



How to open up your research

A practical primer on transparent research workflows

Frederik Aust
Johannes Breuer



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About us

Frederik Aust

- PhD student at the University of Cologne (Prof. Dr. Christoph Stahl)
- Founding memeber of **Cologne Open Science working group**
- Author and contributor to several R packages (e.g., **afex**, **citr**, **papaja**, **prereg**)

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About us

Johannes Breuer



- PhD in psychology, University of Cologne (media psychology, Prof. Dr. Gary Bente)
- Previously worked at different comm and psych departments
- Now senior researcher at **GESIS – Leibniz Institute for the Social Sciences** (Data Archive for the Social Sciences)

Preliminaries

- We want to make this an (inter)active workshop
 - Feel free to ask questions at any time
- Slides and material are available at

<https://tinyurl.com/y8db2fu>

Workshop material is based on

Klein, O., Hardwicke, T. E., Aust, F., Breuer, J., Danielsson, H., Hofelich Mohr, A., ... Frank, M. C. (2018). A Practical Guide for Transparency in Psychological Science. Collabra: Psychology, 4(1). doi: [10.1525/collabra.158](https://doi.org/10.1525/collabra.158)

Workshop outline

- General considerations

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- *What* can you share?
 - Study protocol
 - Study materials
 - Data and metadata
 - Standard operating procedures
 - Documentation of analyses
 - Research reports

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- *What* can you share?
 - Study protocol
 - Study materials
 - Data and metadata
 - Standard operating procedures
 - Documentation of analyses
 - Research reports
- *When* can you share?

Workshop outline

- *How* can you share?
 - Compilation of research products
 - Choosing a repository
 - Specialized approaches
 - Licenses

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- *How* can you share?
 - Compilation of research products
 - Choosing a repository
 - Specialized approaches
 - Licenses
- How can you promote openness?

Why should you share?

Why should you share?

- It's just documenting your work
 - Remember what you've done

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 - Remember what you've done

Your closest collaborator is you six months ago, but you don't reply to emails.

— Paul Wilson, University of Wisconsin Madison

Why should you share?

- It's just documenting your work
 - Remember what you've done
 - Lab members can learn from each other
 - Colleagues can scrutinize and build on your work

Why should you share?

Open Science is just science done right

—Jon Tennant, Imperial College London

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Why would you *not* share?

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 - Usually an unwarranted fear
 - Share upon publication or with an embargo

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Why would you *not* share?

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 - Usually an unwarranted fear
 - Share upon publication or with an embargo
- Fear of being corrected
 - Errors are inevitable and a normal part of science
 - Promotes scientific self-correction
 - Constructive self-correction can enhance researchers' standing (Fetterman & Sassenberg, 2015)

Why would you *not* share?

- Personal data
 - Get informed consent
 - Pseudonymize data
 - Employ access controls
 - Share other research products

Why would you *not* share?

Although I was committed to open data, I was not implementing it [...] It was a pain to document the data; [...] to format the data; [...] to contact the library personnel; [...] to figure out which data were indeed published as part of which experiments. [...] I had neither a routine nor any daily incentive to archive data (p. 1063, Rouder, 2016)

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- Time-consuming
 - Take one step at a time ("baby steps")
 - Iteratively improve your workflow
 - Increases efficiency in the long-run
 - Increases exposure and citations



How to open up your research

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being an open scientist means adopting a few straightforward research management practices, which lead to less error-prone, reproducible research workflows (p. 11, Klein et al., 2018).



General recommendations

- Make transparency your default
 - Share all research products (as early as possible)
 - Declare and justify constraints on transparency



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- Routinely perform *Amnesia test*
 - Would I still understand this after losing my memory?

Example project

Example project

Research question

- Can we judge a person's IQ from their face?

Example project

Research question

- Can we judge a person's IQ from their face?

Study design

- Photographs of students with known IQ scores



- Ratings of IQ
- Likert-scale ratings of attractiveness

Example project



What is this person's IQ? —————

70 ————— 130

A horizontal slider bar with a white circle in the center, indicating a value of approximately 90.

How attractive is this person? —————

Very unattractive ○ ○ ○ ○ ○ ○ ○ Very attractive

A horizontal scale with seven empty circles for rating attractiveness from very unattractive to very attractive.

Example project



What is this person's IQ? —————

70 ————— 130

A horizontal slider bar with a white circle in the center, indicating a value of approximately 100.

How attractive is this person? —————

Very unattractive ○ ○ ○ ○ ○ ○ ○ Very attractive

A horizontal scale with seven empty circles, representing a range from 'Very unattractive' to 'Very attractive'.

Example project



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Example project



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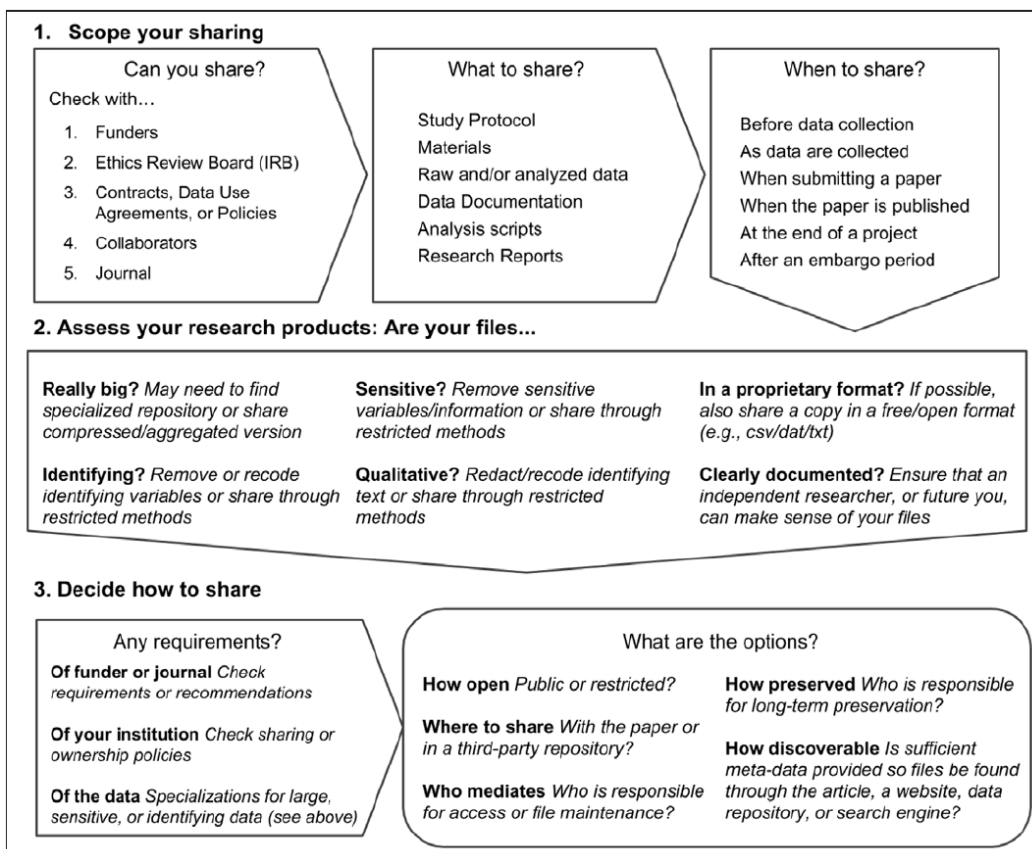
A horizontal slider bar with a white circle in the center, positioned exactly halfway between the numbers 70 and 130.

How attractive is this person? —————

Very unattractive ○ ○ ○ ○ ○ ○ ○ Very attractive

A horizontal scale with seven empty circles between the labels 'Very unattractive' and 'Very attractive'.

What can you share?



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Study protocol

- "Recipe for replication"



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- Collates, describes, and organizes more specific research products



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- "Recipe for replication"
- Collates, describes, and organizes more specific research products
 - Hypotheses
 - Study materials
 - Detailed description of procedure



Study protocol

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- Collates, describes, and organizes more specific research products
 - Hypotheses
 - Study materials
 - Detailed description of procedure
 - Instructive video documentation (e.g., **OBS** for computer-based studies)



Study materials

- Anything necessary to conduct the study, e.g.,



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 - Questionnaires
 - Stimulus material
 - Computer code to present stimuli and collect responses
 - Instructions for interaction with participants
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 - Instructions for interaction with participants
 - Scripts and instructions for confederates
- Mind intellectual property rights!



Data

- Include information about data sharing in informed consent



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- Use open and interoperable file formats (e.g., CSV, TSV, JSON, ODS)
 - Use UTF-8 character encoding



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Eternal hell and damnation to people who put tables in pdf format with formatting as Supplementary Data, without a csv/excel version.

— Dr Dutchy McDutchFace (@dutchscientist) August 19, 2017





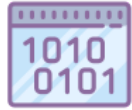
Data

- Raw data
 - As originally recorded (e.g., paper-pencil-questionnaires, CSV files, video recordings)



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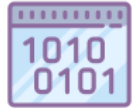
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 - As used for analyses (e.g., coded, digitized, merged)



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 - Ideally "Tidy Data" ([Wickham, 2014](#))





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- Processed data
 - As used for analyses (e.g., coded, digitized, merged)
 - Ideally "Tidy Data" ([Wickham, 2014](#))
 1. Each measured variable in one column
 2. Different observation of the variables in different rows
 3. Multiple tables should include a column that allows them to be linked



Participant privacy

- EU General Data Protection Regulation
 - "Data protection by design and by default"



Participant privacy

- **EU General Data Protection Regulation**
 - "Data protection by design and by default"
 - Designed to protect personal data
 - Data are personal if attributable to a specific person (using additional datasets if necessary)



Participant privacy

To determine whether a natural person is identifiable, account should be taken of all the means reasonably likely to be used, such as singling out, either by the controller or by another person to identify the natural person directly or indirectly.



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To ascertain whether means are reasonably likely to be used to identify the natural person, account should be taken of all objective factors, such as the costs of and the amount of time required for identification, taking into consideration the available technology at the time of the processing and technological developments. (Recital 26 EU GDPR)

Show 20 entries

Search:

Raw data of participant 01

id	date	time	sex	age	stimulus	stimulus_gender	iq	perc_iq	perc_attr
1	2018-06-13	09:15:32	Male	26	CF0001_1101_NE.jpg	Female	107	107	1
1	2018-06-13	09:15:32	Male	26	CF00016_1100_NE.jpg	Female	106	130	1
1	2018-06-13	09:15:32	Male	26	CF00017_1100_NE.jpg	Female	118	118	4
1	2018-06-13	09:15:32	Male	26	CF00018_1100_NE.jpg	Female	110	104	1
1	2018-06-13	09:15:32	Male	26	CF00019_1100_NE.jpg	Female	93	107	7
1	2018-06-13	09:15:32	Male	26	CF0002_1100_NE.jpg	Female	90	95	3
1	2018-06-13	09:15:32	Male	26	CF0003_1100_NE.jpg	Female	98	94	1
1	2018-06-13	09:15:32	Male	26	CF0004_1100_NE.jpg	Female	93	93	1
1	2018-06-13	09:15:32	Male	26	CF0005_1100_NE.jpg	Female	101	71	1
1	2018-06-13	09:15:32	Male	26	CF0006_1100_NE.jpg	Female	124	110	6
1	2018-06-13	09:15:32	Male	26	CF0007_1100_NE.jpg	Female	102	82	1
1	2018-06-13	09:15:32	Male	26	CF0008_1100_NE.jpg	Female	102	105	5
1	2018-06-13	09:15:32	Male	26	CF0009_1100_NE.jpg	Female	93	93	4
1	2018-06-13	09:15:32	Male	26	CF0010_1100_NE.jpg	Female	114	114	4
1	2018-06-13	09:15:32	Male	26	CF0011_1101_NE.jpg	Female	96	94	7
1	2018-06-13	09:15:32	Male	26	CF0012_1110_NE.jpg	Female	82	82	6
1	2018-06-13	09:15:32	Male	26	CF0013_1110_NE.jpg	Female	101	80	7
1	2018-06-13	09:15:32	Male	26	CF0014_1100_NE.jpg	Female	89	119	3
1	2018-06-13	09:15:32	Male	26	CF0015_1110_NE.jpg	Female	113	107	1
1	2018-06-13	09:15:32	Male	26	CF0020_1100_NE.jpg	Female	99	91	6

Showing 1 to 20 of 106 entries

Previous

1

2

3

4

5

6

Next



Participant privacy

- Only collect the data you really need
- Delete identifying information used for logistics as soon as possible (e.g., e-mail addresses)



Participant privacy

- Only collect the data you really need
- Delete identifying information used for logistics as soon as possible (e.g., e-mail addresses)
- Assess risk of reidentification, e.g.,
 - Small population and rare traits
 - Dyadic data
 - Hierarchical data (e.g., small subsamples of students, co-workers)
 - *Motivated intruder test* (e.g., jealous partner, nosy neighbor, envious co-worker, insurers, criminals)



Participant privacy

- Control access to pseudonymized data



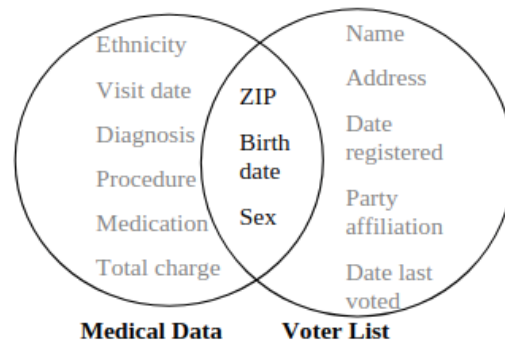
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 - Mind combinations of indirect identifiers (e.g., ZIP code, gender, date of birth, **Sweeney, 2000**)





Participant privacy

- Separate demographics used for sample description and study data



Participant privacy

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- Check or remove free text entries and alter them when citing in publications



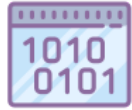
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- If necessary, transform data, e.g.,
 - Binning
 - Top and bottom coding
 - Add noise
 - Aggregation



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- For complex and high-risk data, use anonymization tools (e.g., **ARX**, **Amnesia**)



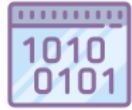
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- Dataset, e.g.,
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 - Name and description of variables (incl. source of a measure, information about translation)
 - Units of measurement, coding of values, possible options or range
 - Value(s) used for missing data
 - How a variable was derived from other variables

$$\text{BMI} = \frac{m}{l^2}$$



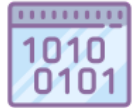
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- Automate codebook generation
 - Analysis software (e.g., R `codebook` package, SPSS `codebook` function, or Stata `codebook` function)
 - Specialized software (e.g., Nesstar, DataWiz)



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 - Specialized software (e.g., Nesstar, DataWiz)
- If reuse value is high, consider standardized, machine-readable format (e.g., DDI)
 - Some repositories provide implementation as a service



Standard operating procedures

- Define default practices ([Lin & Green, 2016](#))



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- Study planning, e.g.,
 - Sample size determination



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- Study planning, e.g.,
 - Sample size determination
- Data analysis, e.g.,
 - Statistical models
 - Assumption tests
 - Follow-up tests
 - Exclusion criteria
 - Outlier and dropout treatment
 - Handling of missing values
 - Corrections for multiple comparisons



Documentation of analyses

- How to move from raw data to reported results
 - Step-by-step documentation for non-scriptable software programs



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 - Write reports as dynamic documents (e.g., R package `papaja`)



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 - Set and record seeds for pseudo-random number generators



Documentation of analyses

- Share intermediate results for complex analyses



Documentation of analyses

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- Documentation of computational environment
 - Hardware
 - Software version incl. extensions



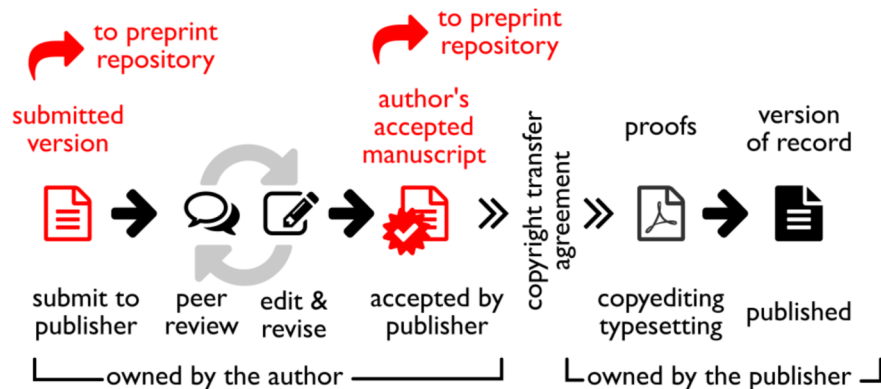
Documentation of analyses

- Share intermediate results for complex analyses
- Documentation of computational environment
 - Hardware
 - Software version incl. extensions
 - Containers and virtual machines (e.g., **Docker**, **Vagrant**, **Singularity**)



Research reports

- Paywalled publications (green open access)
 - Preprint (initially submitted manuscript)
 - Postprint (accepted manuscript)
 - Mind journal policy (e.g., [SHERPA/RoMEO](#))



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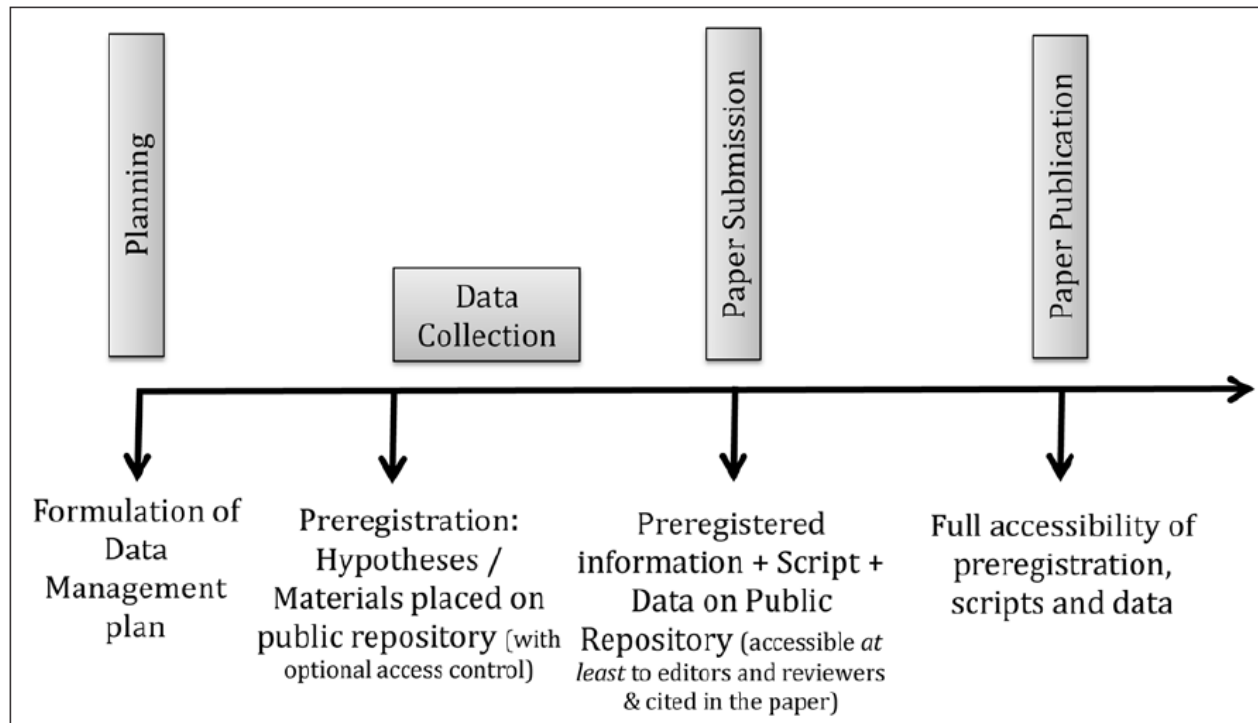
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- Gold open access
 - Published article

When can you share?

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any time is better than never (p. 4, Klein et al., 2018).



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Planning a study

- Have a *basic* data management plan (DMP), ideally before starting a project
 - Create basic reusable DMP templates
 - Use online tools to get started (e.g., [ZPID DataWiz](#), [DMPonline](#))
 - Simplifies addressing legal and ethical issues

Before data collection

- Timely archiving
 - Study protocol and materials
 - Standard operating procedures
 - Analysis plan and scripts
- Preregistration

During data collection

- Born-open data (Rouder, 2016)
 - Automatically uploaded to a public repository
 - Offsite backup
 - But: Protect participants' privacy!

Upon submission

- Data, materials, and analysis scripts
 - Facilitates thorough peer-review
 - Errors can be spotted early on (no public correction)
 - Possibly limit access to reviewers prior to publications (e.g., [OSF view-only links](#))

Upon submission

- Research report
 - Fast dissemination of results (citation advantage, e.g., Piwowar & Vision, 2013)
 - Public peer review
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 - Not typically considered a "prior publication" (Bourne, Polka, Vale, & Kiley, 2017)
 - Exceptions: For example, *New England Journal of Medicine* and *Journal of Clinical Investigation*

After publication



- Archive continuously in online repository, publish later
- Automate by use of embargoes

How can you share?

Compilation of research products

- Develop a default project file structure, e.g.,
 - Klein et al. (2018) **example project** and **ready-to-fork OSF template**
 - Study protocol
 - Materials
 - Raw data
 - Processed data
 - Analyses
 - Research report

Choose a repository

Sharing option		Discoverability	Sustainability	Access control
On request		--	--	++
Personal website		-	-	0
Journal website		+	0	0
Institutional repository		+	++	+
Public repository		++	++	+

Choose a repository

- Self-deposit vs. curated repositories
- **FAIR Data Principles** (Wilkinson et al., 2016)
 1. *Findable*: Persistent identifiers; metadata; indexed
 2. *Accessible*: Retrievable by identifier; controlled access where necessary
 3. *Interoperable*: Standardized metadata; open, lightweight, and interoperable file formats (e.g., CSV, TSV, JSON, ODS)
 4. *Reusable*: Documented; clear usage license

Choose a repository

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 5. Supports systematic licensing (e.g., declare (no) legal restrictions on reuse)
 6. Supports structured metadata

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 6. Supports structured metadata
 7. Tracks reuse of shared products (e.g., citations, downloads)



Specialized approaches

- Study protocol
 - (Embargoed) Public preregistration
 - Registered reports
 - Video methods journal JoVE Behavior



Specialized approaches

- Analysis scripts and software
 - Hosted Version Control Systems (e.g., [GitHub](#))
 - Cloud-based analysis platforms (e.g., [Code Ocean](#), [RStudio cloud](#), [Colaboratory](#))
 - Cloud-based experiment platforms (e.g., [Pavlovía](#) for [PsychoPy](#), [jspsych](#), and [lab.js](#))



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 - Usually no guarantee of long-term access
 - Additionally, archive in public repository



Specialized approaches

- Research reports
 - Institutional repositories
 - Preprint repositories (e.g., [PsyArXiv](#), [BioRxiv](#), [PeerJ](#))



Licenses

- Licenses define conditions of access and reuse



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The selection, coordination, and arrangement of the database is subject to copyright if it is sufficiently original. [...] The data or other contents contained in the database are subject to copyright if they are sufficiently creative. Original poems contained in a database would be protected by copyright, but purely factual data (such as gene names or city populations) would not. Facts are not subject to copyright, nor are the ideas underlying copyrighted content (Creative Commons, 2018).



Licenses

- Licenses define conditions of access and reuse
- Factual information are usually *not* protected by copyright
 - For example, response times, mortality rates, currency values, the number of Twitter followers someone has
 - Database structures and compilations of data can be copyrightable



Licenses

- Copyright owners may assign licenses
 - Standardized scales may be owned by publisher
 - Copyright to long verbatim free text responses may belong to participants



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- Copyright owner can always grant exceptions



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 - Access categories vs. licenses
 - Repositories may have different access categories (e.g., **GESIS DBK access categories**)



Licenses

- Public availability does not authorize to reuse
 - Always explicitly apply licenses
 - Access categories vs. licenses
 - Repositories may have different access categories (e.g., **GESIS DBK access categories**)
- Use easy-to-understand standard licenses (e.g., **Creative Commons**)
 - README: "All files in this repository are licensed under a Creative Commons Zero License (CC0 1.0)"





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 - Access categories vs. licenses
 - Repositories may have different access categories (e.g., **GESIS DBK access categories**)
- Use easy-to-understand standard licenses (e.g., **Creative Commons**)
 - README: "All files in this repository are licensed under a Creative Commons Zero License (CC0 1.0)"
- Use most permissive license possible (e.g., CC0, CC-BY)



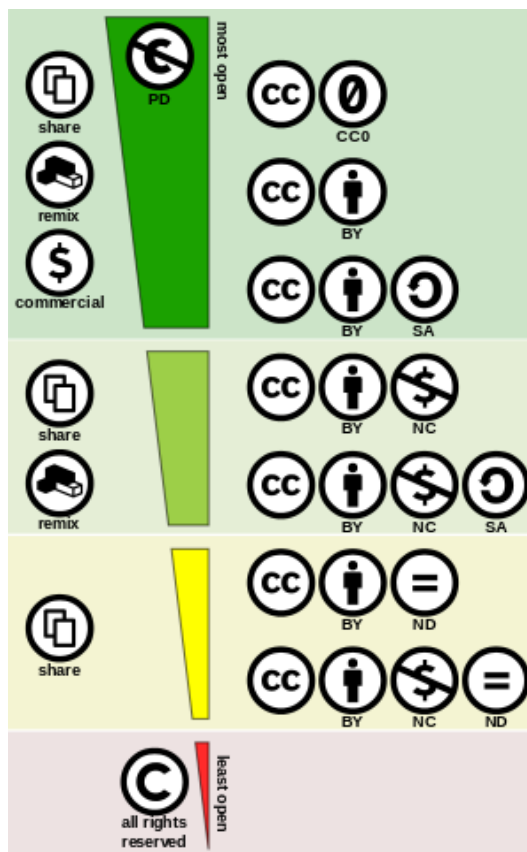
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- Modular license "building set"
 - In practice, seven combinations are supported

License module		Abbreviation	Summary
No rights reserved		0	Waive all possible rights to work
Attribution		BY	Prohibits reuse without citation
Non-commercial		NC	Prohibits commercial reuse
Share-alike		SA	Prohibits derived works under a different license
No Derivatives		ND	Prohibits any derived works



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- Mind version numbers (e.g., CC-BY 4.0)

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 - Promote selfish reasons for transparency, e.g.,
 - Remember what you've done
 - Easily find your own data and materials
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 - Commit to Research Transparency and Open Science

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 - Value openness in hiring committees (e.g., **job offers that mentioned open science**)

How can you promote research transparency?

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 - Transparent research practices in theses, e.g.,
 - "Safe" transparency for capstone project (OSF group)
 - Stage-1 registered report as non-empirical Bachelor's thesis

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 - Collate and share materials on transparent research practices
 - Teach workshops

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- Be forgiving of your own and other's honest mistakes!

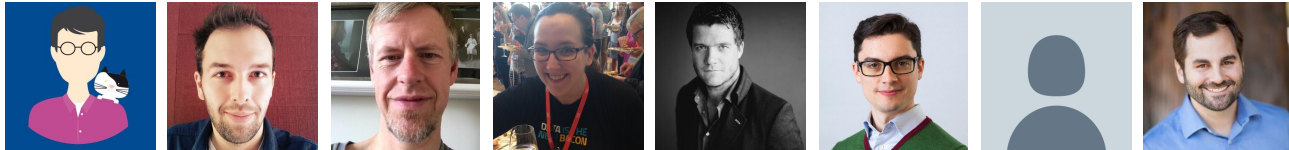
Learn more about transparent research practices

- Open Science Knowledge Base
- DataWiz Knowledge Base
- FOSTER Open Science Courses
- Center for Open Science Webinars
- Open Science Short Course at the **GESIS Summer School**

Open Science is just science done right

—Jon Tennant, Imperial College London

Acknowledgments



- Workshop material is based on Klein, O., Hardwicke, T. E., Aust, F., Breuer, J., Danielsson, H., Hofelich Mohr, A., ... Frank, M. C. (2018). A Practical Guide for Transparency in Psychological Science. Collabra: Psychology, 4(1). doi: [10.1525/collabra.158](https://doi.org/10.1525/collabra.158) (CC-BY 4.0)
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