Research Transparency and Reproducibility Training (RT2)

Participant Manual

September 21-25, 2020

Contents

About RT2

Welcome to the BITSS community! We are pleased to host you for our Research Transparency and Reproducibility Training (RT2), hosted for the first time online Sep. 21-25, 2020. RT2 provides an overview of tools and practices for transparent and reproducible social science research. We focus on topics such as:

- ***Scientific norms and threats to credibility:*** The scientific ethos as interpreted by Robert Merton in 1942 asserts collaborative, ethical, transparent, and reproducible research as a means of advancing the credibility of the scientific enterprise.
- ***Pre-registration:*** The registration of study designs in public repositories prior to data collection allows for better tracking of the universe of studies in a given domain, including studies with null results that are rarely published. This begins to tackle the "file-drawer problem" whereby only statistically significant findings are reported.
- ***Pre-analysis plans:*** The design and use of a pre-analysis plan (PAP)—a step-by-step plan, written before data are analyzed, describing hypotheses and strategies for analyzing data—can help protect against data mining and restrict researcher "degrees of freedom" in confirmatory research.
- ***Tools for transparent and reproducible workflows:*** A plethora of software and online tools can facilitate transparent and reproducible workflows. Some examples are the Open Science Framework (OSF), Git, various *R and Stata* packages, Dynamic Documents, and Jupyter notebooks.
- ***Open data:*** To facilitate review, replication, and reuse, researchers can publicly post their data and code. Data provenance helps original authors, as well as replicators and research users, appropriately attribute and track the data that underlies the analysis. When relevant, researchers should also have a good understanding of how to balance data usability with the protection of human subjects and privacy by making use of data de-identification and other tools for mitigating loss of confidentiality .
- ***Appropriate use of statistics and interpretation of evidence:*** Adequate powering of studies to avoid false positives, adjustment of statistical tests for multiple hypotheses, and use of appropriate meta-analytic techniques are first steps in accurately interpreting results.

RT2 aims to sustainably change scientific norms and practices as learners and instructors like you continue to incorporate innovative tools and methods into curricula at your own institutions, as well as your own workflows.

To help you get the most out of this five-day event, this **Participant Manual** includes instructions for preparing for hands-on sessions, required software downloads, a Glossary with definitions of basic concepts, a pre-event Reading List, and bios of RT2 faculty, participants, and organizers.

If you are interested in joining our network of trainers and consultants, or in finding someone who can provide support tailored to a specific situation or project, please visit our website to learn more about the **BITSS Catalyst Program**.

Pre-Training Actions

Before September 21, 2020, please take the following actions:

1. Sign up for a Zoom account

All sessions and office hours will be hosted on Zoom, a popular video conferencing platform. If you don't have a Zoom account, you can sign up for free here. To join a Zoom video conference at RT2, first log in to your account and then click on the link provided by BITSS (we'll include these in calendar invitations and an email to be sent before the event). For security purposes, we will provide you with a different link and password for every day of the training – please don't share them with anyone.

During hands-on sessions, there will be a "help desk"—a parallel Zoom room where a BITSS staff member or RT2 helper will be available to answer quick questions related to the session. During "off hours" and in-between sessions, the help desk link will serve as a "virtual water cooler," where you can come and chat with other RT2 participants.

2. Sign up for a Slack account

Just because this is a virtual training, doesn't mean that you can't meet new friends and collaborators! To help you learn more about your fellow RT2 participants and share your thoughts and experiences on transparency-related topics, we have set up a few Slack channels, organized by days and topics. Each day, we will post a few questions and prompts related to topics discussed that day and **ask you to chime in by sharing your personal perspective or experience in response to at least two postings by other participants**. Click here to create a free account (if you don't have one already) and join the Slack workspace for RT2. If you're new to Slack, get started with this quick tutorial.

3. Sign up for an OSF account

The Open Science Framework (OSF) allows you to store your research files and link research components together across several platforms, such as Dropbox, Dataverse, and GitHub. It version-controls any files you upload, and you can register a project to create a frozen time-stamped version with a persistent URL. Sign up for a free account here.

4. Review study pre-registration

In the Improved Specification hands-on sessions, you'll walk through a power analysis using DeclareDesign and develop a pre-analysis plan for an experimental or observational research project. By writing a PAP, you can demonstrate that your significant results are not just findings from a successful fishing expedition. Think of one of your recent studies, or a study that you would like to conduct, and see **Appendix A** (for experimental studies) and **Appendix B** (for observational studies) to read more about how to prepare your pre-registration.

