

Open Science Practices: Reproducibility

What it is and why to practice it

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What is Open Science?

“Open science” is an umbrella term used to refer to the concepts of openness, transparency, rigor, reproducibility, replicability, and accumulation of knowledge, which are considered fundamental features of science”

— Crüwell et al. (2019), p.3

- a movement developed to respond to crisis in scientific research
 - lack of accessibility, transparency, reproducibility, and replicability of previous research
- transparency is key to all facets of Open Science
 - it allows for full evaluation of all stages of science
- Open Access, software, data, code, materials...

Systemic problem in science

- the combination of
 - publication bias
 - * journals favour novel, significant findings
 - publish or perish
 - * researchers' careers depend on publications
- can/does/did lead to:
 - HARKing
 - * Hypothesising After Results are Known
 - p-hacking
 - * (re-)running analyses until a significant effect is found
 - replication crisis
 - * pervasive failure to replicate previous research

Why do Open Science?

- open science is good science
- it encourages organisation and planning
 - helpful for future you
- increases *transparency*
- makes our work more robust
 - so future work stands on solid ground
- not all-or-nothing
- there are things I consider the bare minimum
 - detailed experiment plan, ideally public
 - openly available materials (e.g., stimuli)
 - share code and data
- the important thing is to do what you can

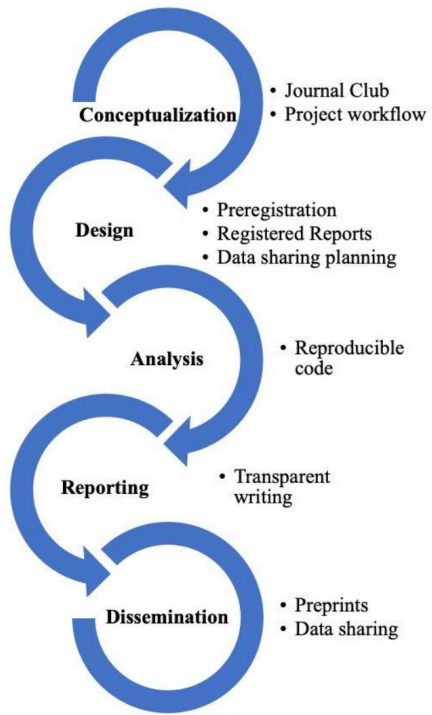


Figure 1. Open Science research practices across the research cycle

Figure 1: Image source: Kathawalla et al. (2021) (all rights reserved)

What is reproducibility?

- one piece of the Open Science pie
- generating the same results with the same data and analysis scripts
- seems obvious, but requires organisation and forethought before and during data collection/analysis
- bare minimum: share the code and the data (Laurinavichyute et al., 2022)

Reproducibility vs. replication

- the two terms have been used interchangeably in the past (e.g., in the title of Open Science Collaboration, 2015)
 - we'll define them as follows (and this is becoming the standard distinction, imo)

Reproducibility

- re-analysing the same data using (ideally) the same scripts, software, etc
- aim: produce the same results (means, model estimates, etc.)
- why: tests for errors, coding mistakes, biases, etc.

Replication

- re-running a previous experiment, ideally with the same materials, set-up, etc.
- ideally the same analysis workflow as the original study (i.e., like reproducing the analyses but with new data)
- aim: test whether results are replicated with new data in terms of direction and magnitude
- in short:
 - reproducibility = re-analysis of the *same data*
 - replication = collection of *new data*

Why implement reproducibility in my workflow?

- firstly: the help future you (or collaborators/other researchers)!
 - you may return to your analyses tomorrow, next month, or next year
- to ensure robustness and to document your steps
 - ‘researcher degrees of freedom’ and the ‘garden of forking paths’: there’s more than one way to analyse a certain dataset

- we can try to plan ahead in detail (e.g., pre-register your analysis plan), but there will always be decisions made that were not foreseen
- lastly: it makes your life *much* easier and streamlines your workflow

The reproducibility spectrum

- reproducibility is on a continuum, referred to as the *reproducibility spectrum* in Peng (2011) (Figure 2)
 - *linked* means “all data, metadata, and code [is] stored and linked with each other and with corresponding publications” (Peng, 2011, p. 1227)
 - *executable* is not explained, and is more difficult to guarantee long-term as it depends on software versions
 - but at minimum we can assume it refers to code running on someone else’s machine

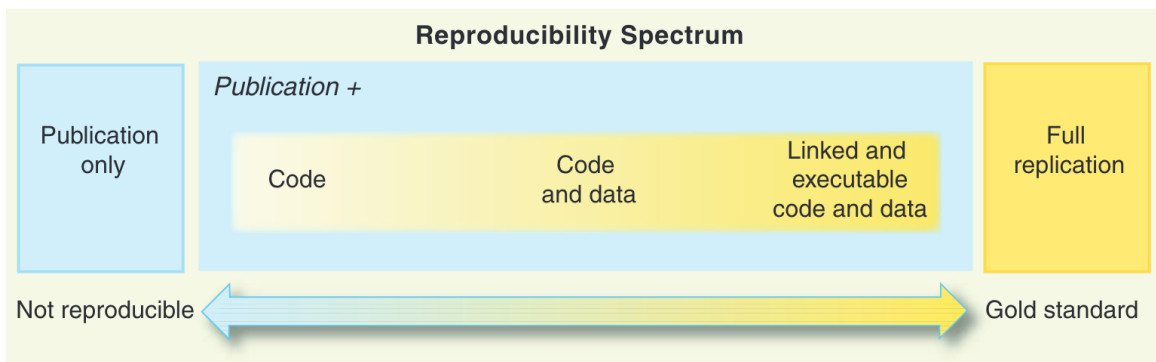


Fig. 1. The spectrum of reproducibility.

Figure 2: Source: Peng (2011)

Steps we'll take

1. Open source software:
 - R, an open source statistical programming language
 - in RStudio, an IDE (integrated developer environment)
 - with [R Projects](#)
2. Project-oriented workflow:
 - establish folder structure
 - and file/variable naming conventions

- use project-relative filepaths with the **here** package
 - establish and maintain project-relative package library with **renv** (time permitting)
3. Practice literate programming:
- writing clean, commented, linear code
 - in dynamic reports (e.g., Quarto, R markdown)
 - practice modularity, i.e., 1 script = 1 purpose
4. Sharing and checking our code
- uploading our code and data to an OSF repository
 - conducting a code review

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