

# Improving the reproducibility of scientific research

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## IS THERE A REPRODUCIBILITY CRISIS?



©nature

# The reproducibility crisis in mass media

≡ EL PAÍS

Materia  
!!!

## La ciencia vive una epidemia de estudios inservibles

Científicos de EE UU, Reino Unido y Holanda denuncian que la investigación está perdiendo parte de su credibilidad

[El País](#)

NEWS | 09 December 2021

## **Half of top cancer studies fail high-profile reproducibility effort**

- Goal: Replicate 193 experiments from 53 papers

Errington et al 2021

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- 1/3 authors **didn't respond or help**

Errington et al 2021



Sylvain Deville ❄️ 🧑  
@DevilleSy

...

Trying to reproduce the results of a paper using only what's in the Methods section



Most scientific articles

**are NOT reproducible**

Reproducibility

[*crisis*]

REVOLUTION

## What is reproducibility?

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# Reproducibility vs Replicability

		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

The Turing Way

We can't guarantee that  
our results are **REPLICABLE**.

But at least  
they should be **REPRODUCIBLE**.

Most scientific articles

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## The prevalence of statistical reporting errors in psychology (1985–2013)

Michèle B. Nuijten<sup>1</sup> · Chris H. J. Hartgerink<sup>1</sup> · Marcel A. L. M. van Assen<sup>1</sup> · Sacha Epskamp<sup>2</sup> · Jelte M. Wicherts<sup>1</sup>

### WHAT STATCHECK LOOKS FOR

This computer algorithm scans papers for statistical tests, uses reported results to recompute the  $P$  value and flags up inconsistencies.

#### Type of test

The  $t$ -test assesses differences between two groups.

#### Test statistic

Compares observed values with those expected under the null hypothesis.

$$t(37) = 4.93, P < 0.01$$

#### Degrees of freedom

Accounts for size of sample.

#### $P$ value

The likelihood of observing differences as extreme, or more so, if the null hypothesis is true.

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1/2 articles: **inconsistencies** in p-values

1/8 articles: **grossly inconsistent** p-values

(affecting conclusions -> significance)

In ecology

< 20% articles are **reproducible**

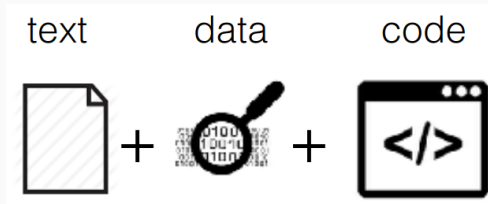
Culina et al 2020

# We can't even reproduce our own work

## Data/Code lost or unusable

qualitative_data.csv	04/07/2016 15:50
cleandata.xlsx	25/06/2015 01:14
cleandata_YC.xlsx	30/06/2015 16:22
COORDENADAS PACO_20-05-2016 CON REVIEWS.xlsx	20/05/2016 16:23
COORDENADAS PACO_20-05-2016 CON REVIEWS_FRS.xlsx	27/05/2016 19:41
COORDENADAS_paper195(Girella_elevata).xlsx	08/06/2016 13:09
coordenadas_raw_2016-06-08.xlsx	09/06/2016 15:53
coordenadas_raw_2016-06-08_old.xlsx	08/06/2016 16:00
coordenadas_raw_2016-06-21.xlsx	21/06/2016 16:12
coords_2015-09-09_modif.xlsx	05/11/2015 15:23
coords_2015-10-11_modif_YC.xlsx	17/11/2015 13:37
coords_2015-10-11_modif_YC_PACO.xlsx	17/11/2015 17:06
coords_2015-10-18_modif_YC.xlsx	18/11/2015 17:24
coords_2015-12-26_modif_YC.xlsx	30/03/2016 19:38
coords_2016-04-02.xlsx	06/04/2016 17:46
coords_2016-04-02_YC.xlsx	06/04/2016 18:03
coords_2016-04-08_YC.xlsx	11/04/2016 13:51
dataset_y_coords_09_09_15.xlsx	23/09/2015 17:18
Datos metaanálisis_18-04-2016.xlsx	19/04/2016 16:24
FINAL METAANALYSIS_14-6-2016_WITH REVIEWS.xlsx	21/06/2016 16:15
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FINAL METAANALYSIS_2016-04-27_WITH REVIEWS.xlsx	25/05/2016 18:05
FINAL METAANALYSIS_2016-04-27_WITH REVIEWS_FRS.xlsx	27/05/2016 18:44
FINAL METAANALYSIS_2016-04-29_EXCLUDING REVIEWS.xlsx	08/06/2016 13:06
FINAL VOTECOUNTING_1-7-2016.xlsx	04/07/2016 15:46
fitnessdata_2016-06-22.xlsx	22/06/2016 21:00
IFs for Bastien_19-3-2016_YC.xlsx	28/03/2016 19:26
Metaanalysis final_01-05-2015 with coordinates.xlsx	18/05/2015 19:20
Metaanalysis final_22-05-2015 coords.xlsx	24/06/2015 15:50
Metaanalysis final_25-06-2015.xlsx	30/06/2015 16:55
Metaanalysis y coords revisadas_06-08-2015_AH_JE.xlsx	23/09/2015 12:57

# What's a reproducible manuscript?



## DATA + CODE

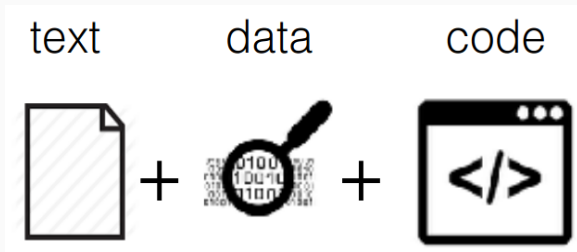
- analysis fully **traceable**
- results can be **regenerated**

A scientific article is **advertising**, not scholarship.