5. Create a GitHub account and install the GitHub Desktop app or GitKraken

The date-and-initial version of tracking changes to your files is not very helpful when working on projects that are complex or involve multiple contributors. If you want your work to be reproducible, use version control. It has a learning curve even for xkcd-type people, but it's worth it! (Read Gentzkow and Shapiro, chapter 3 on why.) Software Carpentry and GitHub have great tutorials.

Create a GitHub account

Create an account at GitHub.com. GitHub is a popular online storage platform for your repositories (folders/projects) that are version-controlled with Git.

Install the GitHub Desktop app

If you plan to attend one of the sessions for version control with GitHub Desktop app, download and install the GitHub Desktop GUI app. Note that this is currently only available for Windows and Mac users. Linux users can use the command line or pick one of the other GUIs listed here.

If you are comfortable using the command line and would like to, we also recommend Windows users install Git Bash.

Install the GitKraken app

If you plan to attend the "Collaboration with GitHub and GitKraken" session, download and install GitKraken. Make sure you open the software at least once and log in using your GitHub account.

Then, watch this introductory video (90 min) at and try to complete the solo exercise by following the slides at https://osf.io/b4yvj/. This will ensure you have the setup correctly installed for the group hands-on session.

Don't worry if you have any issues or don't fully understand any of the above -- attend the software office hours before the training and we will get you sorted out.

6. Install software for Dynamic Documents – for R or Stata

You can write your code and your paper in one place. This means less chance of making silly copy+paste errors, and that you'll never have to wonder which code chunk produced which figure, where on earth you saved it, or whether your paper uses the most up-to-date version.

In **R**, this can be done with R Markdown, which is built into R Studio. If you're an R user, please download and install R and R Studio. When you open a new R Markdown file in R Studio, it starts with a really simple example, or you can learn more here.

In **Stata**, a few user-written commands have been developed to do this. The RT2 session will use markstat, which can be installed or updated with the following commands:

```
ssc install markstat, replace
ssc install whereis, replace
```

The syntax is explained in the built-in help file. For markstat to work you also need to install Pandoc, a pretty cool Swiss-army knife that converts almost any markup file to almost any other..

From Stata 15 onwards, the built-in commands putpdf, putdocx and dyndoc were created to ease the generation of dynamic documents in the Pdf, Word or Latex format (here is a nice review of dyndoc). Other available user-written commands, which will be briefly discussed, include texdoc and markdoc.

For **Python and/or Jupyter notebooks**, please install Anaconda, and make sure that JupyterLab works, once you run Anaconda Navigator. Please also install Pandoc and latex, as described above.

Once Anaconda is installed, please go to the following websites and install jupytext and jupyter-book.

7. Install DeclareDesign in R

DeclareDesign is a system for describing research designs in code and simulating them in order to understand their properties. Because DeclareDesign employs a consistent grammar of designs, you can focus on the intellectually challenging part – designing good research studies – without having to code up simulations from scratch.

To install the latest stable release of DeclareDesign, please ensure that you are running version 3.3 or later of R and run the following code:

```
install.packages("DeclareDesign")
```

If you don't think you'll ever use R, ...

Companion software

The core DeclareDesign package relies on four companion packages, each of which is useful in its own right.

1. randomizr: Easy to use tools for common forms of random assignment and sampling. This is also available in Stata.
2. fabricatr: Imagine your data before you collect it.
3. estimatr: Fast estimators for social scientists.
4. DesignLibrary: Templates to quickly adopt and adapt common research designs.

8. Install LaTeX

Microsoft Word is nice and easy for writing short papers, but when you start writing longer papers, or you want to include any equations, quick formatting can become cumbersome. LaTeX is better for reproducibility since when you include your figures, you just refer to files, so there's no question of whether you remembered to update or not. LaTeX (download here) is also used by R Markdown and Stata dynamic document packages when you make PDFs, so you have to at least have it installed in the background. *This is a large file, and you have to install the full version, so don't leave this until the last minute.* If you don't install this, you won't be able to make PDFs with the above dynamic documents software.

9. Install a decent text editor

You need a good way to edit plain text. On a Mac, the simplest thing to do is use the built-in TextEdit, but you will need to change the default so plain text, not rich text (rtf), is the output format. On Windows, you can use Notepad if you like, but we suggest something a little more powerful, like Atom, Notepad++, or Sublime Text. These have syntax highlighting, and add-on packages that can render markdown and things like that.

Suggested Reading List

This is a list of foundational and more recent literature related to social science research transparency and reproducibility challenges, as well as potential solutions and best practices. We suggest reading the **starred papers before RT2.

Find open access versions of the reading materials in this Zotero library.

1. Foundational literature

Akerlof, George A., and Pascal Michaillat. "Persistence of False Paradigms in Low-Power Sciences." *Proceedings of the National Academy of Sciences* 115, no. 52 (December 26, 2018): 13228–33. https://doi.org/10.1073/pnas.1816454115.

Christensen, Garret, and Edward Miguel. "Transparency, Reproducibility, and the Credibility of Economics Research." *Journal of Economic Literature* 56, no. 3 (September 2018): 920–80. https://doi.org/10.1257/jel.20171350.

**Goodman, Steven N., Daniele Fanelli, and John P. A. Ioannidis. "What Does Research Reproducibility Mean?" *Science Translational Medicine* 8, no. 341 (June 1, 2016): 341ps12-341ps12. https://doi.org/10.1126/scitranslmed.aaf5027.

**Ioannidis, John P. A. "Why Most Published Research Findings Are False." *PLOS Medicine* 2, no. 8 (August 30, 2005): e124. https://doi.org/10.1371/journal.pmed.0020124.

Leamer, Edward. "Let's Take the Con Out of Econometrics." *The American Economic Review* 73 (1983): 31–43.

**Merton, Robert. "The Normative Structure of Science." In *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press, n.d. https://www.collier.sts.vt.edu/5424/pdfs/merton_1973.pdf.

Miguel, E., C. Camerer, K. Casey, J. Cohen, K. M. Esterling, A. Gerber, R. Glennerster, et al. "Promoting Transparency in Social Science Research." *Science* 343, no. 6166 (January 3, 2014): 30–31. https://doi.org/10.1126/science.1245317.

National Academies of Sciences, Engineering. *Fostering Integrity in Research*, 2017. https://doi.org/10.17226/21896.

———. *Reproducibility and Replicability in Science*, 2019. https://doi.org/10.17226/25303.

Nosek, B. A., G. Alter, G. C. Banks, D. Borsboom, S. D. Bowman, S. J. Breckler, S. Buck, et al. "Promoting an Open Research Culture." *Science* 348, no. 6242 (June 26, 2015): 1422–25. https://doi.org/10.1126/science.aab2374.

Open Science Collaboration. "Estimating the Reproducibility of Psychological Science." *Science* 349, no. 6251 (August 28, 2015): aac4716. https://doi.org/10.1126/science.aac4716

Plemmons, D. K., Baranski, E. N., Harp, K., Lo, D., Soderberg, C. K., Errington, T. M., Nosek, B. A., & Esterling, K. M. (2020). A randomized trial of a lab-embedded discourse intervention to improve research ethics. Proceedings for the National Academy of Sciences. https://doi.org/10.1073/pnas.1917848117

**Rosenthal, Robert. "The File Drawer Problem and Tolerance for Null Results." *Psychological Bulletin* 86, no. 3 (1979): 638–41. https://doi.org/10.1037/0033-2909.86.3.638.

Steneck, Nicholas. (2006). Fostering Integrity in Research: Definitions, Current Knowledge, and Future Directions. Science and engineering ethics. 12. 53-74. 10.1007/s11948-006-0006-y.

Steneck, Nicholas & Bulger, Ruth. (2007). The History, Purpose, and Future of Instruction in the Responsible Conduct of Research. Academic medicine : journal of the Association of American Medical Colleges. https://doi.org/10.1097/acm.0b013e31812f7d4d.

Stodden, Victoria, Marcia McNutt, David H. Bailey, Ewa Deelman, Yolanda Gil, Brooks Hanson, Michael A. Heroux, John P. A. Ioannidis, and Michela Taufer. "Enhancing Reproducibility for Computational Methods." *Science* 354, no. 6317 (December 9, 2016): 1240–41. https://doi.org/10.1126/science.aah6168.

2. P-curve

Gerber, Alan S., and Neil Malhotra. "Publication Bias in Empirical Sociological Research: Do Arbitrary Significance Levels Distort Published Results?" *Sociological Methods & Research* 37, no. 1 (August 1, 2008): 3–30. https://doi.org/10.1177/0049124108318973.

Simmons, Joseph P., Leif D. Nelson, and Uri Simonsohn. "False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant." *Psychological Science* 22, no. 11 (November 1, 2011): 1359–66. https://doi.org/10.1177/0956797611417632.

**Simonsohn, Uri, Leif D. Nelson, and Joseph P. Simmons. "P-Curve: A Key to the File-Drawer." *Journal of Experimental Psychology: General* 143, no. 2 (2014): 534–47. https://doi.org/10.1037/a0033242.

3. Researcher Degrees of Freedom

Gelman, Andrew, and Eric Loken. "The Garden of Forking Paths: Why Multiple Comparisons Can Be a Problem, Even When There Is No 'Fishing Expedition' or 'p-Hacking' and the Research Hypothesis Was Posited Ahead of Time." *Unpublished*. Accessed August 2, 2019. http://www.stat.columbia.edu/~gelman/research/unpublished/p_hacking.pdf.

Lenz, Gabriel, and Alexander Sahn. "Achieving Statistical Significance with Covariates and without Transparency," April 7, 2017. https://doi.org/10.31222/osf.io/s42ba.

**Wicherts, Jelte M., Coosje L. S. Veldkamp, Hilde E. M. Augusteijn, Marjan Bakker, Robbie C. M. van Aert, and Marcel A. L. M. van Assen. "Degrees of Freedom in Planning, Running, Analyzing, and Reporting Psychological Studies: A Checklist to Avoid p-Hacking." *Frontiers in Psychology* 7 (November 25, 2016). https://doi.org/10.3389/fpsyg.2016.01832.

4. Power and Priors

Benjamin, Daniel Jacob, James Berger, Magnus Johannesson, Brian A. Nosek, Eric-Jan Wagenmakers, Richard Berk, Kenneth Bollen, et al. "Redefine Statistical Significance." *Nature Human Behaviour,* 2(1): 6-10. https://doi.org/10.1038/s41562-017-0189-z

Burlig, Fiona, Louis Preonas, and Matt Woerman. "Panel Data and Experimental Design," *MaetaArXiv,* March 4, 2017. https://doi.org/10.31222/osf.io/d5eud.

Button, Katherine S., John P. A. Ioannidis, Claire Mokrysz, Brian A. Nosek, Jonathan Flint, Emma S. J. Robinson, and Marcus R. Munafò. "Power Failure: Why Small Sample Size Undermines the Reliability of Neuroscience." *Nature Reviews Neuroscience* 14, no. 5 (May 2013): 365–76. https://doi.org/10.1038/nrn3475.

Coville, Aidan, and Eva Vivalt. "How Often Should We Believe Positive Results? Assessing the Credibility of Research Findings in Development Economics." *MetaArXiv*, August 14, 2017. https://doi.org/10.31222/osf.io/5nsh3.

5. Reproducibility and Replication

**Bowers, Jake. "Six Steps to a Better Relationship with Your Future Self." *The Political Methodologist* 18, no. 2. Accessed August 2, 2019. http://www.jakebowers.org/PAPERS/tpm_v18_n2.pdf.

Dafoe, Allan. "Science Deserves Better: The Imperative to Share Complete Replication Files." *PS: Political Science & Politics* 47, no. 1 (January 2014): 60–66. https://doi.org/10.1017/S104909651300173X.

DellaVigna, Stefano, and Devin Pope. "Predicting Experimental Results: Who Knows What?" Working Paper, August 2016. https://doi.org/10.3386/w22566.

Gandrud, Christopher. *Reproducible Research with R and R Studio Second Edition*. CRC Press, 2015. https://englianhu.files.wordpress.com/2016/01/reproducible-research-with-r-and-studio-2nd-edition.pdf.

Gertler, Paul, Sebastian Galiani, and Mauricio Romero. "How to Make Replication the Norm." *Nature* 554, no. 7693 (February 2018): 417–19. https://doi.org/10.1038/d41586-018-02108-9.

Hamermesh, Daniel S. "Viewpoint: Replication in Economics." *Canadian Journal of Economics/Revue Canadienne d'économique* 40, no. 3 (2007): 715–33. https://doi.org/10.1111/j.1365-2966.2007.00428.x.

King, Gary. "Replication, Replication." *PS: Political Science and Politics* 28 (1995): 444–52.

**Klein, Richard A., Kate A. Ratliff, Michelangelo Vianello, Reginald B. Adams, Štěpán Bahník, Michael J. Bernstein, Konrad Bocian, et al. "Investigating Variation in Replicability." *Social Psychology* 45, no. 3 (January 1, 2014): 142–52. https://doi.org/10.1027/1864-9335/a000178.

Ozier, Owen. "Replication Redux: The Reproducibility Crisis and the Case of Deworming." *Policy Research Working Paper* 8835 (April 2019). http://documents.worldbank.org/curated/en/118271556632669793/pdf/Replication-Redux-The-Reproducibility-Crisis-and-the-Case-of-Deworming.pdf.

Wood, Benjamin D. K., Rui Müller, and Annette N. Brown. "Push Button Replication: Is Impact Evaluation Evidence for International Development Verifiable?" *PLOS ONE* 13, no. 12 (December 21, 2018): e0209416. https://doi.org/10.1371/journal.pone.0209416.

6. Pre-Registration and Pre-Analysis Plans

**Burlig, Fiona. "Improving Transparency in Observational Social Science Research: A Pre-Analysis Approach." *Economics Letters* 168 (2018): 56–60. Link. (for an extended version, see Burlig (2017) below.

Burlig, Fiona. "Improving Transparency in Observational Social Science Research: A Pre-Analysis Plan Approach." *MetaArxiv*, October 30, 2017. https://doi.org/10.17605/OSF.IO/QEMKZ.

**Casey, Katherine, Rachel Glennerster, and Edward Miguel. "Reshaping Institutions: Evidence on Aid Impacts Using a Preanalysis Plan." *The Quarterly Journal of Economics* 127, no. 4 (November 1, 2012): 1755–1812. https://doi.org/10.1093/qje/qje027.

Lin, Winston, and Donald P. Green. "Standard Operating Procedures: A Safety Net for Pre-Analysis Plans." *PS: Political Science & Politics* 49, no. 3 (July 2016): 495–500. https://doi.org/10.1017/S1049096516000810.

**Olken, Benjamin A. "Promises and Perils of Pre-Analysis Plans." *Journal of Economic Perspectives* 29, no. 3 (September 2015): 61–80. https://doi.org/10.1257/jep.29.3.61.

"Political Analysis: Volume 21 - Issue 1 - Symposium on Pre-Registration." Cambridge Core. Accessed August 2, 2019. /core/journals/political-analysis/issue/CBBBC17238455387C18603FCFCD77E15.

Wicherts, Jelte M., Coosje L. S. Veldkamp, Hilde E. M. Augusteijn, Marjan Bakker, Robbie C. M. van Aert, and Marcel A. L. M. van Assen. "Degrees of Freedom in Planning, Running, Analyzing, and Reporting Psychological Studies: A Checklist to Avoid p-Hacking." *Frontiers in Psychology* 7 (2016). https://doi.org/10.3389/fpsyg.2016.01832.

7. Statistical Disclosure Limitation

Barth-Jones, Daniel, The 'Re-Identification' of Governor William Weld's Medical Information: A Critical Re-Examination of Health Data Identification Risks and Privacy Protections, Then and Now (July 2012). Available at SSRN: https://ssrn.com/abstract=2076397 or http://dx.doi.org/10.2139/ssrn.2076397

Federal Committee on Statistical Methodology, Report on Statistical Disclosure Limitation Methodology, Statistical Policy Working Paper 22 (Second version, 2005), https://nces.ed.gov/FCSM/pdf/spwp22.pdf

Garfinkel, Simson, "De-identifying government datasets", National Institute of Standards and Technology Special Publication 800-188 68 Natl. Inst. Stand. Technol. Spec. Publ. 800-188, 85 pages (December 2016) https://csrc.nist.gov/csrc/media/publications/sp/800-188/draft/documents/sp800_188_draft2.pdf

Goodman, Alyssa, Alberto Pepe, Alexander W. Blocker, Christine L. Borgman, Kyle Cranmer, Merce Crosas, Rosanne Di Stefano, et al. "Ten Simple Rules for the Care and Feeding of Scientific Data." *PLOS Computational Biology* 10, no. 4 (April 24, 2014): e1003542. https://doi.org/10.1371/journal.pcbi.1003542.

Nissim, Kobbi, T. Steinke, A. Wood, M. Altman, A. Bembenek, M. Bun, M. Gaboardi, D. O'Brien, and S. Vadhan. February 14, 2018."Differential Privacy: A Primer for a Non-technical Audience." Accessed on August 30, 2020 https://privacytools.seas.harvard.edu/files/privacytools/files/pedagogical-document-dp_new.pdf

Playford, Christopher J., