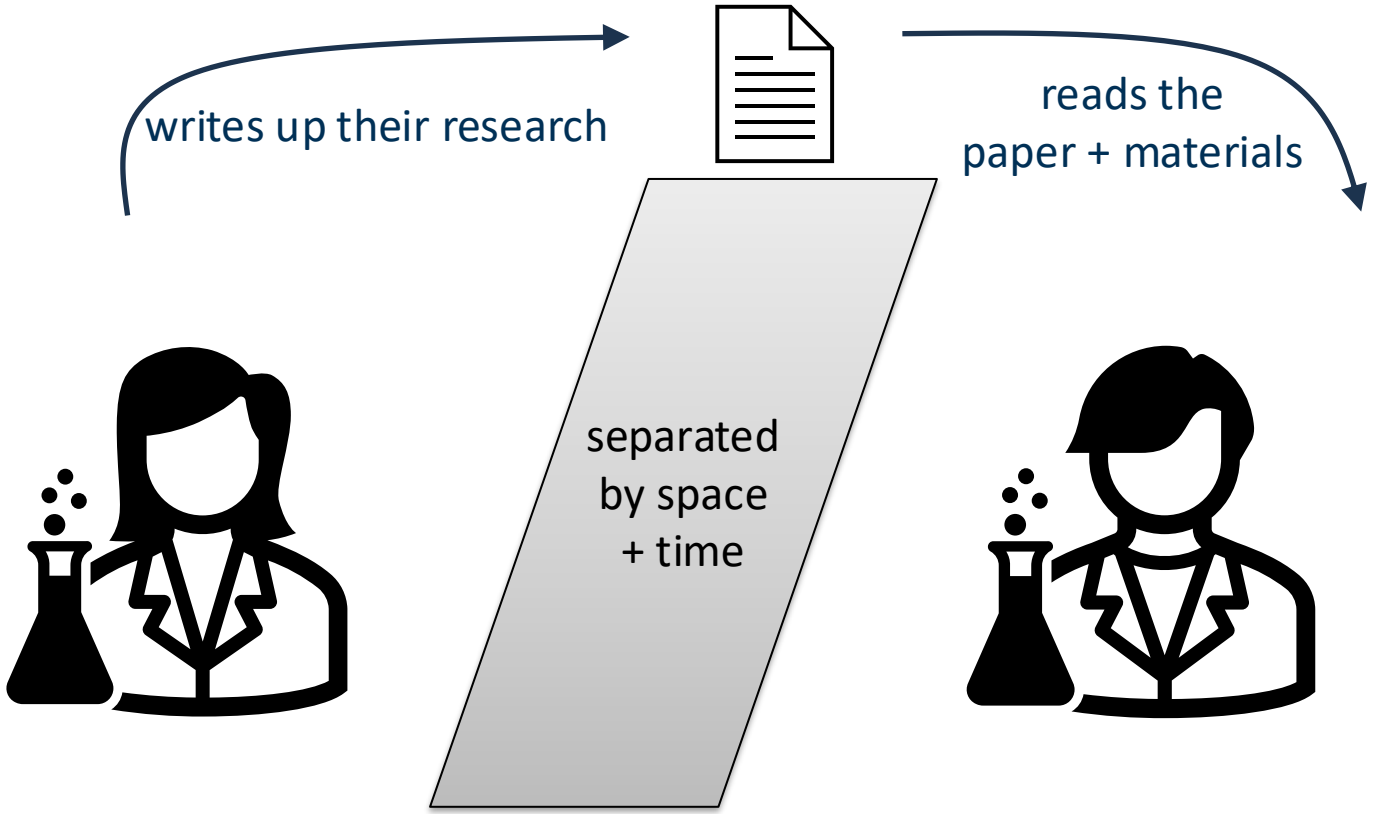
published literature

positive results



share plans + intermediate results

Reproducible research



Open Science is more than just Open Access and Data

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Pre-registration
Registered Reports

Replicability

Open Materials

Inclusivity

Citizen Science, Science Communication, Knowledge Exchange

Accessible and Re-usuable

Open Access

Reproducible Manuscripts

Reproducibility & Transparency

FAIR Data, Open Data, Open Code

Reproducible Code

Open Science Practices throughout the research process

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Open Science Office

Hypothesis Generation

Pre-registration
Registered Reports

Research Design

Open Materials

Reproducible Code

Sharing

Citizen Science, Science Communication, Knowledge Exchange

Publishing

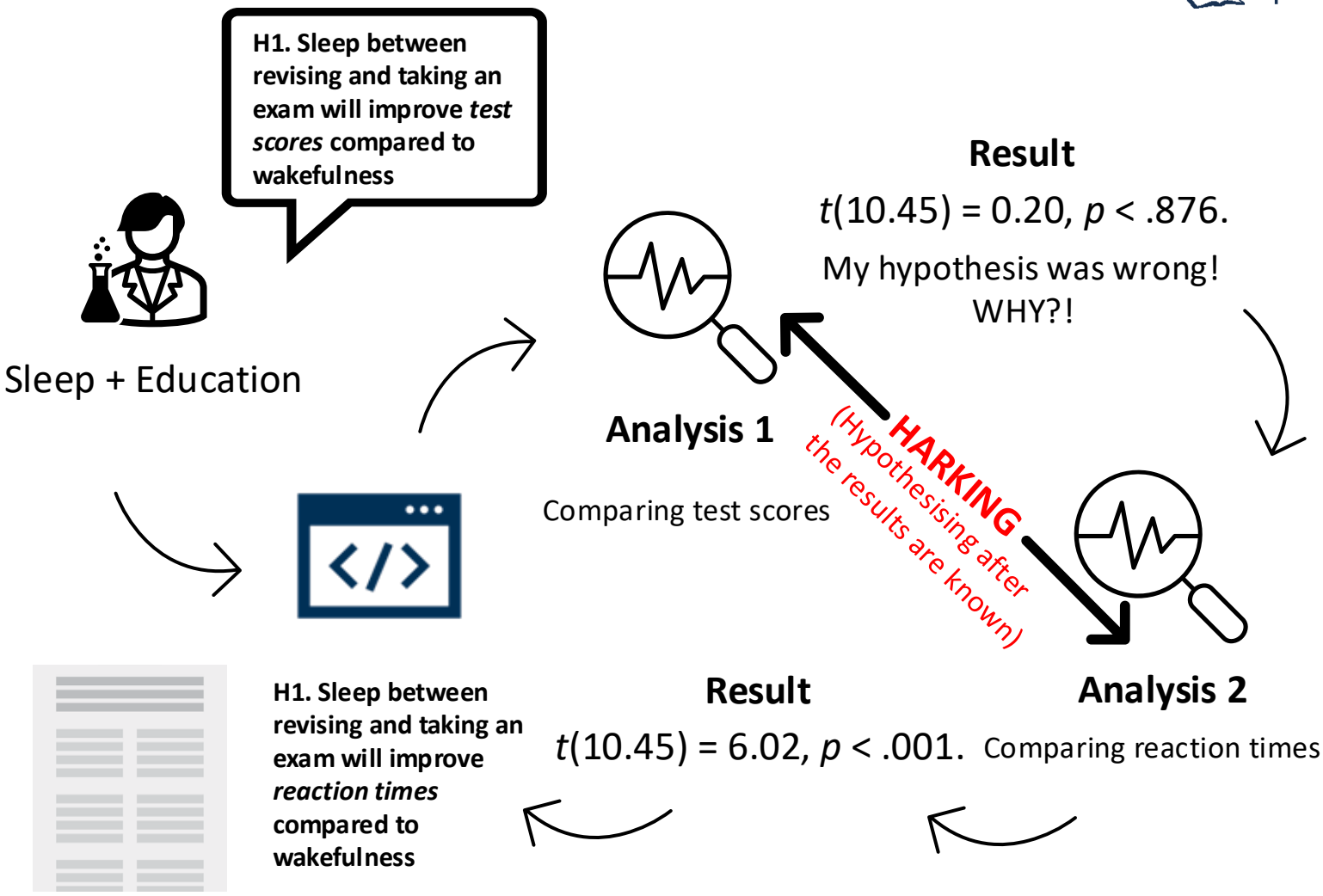
Open Access

Reproducible Manuscripts

Data (Collection and Analysis)

FAIR Data, Open Data, Open Code

Scenario


H1. Sleep between revising and taking an exam will improve *test scores* compared to wakefulness
Sleep + Education
Result
$t(10.45) = 0.20, p < .876.$
My hypothesis was wrong!
WHY?!
Analysis 1
Comparing test scores
HARKING
(Hypothesising after the results are known)
Analysis 2
Comparing reaction times
Result
$t(10.45) = 6.02, p < .001.$
H1. Sleep between revising and taking an exam will improve *reaction times* compared to wakefulness

Questionable Research Practices and the Replication Crisis

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Questionable Research Practices include HARKING, optional stopping omitting results based on their significance etc. (see Stefan & Schönbrodt, 2023)

As examples, these practices are thought to be one of the reasons which drive up issues like the **Replication Crisis**.

Article(s)	Discipline	N of replication attempts	Range % successful replications[1]
Soto (2019), Camerer et al. (2018), Open Sci. Collab. (2015)	Psychological Science	101	36% - 90%
Perry et al. (2022)	Educational Research	145	60%
Murphy et al. (2025)	Sports Science	25	28% - 58%

[1]% replications vary based on the replication metric used, field and type of replication conducted

Scenario with Open Science

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H1. Sleep between revising and taking an exam will improve *test scores* compared to wakefulness

Sleep + Education

Analyses
Research Design
Hypotheses

Preregistration

Pre-registered analysis

Comparing test scores

Result

$t(10.45) = 0.20, p < .876.$

My hypothesis was wrong!
WHY?!

Exploratory Analysis

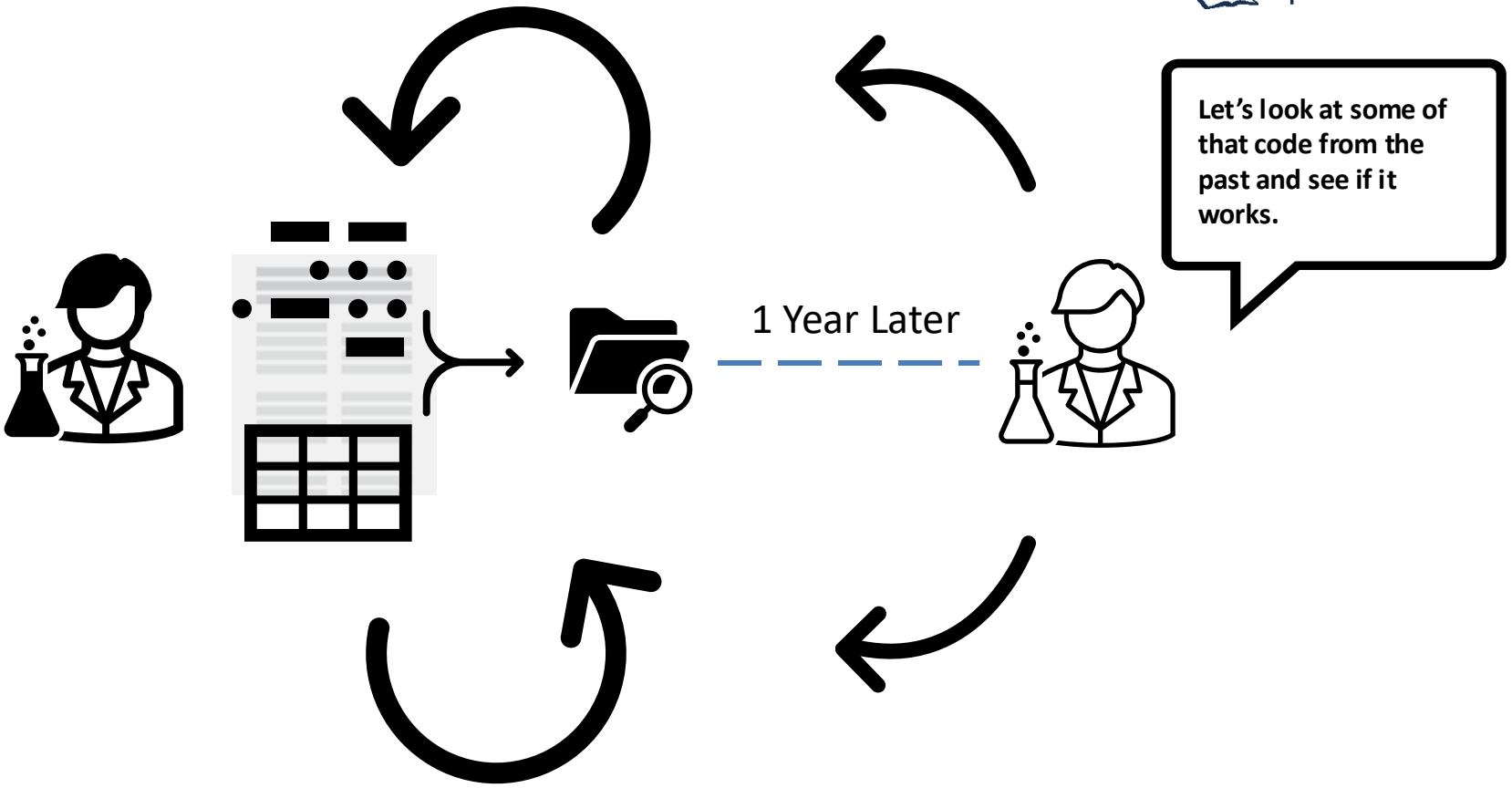
Comparing reaction times

Result

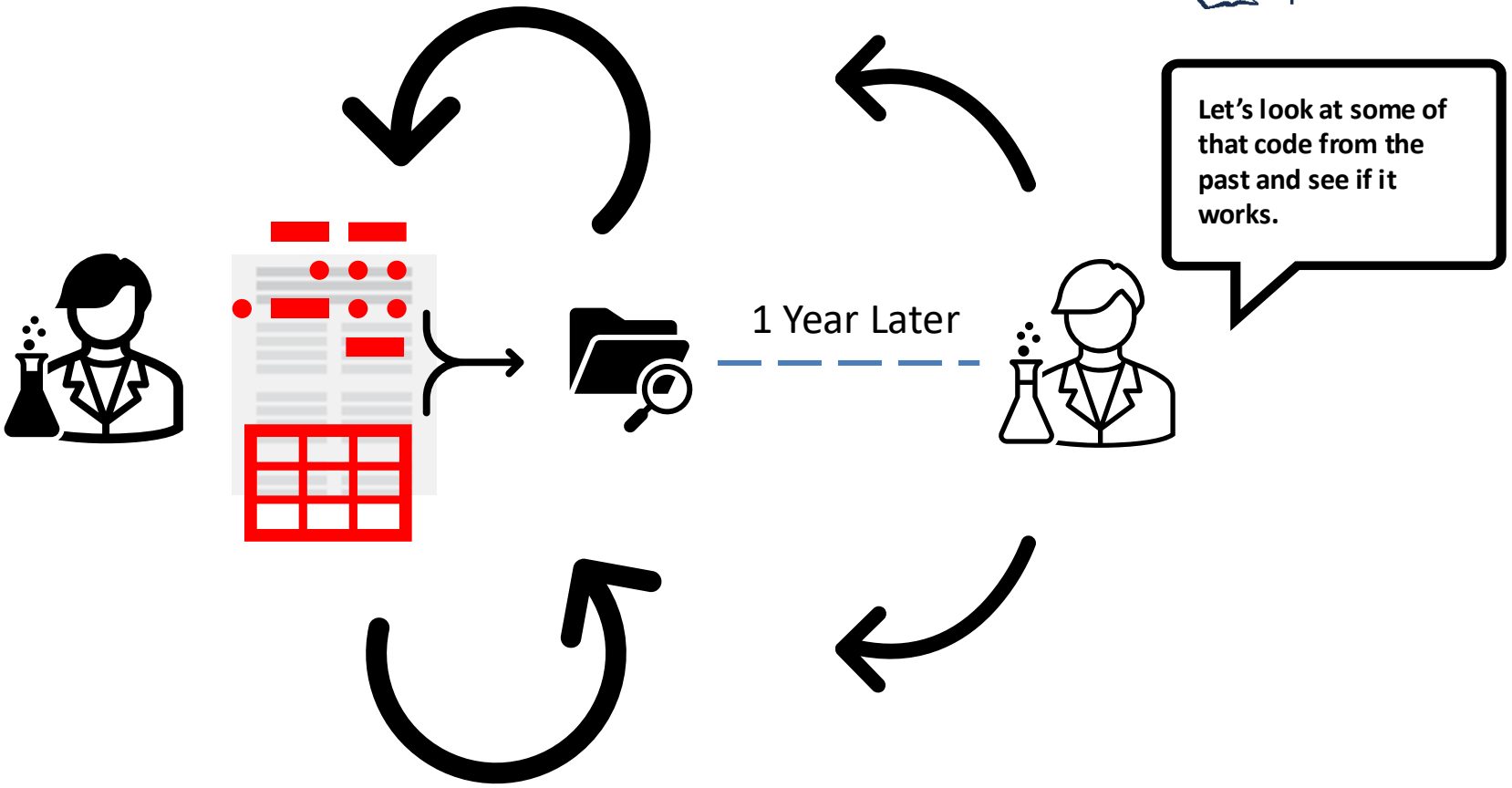
$t(10.45) = 6.02, p < .001.$

Write the publication with the original hypothesis and distinguish between preregistered analyses and exploratory analyses

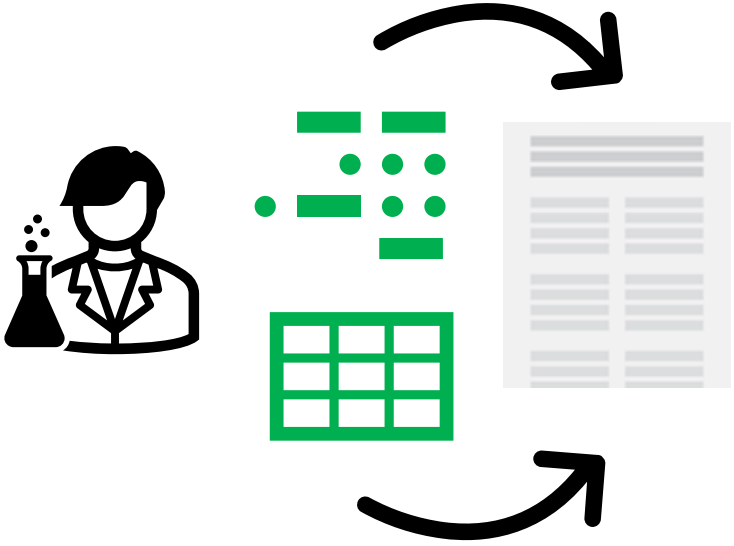
Scenario


1 Year Later
Let's look at some of that code from the past and see if it works.

Scenario


1 Year Later
Let's look at some of that code from the past and see if it works.

Scenario with Open Science



Provide the code, data and documentation to journal

Goes out for review

Reproducibility Check

1. Documentation
2. Execution
3. Reproducibility

Reproducibility Crisis

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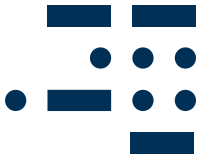
Crüwell et al. (2023) asked researchers to attempt to reproduce the results of 14 papers:

Article	Rating
108	Exactly reproducible
101	Essentially reproducible
109	Essentially reproducible
111	Essentially reproducible
102	Partially reproducible
103	Partially reproducible
104	Partially reproducible
110	Partially reproducible
113	Partially reproducible
114	Partially reproducible
112	Mostly not reproducible
112	Not reproducible
113	Not reproducible
114	Not reproducible

Missing Data/
Post processed data



Insufficient or
Missing Code

Documentation Missing
(e.g., Readme, Codebook)

Adapted from Crüwell et al. (2023), Psychological Science, Table 3. https://doi.org/10.1177/09567976221140828

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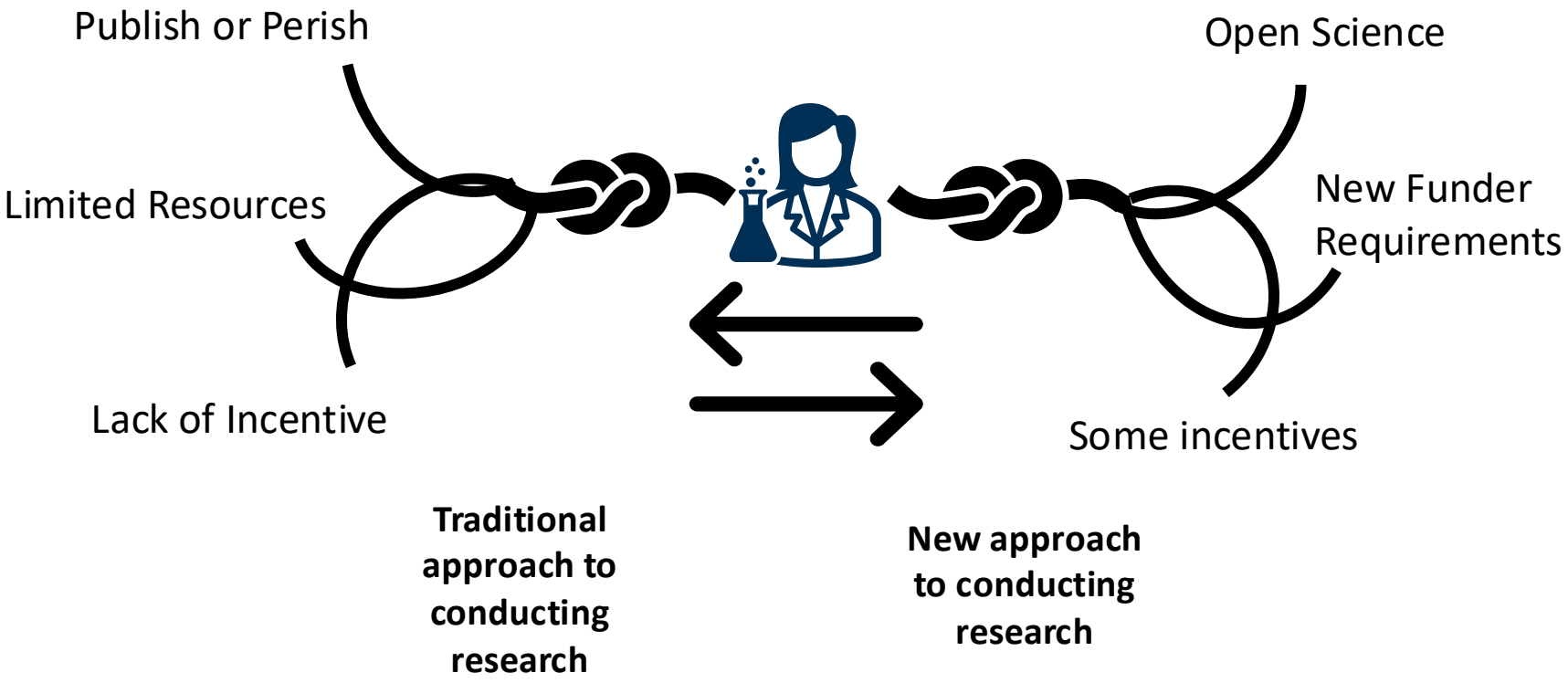
Is it me? Am I the problem?

The context


Publish or Perish
Limited Resources
Lack of Incentive
Open Science
New Funder Requirements
Some incentives
Traditional approach to conducting research
New approach to conducting research

What do the practices look like in this context?

What do the practices look like in this context?

The Open Science Office

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Supporting Researchers with Open Science

Open Science Office

Embedded within UB since 2021

- **Institutional approach** to supporting researchers with Open Science
- Initial funding support for **3 years** from the **university research fund**
- Open Science Office and Open Science Officer position made **permanent** in 2024

Tasks of the Open Science Office

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Training and Educating Researchers:

Provides and organises:

- Open Science seminars and workshops
- (an) Open Science Summer School
- Lectures on faculties' courses

Open Access, Open Data and Open Research Practices

Preregistrations and Registered Reports

Technical Workflows for Reproducibility (e.g., R Markdown and Docker)

Citizen Science

Tasks of the Open Science Office

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Research Support and Services:

Open Science consultations (e.g., for **DFG**, or **EU** funding applications, practical implementation)

Open Science Grants (up to 6,500 EURs).

funded by Open Science Office

Open Science in Practice

Open Science Grants - In a nutshell

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Internal grants for researchers at the University of Mannheim:

Goal: Incentivise and reward early adoption of Open Science practices

The call for applications runs annually.

95,000 EURs to 21 projects, across disciplines over 4 application rounds (2021, 2022, 2024, 2025).

Open Science Grants - Evaluation

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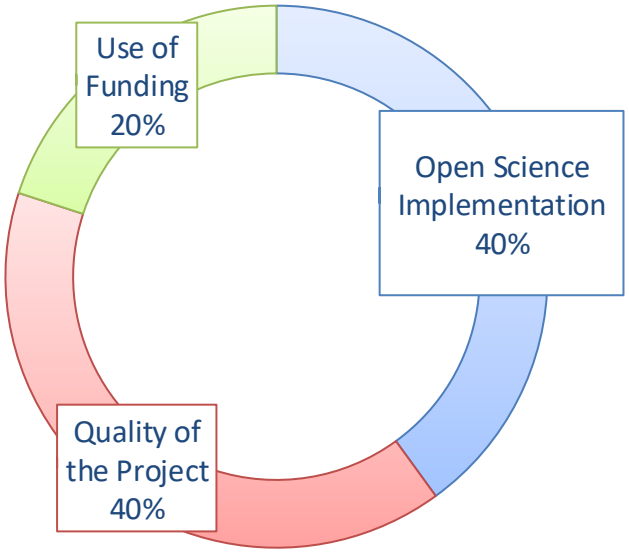
Open Science Grants



Open Science Implementation

Open Science Methods/Reflection on the use of Open Science in your project. Contribution to the University of Mannheim as an Open Science stakeholder (where relevant).

Quality of Project

Content Quality (background, motivation, etc.) Implications for theory, practice and society Quality of writing and presentation.

Use of Funding

Open Science Grants - Implementation Plan

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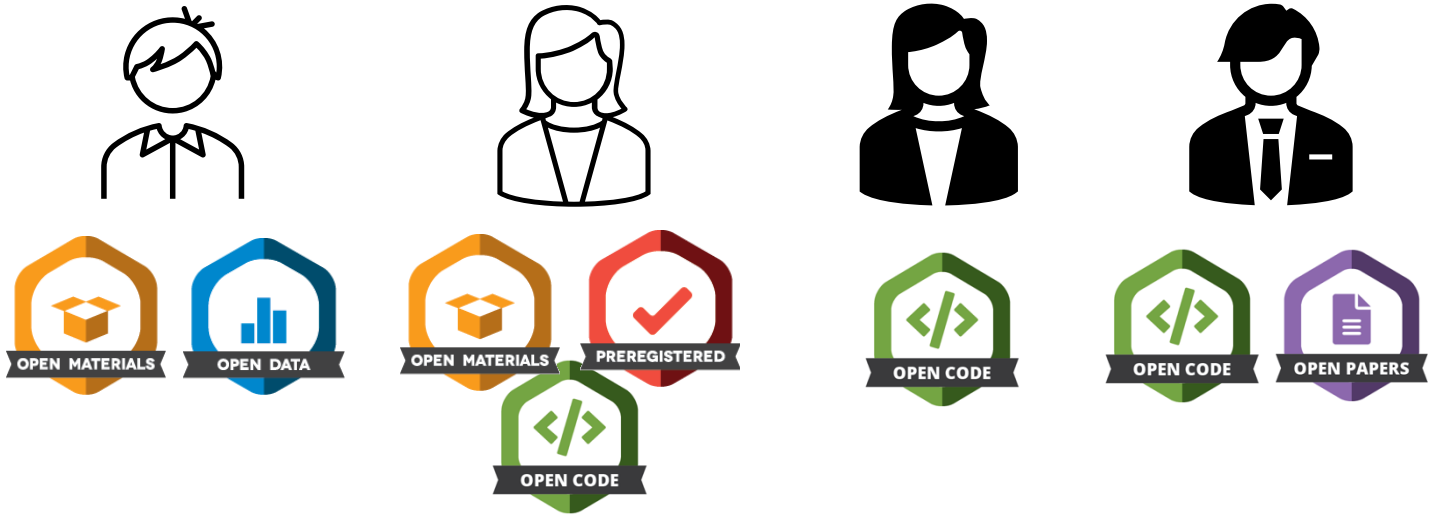
- The goal is not to "Open Wash" research. Applicants do not need to use all Open Science practices:

Open Science Badges by the Open Science Framework (Centre for Open Science) are licensed under a Creative Commons Attribution 4.0 International (CC BY 4.0) licence. Source: https://osf.io/tvyxz/overview



Open Science Grants - Implementation Plan

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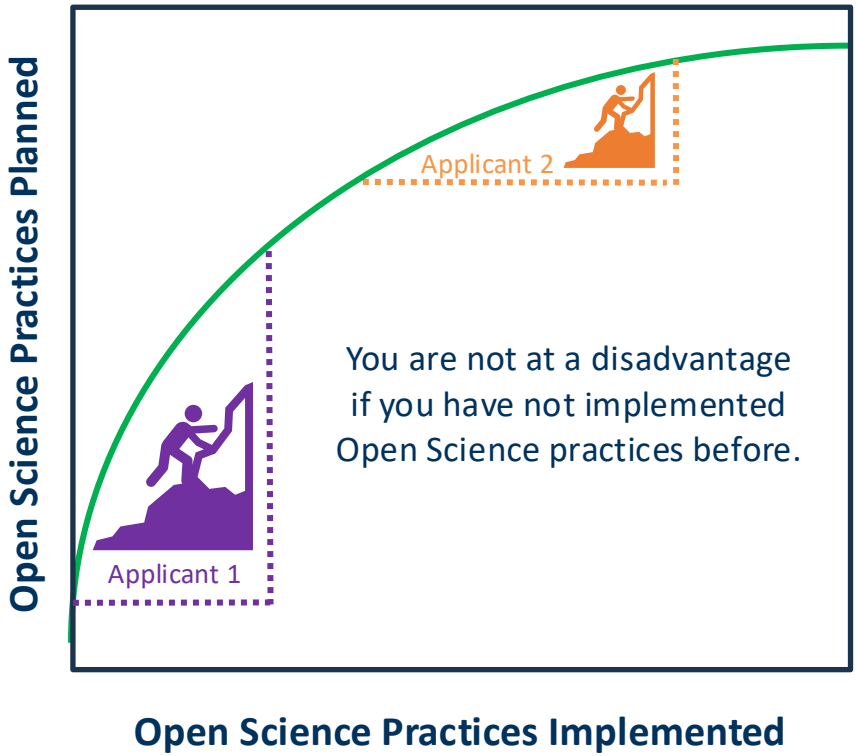
The level of experience with Open Science will does not impact the evaluation:



Open Science Grants - Practices Across Disciplines

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Discipline:
Linguistics

Career Level:
Post-doc

Experience:
Beginner

Open Practices:
Preregistration,
Open Data + Code

Understanding the underlying mechanisms of cross-linguistic influence: Evidence from priming in German-Italian bilinguals

Aim: Investigating the use/acceptance of linguistic properties in bilinguals under the influence of a second language

Study: Preregistered research on the OSF Identifying the bilingual influence in **German/Italian speaking children**

Point of Interest: Power Analysis, Fixed Participant N

Despite the challenges – this research conducted a power analysis by assessing meta-analytic work and considering the trial-wise contribution to statistical power.

Open Science Grants - Practices Across Disciplines

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Discipline:
Psychology

Career Level:
Post-Doc

Experience:
Advanced

Open Practices:
Preregistration, Open Data+Code+Access Citizen Science, SciComs

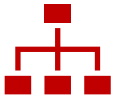
Blessed be ye poor: An open and citizen-focused approach to study cultural religiosity

Aim: Investigating the psychological buffer of religiosity on high vs. low SES countries

Study 1: Exploratory, Qualitative, **Citizen Science Focused Hypothesis Generation** identifying which processes underly the buffering effect of religiosity:

Faith + Norms

Practical Support



Structure + Community

Hope + Optimism

Forthcoming Study 2: **Preregistered** confirmatory investigation of hypotheses derived from study 1

Open Science Grants - Practices Across Disciplines

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Discipline:
German Studies, History

Career Level:
Post-Doc

Experience:
Intermediate

Open Practices:
Knowledge Exchange, Science Communication Open Educational Resources

[German Wikipedia and the Resistance Against National Socialism – An Interdisciplinary Research and Teaching Project at the University of Mannheim]

Aim: Conduct an interdisciplinary seminar series embeded within an **Open Science format**:

Combination of hands-on workshops and lectures:

WIKIPEDIA

Edit-a-thon

New openly available articles + blog posts on resistance against national socialism

Open Science Grants - Other Examples

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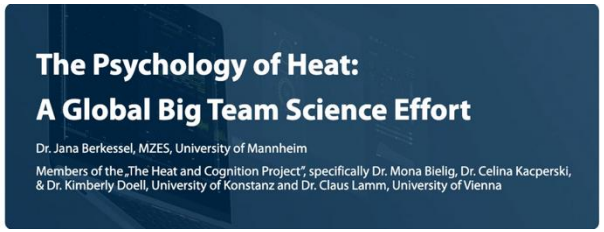
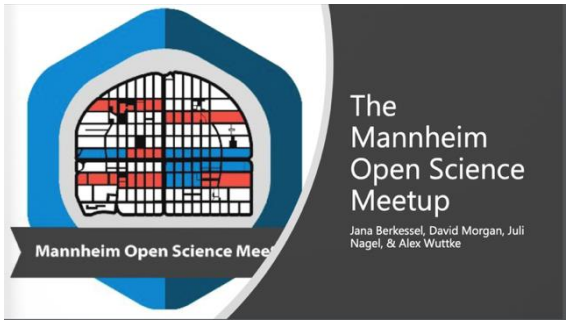
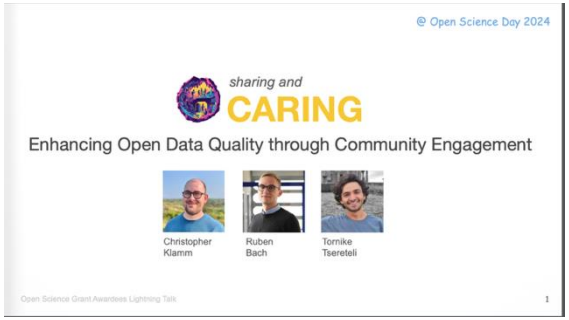
Research Projects

Events

Infrastructure

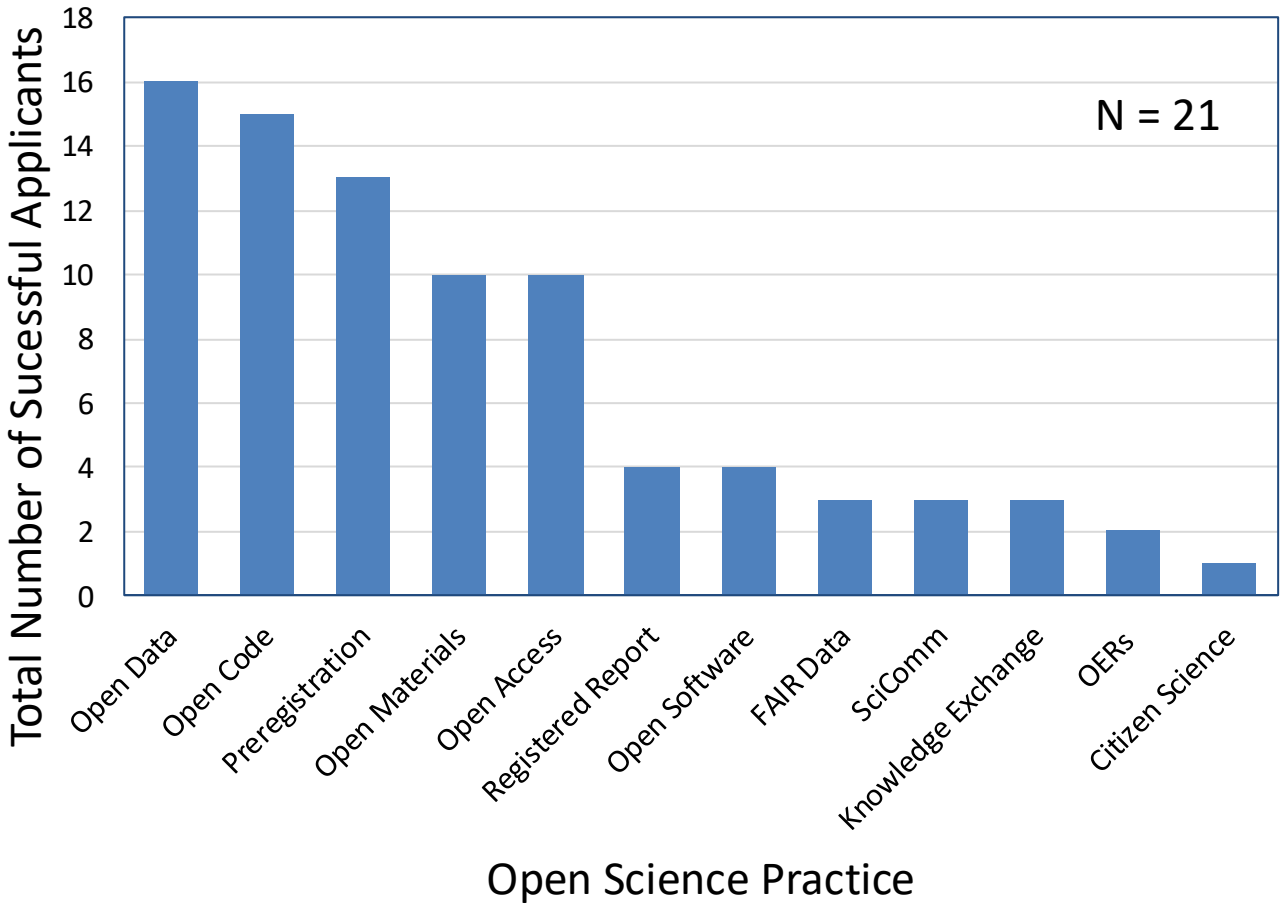




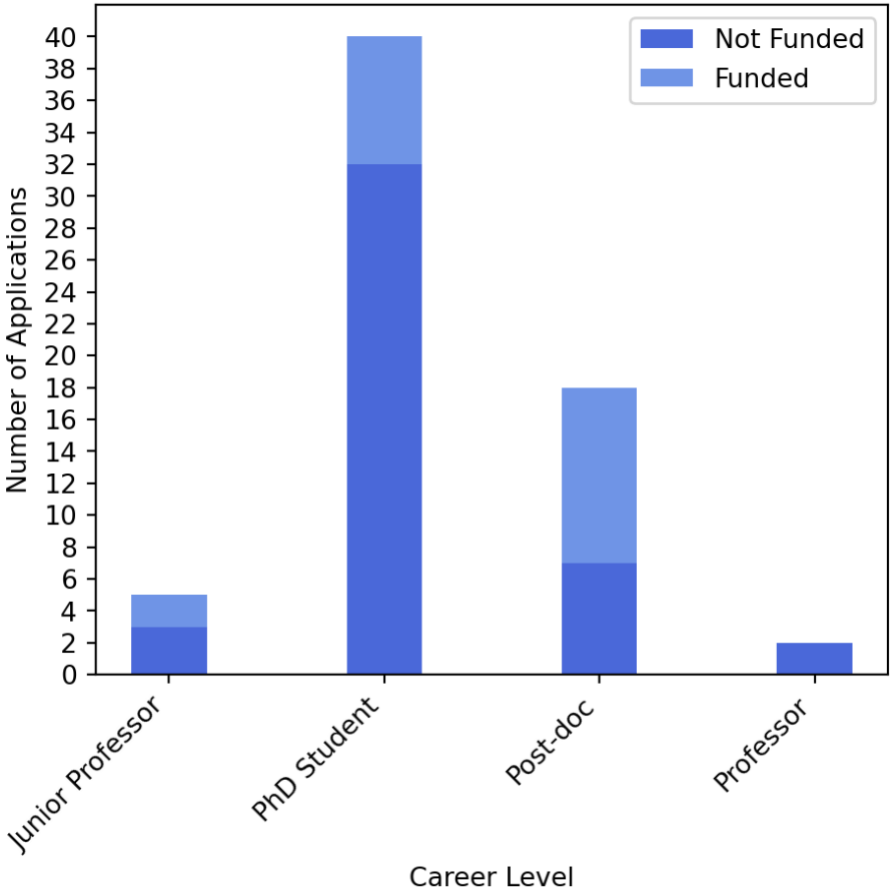


See Best Practices at the University of Mannheim

Open Science Grants - Outcomes



Open Science Grants - Outcomes



"…I think that this format of an Open Science Grant is an excellent way to help junior researchers gain some independence, and by the same token, to get open science practices in the daily routine of the next generation of researchers…." – Open Science Grant Awardee 2021

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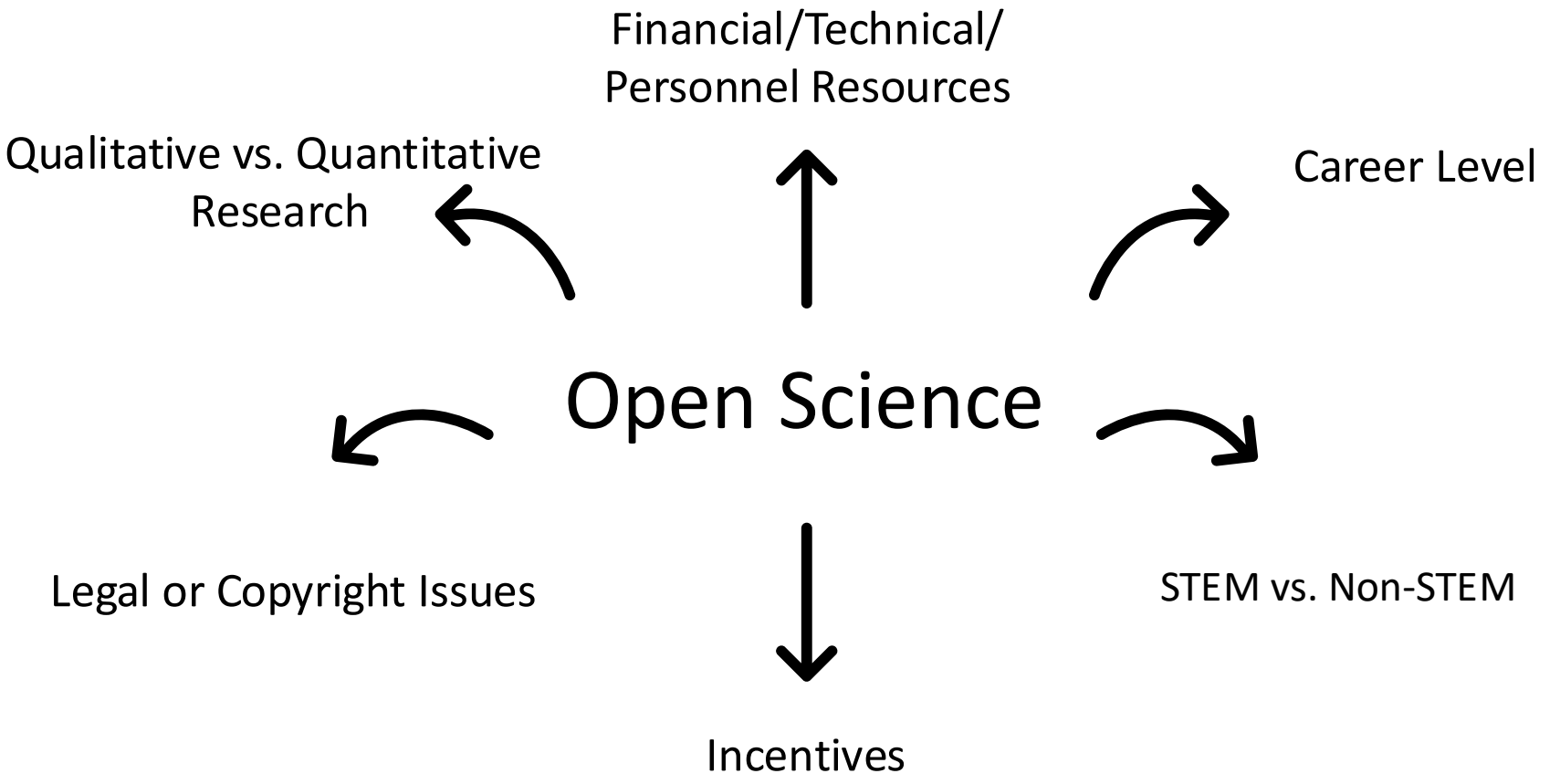
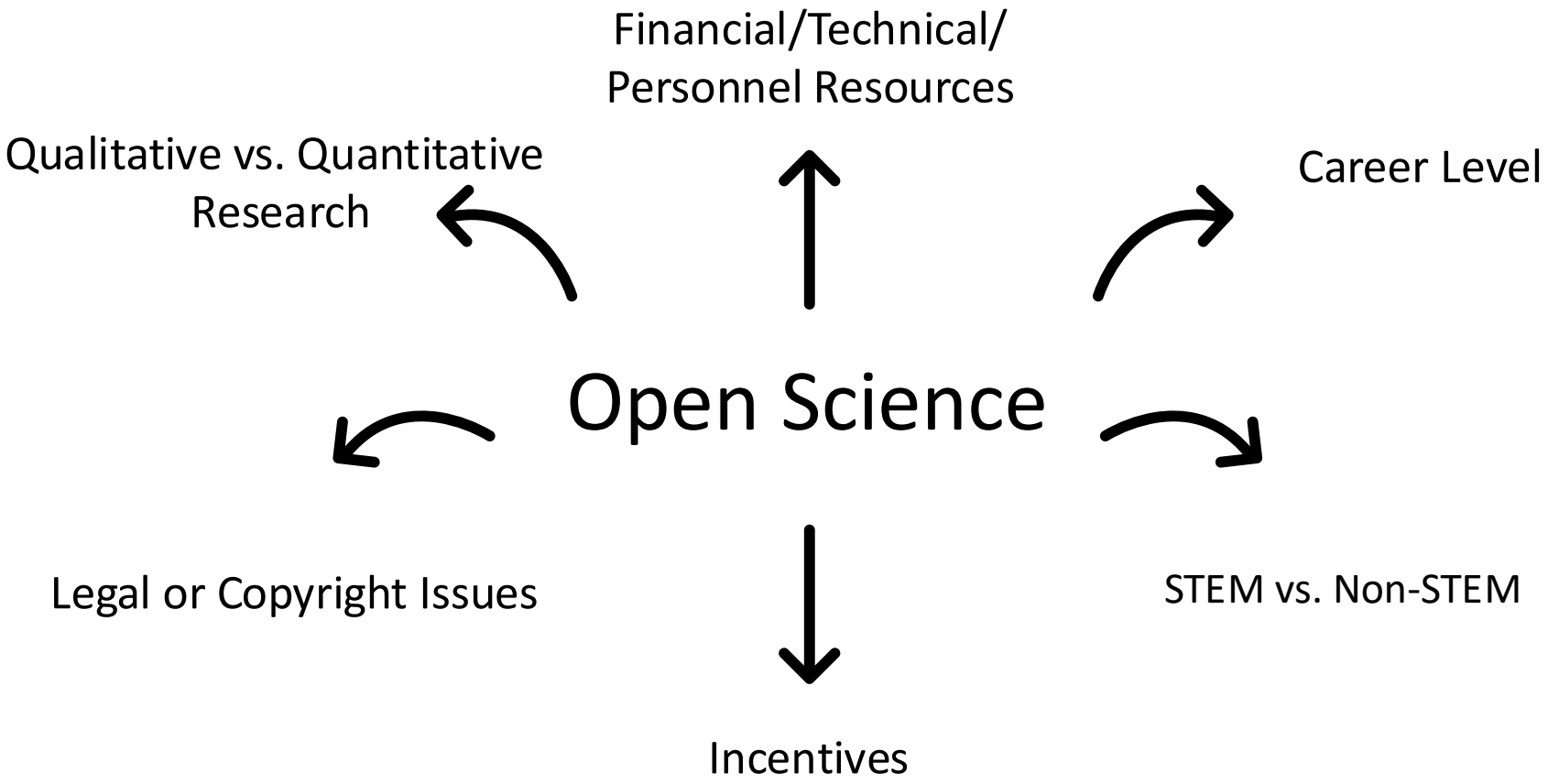
So Open Science is feasible for everyone then, right?

Implementing Open Science: A continuum of Open Science

A question of challenges for Open Science



A question of ~~challenges~~ possibilities for Open Science



There are many aspects that researchers must contend with when implementing Open Science but they do not prevent you from doing Open Science but change how you do it.

A continuum of Open Science: Experience with Open Science

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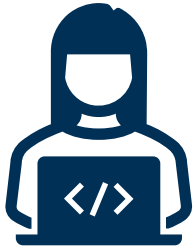
Open Access Publishing

Open Data



Reproducible Code

Registered Report

Open Science Experience

Not at all experienced

Very Experienced

A continuum of Open Science: Open Science Grants

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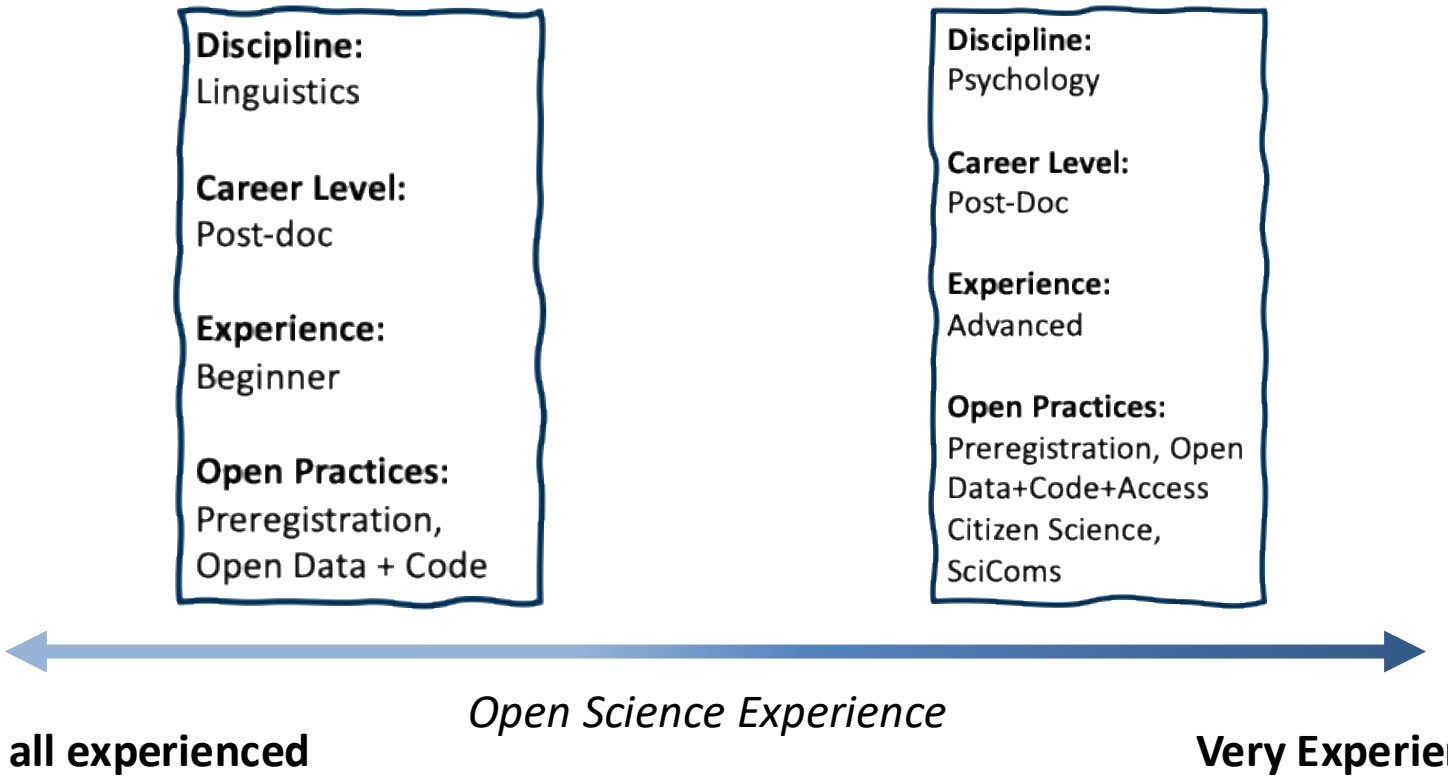

A continuum of Open Science: Quantitative vs. Qualitative

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Open Science can be guided by a quantitative focus which may not apply equally or in the same way to qualitative research:

Replicability/Reproducibility in **Qualitative** Research:

"…the provision of sufficient information to allow readers to trace the reasoning and analytic steps leading from observation to conclusions, and think through the processes of observation or engagement. Replication-in-thought involves the reader asking questions such as: Could I in principle imagine employing the same procedures and getting the same results?…" (Büthe & Jacobs, 2015)

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A continuum of Open Science: Quantitative Data + Analysis

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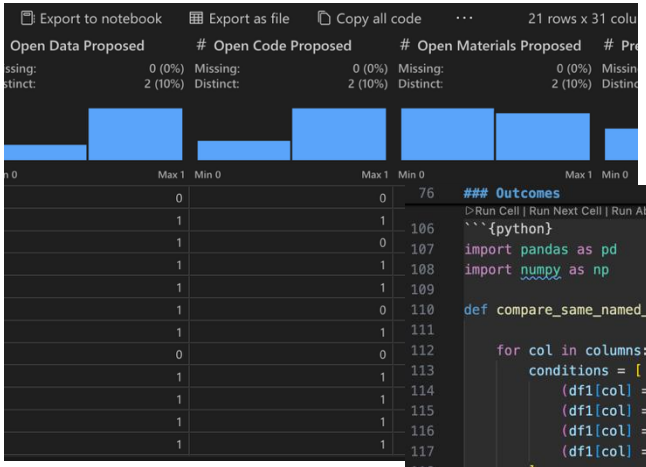
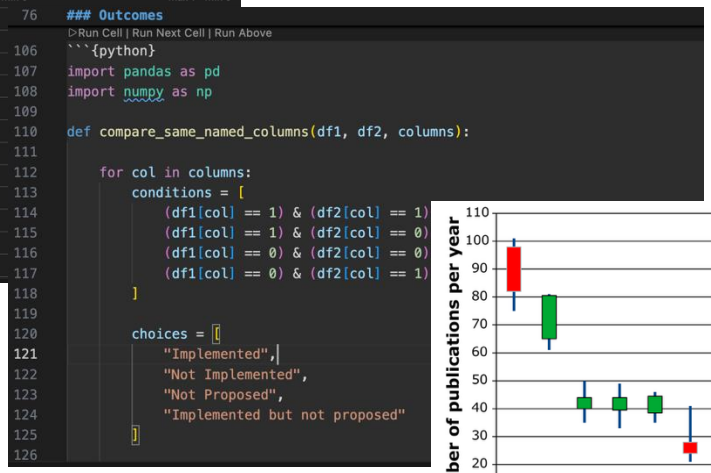
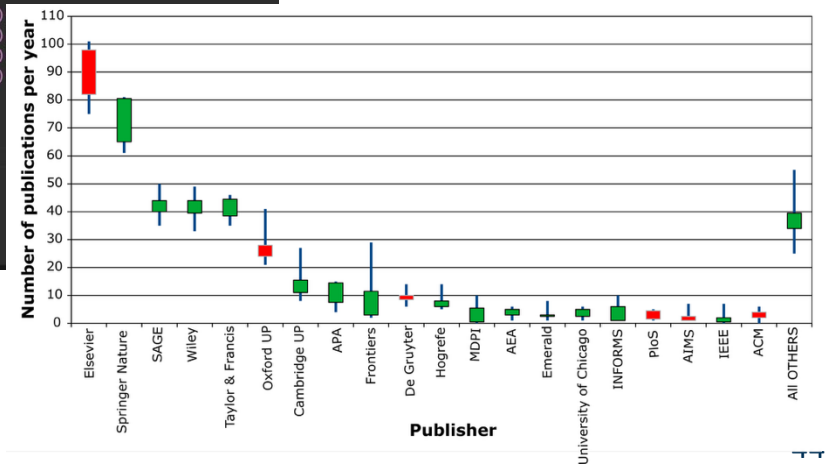


Data



Analytic Code



Results

The data and code could be used to reproduce the research results.

A continuum of Open Science: Qualitative Data + Analysis

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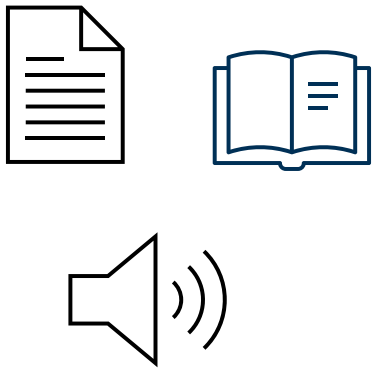
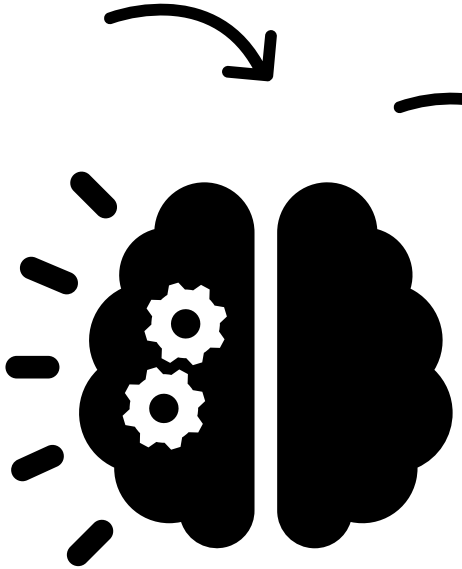
Interviews, Audio, Books



Data



Thematic Analysis

Identifying themes

Explanations
Reasoning
Evidence

There are several steps here which exist in qualitative but not in quantitative research which are needed for reproducibility

A continuum of Open Science: Annotation for Transparent Inquiry (ATI)

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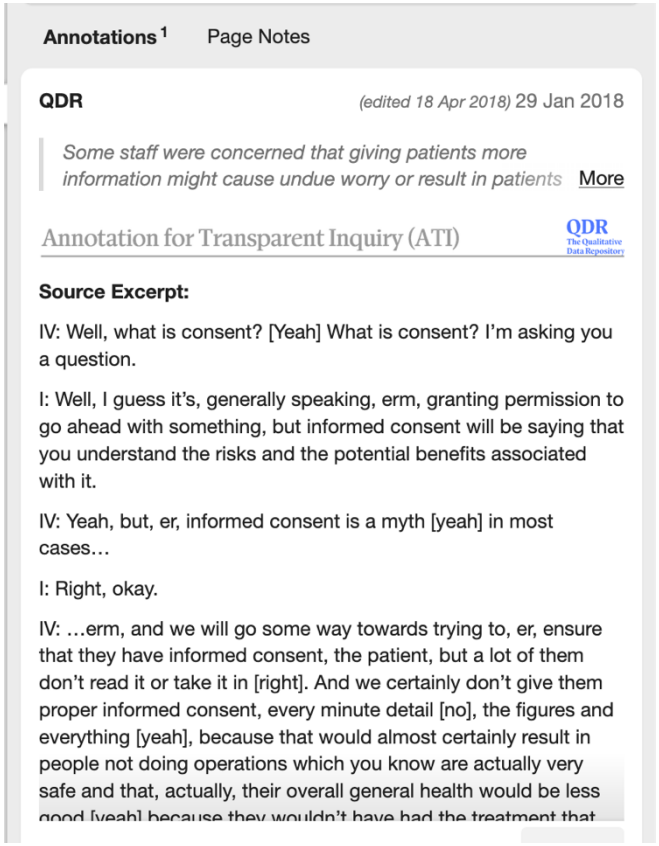
Risk Understanding of Patients

The first theme to emerge from the data was poor understanding of risk on the part of patients. Transplant staff generally felt that patients did not have a detailed understanding of risk, but the staff took a relatively pragmatic attitude toward this, suggesting that it is not always necessary or beneficial for patients to understand everything. Some staff were concerned that giving patients more information might cause undue worry or result in patients making decisions that might be contrary to their best medical interests:

> We will go some way towards trying to ensure that they [patients] have informed consent . . . but a lot of them don't read it or take it in. And we certainly don't give them . . . every minute detail, the figures and everything, because that would almost certainly result in people not doing operations which you know are actually very safe and that, actually, their overall general health would be less good because they wouldn't have had the treatment that would have given them great benefit. (LS17)

Other staff accepted that there may be situations in which patients sign consent forms without fully understanding the risks involved but felt it


Annotations 1 Page Notes

QDR (edited 18 Apr 2018) 29 Jan 2018

Some staff were concerned that giving patients more information might cause undue worry or result in patients More

Annotation for Transparent Inquiry (ATI) QDR The Qualitative Data Repository

Source Excerpt:

IV: Well, what is consent? [Yeah] What is consent? I'm asking you a question.

I: Well, I guess it's, generally speaking, erm, granting permission to go ahead with something, but informed consent will be saying that you understand the risks and the potential benefits associated with it.

IV: Yeah, but, er, informed consent is a myth [yeah] in most cases…

I: Right, okay.

IV: …erm, and we will go some way towards trying to, er, ensure that they have informed consent, the patient, but a lot of them don't read it or take it in [right]. And we certainly don't give them proper informed consent, every minute detail [no], the figures and everything [yeah], because that would almost certainly result in people not doing operations which you know are actually very safe and that, actually, their overall general health would be less good [yeah] because they wouldn't have had the treatment that

https://doi.org/10.1017/S0963180116000086

A continuum of Open Science: Quantitative vs. Qualitative

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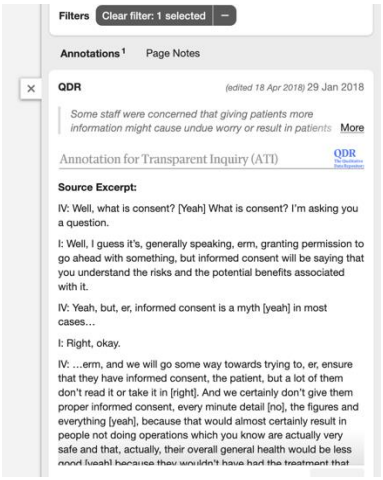
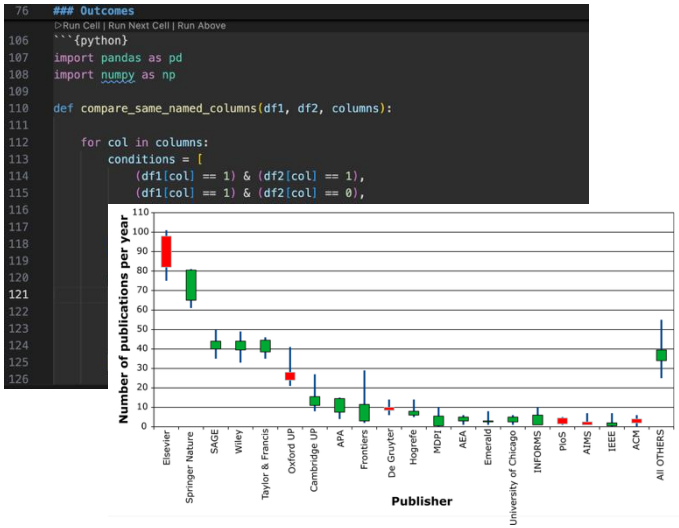


Open Annotation

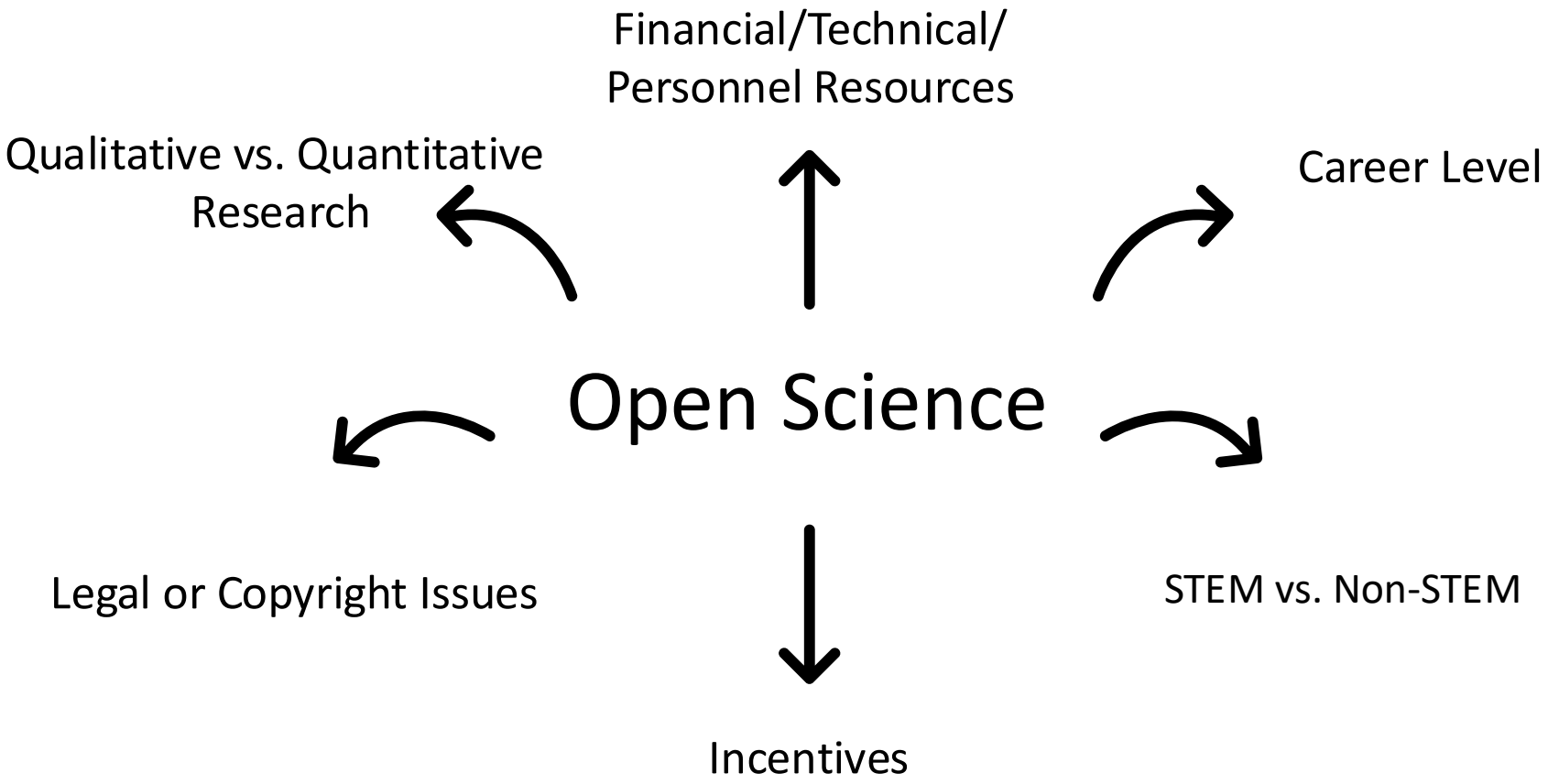


Open Code

Type of Data

Qualitative **Quantitative**

A question of ~~challenges~~ possibilities for Open Science



There are many aspects that researchers must contend with when implementing Open Science but they do not prevent you from doing Open Science but change how you do it.

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Open Science is not a yes or no question.

A continuum of Open Science: Open Science is not yes/no

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Differences in field or type of data aside Open Science Practices are a continuum and are not an all or nothing approach towards doing research:

"As open as possible as closed as necessary"

Data Sharing

Closed Data — **Open Anonymised Data** — **Open Raw Data**

Preregistering

No Preregistration — **Preregistration** — **Preregistration + PAP** — **Registered Report**

Sharing Code

No Code Availability — **Open Code**

Open Science in Practice and Context

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Less Open (Closed) Science

Open Science

A continuum of Open Science may ease the burden

Conclusions

Open Science is a continuum: What's Important to Remember?

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1. Open Science is applicable throughout the research process and across fields

2. Research funding may act as an incentive to balance the tug of war and increase engagement with Open Science

3. Open Science practices are a continuum and not a yes or no binary

4. Be patient with your self and others. Engaging in Open Science is a change process and it takes time to fully adjust

Thanks for listening, questions?

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