The actual scholarship is the **full software environment**,  
**code and data**, that produced the result.

Claerbout & Karrenback 1992

# Reproducible article: text + data + code



Are we sharing the data?



## PERSPECTIVE

# Public Data Archiving in Ecology and Evolution: How Well Are We Doing?

**Dominique G. Roche<sup>1,2\*</sup>, Loeske E. B. Kruuk<sup>1,3</sup>, Robert Lanfear<sup>1,4</sup>, Sandra A. Binning<sup>1,2</sup>**

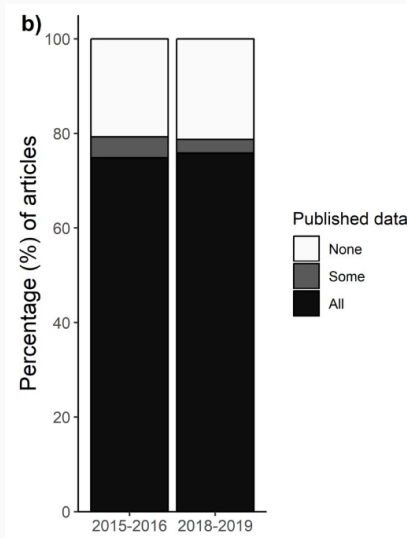
**1** Division of Evolution, Ecology and Genetics, Research School of Biology, The Australian National University, Canberra, Australian Capital Territory, Australia, **2** Éco-Éthologie, Institut de Biologie, Université de Neuchâtel, Neuchâtel, Switzerland, **3** Institute of Evolutionary Biology, School of Biological Sciences, University of Edinburgh, Edinburgh, United Kingdom, **4** Department of Biological Sciences, Macquarie University, Sydney, Australia

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## Abstract

Policies that mandate public data archiving (PDA) successfully increase accessibility to data underlying scientific publications. However, is the data quality sufficient to allow reuse and reanalysis? We surveyed 100 datasets associated with nonmolecular studies in journals that commonly publish ecological and evolutionary research and have a strong PDA policy. Out of these datasets, 56% were incomplete, and 64% were archived in a way that partially or entirely prevented reuse. We suggest that cultural shifts facilitating clearer benefits to authors are necessary to achieve high-quality PDA and highlight key guidelines to help authors increase their data's reuse potential and compliance with journal data policies.

# Are we sharing data?



## Quickly getting better

### **Scientific Life**

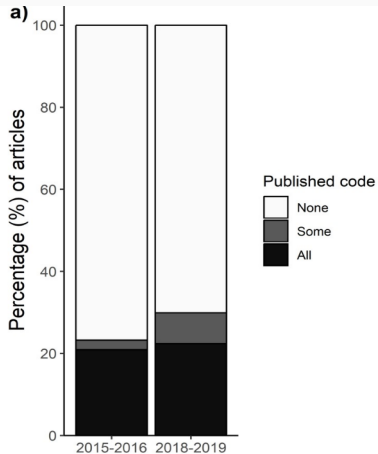
Early Career  
Researchers Embrace  
Data Sharing

Hamish A. Campbell,<sup>1,\*</sup>  
Mariana A. Micheli-Campbell,<sup>1</sup>  
and Vinay Udyawer<sup>2</sup>

Campbell et al. 2019

Are we sharing the code?

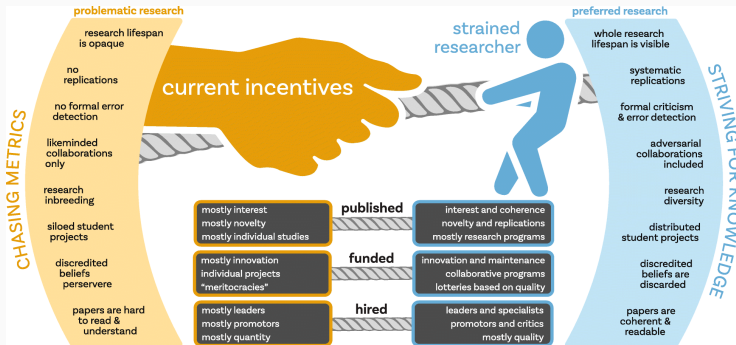
# Code exists but rarely shared



**Fig 1. Code-sharing is at its infancy in ecology, where**

WHY?

# Poor incentives



O'Dea et al 2021

## The Costs of Reproducibility

Russell A. Poldrack<sup>1,\*</sup>



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<https://doi.org/10.1016/j.neuron.2018.11.030>

PERSPECTIVE

Open science challenges, benefits and tips in early career and beyond

Christopher Allen<sup>1</sup> \*, David M. A. Mehler<sup>1,2</sup> \*



## Credit data generators for data reuse

To promote effective sharing, we must create an enduring link between the people who generate data and its future uses, urge **Heather H. Pierce** and colleagues.

[Pierce et al 2019](#)

# Let's knock down psychological barriers

## Publish your computer code: it is good enough

*Freely provided working code — whatever its quality — improves programming and enables others to engage with your research, says **Nick Barnes**.*

Barnes 2010

- Improve training
- Code review, preprints...
- Avoid shaming -> constructive critique
- Ugly code better than no code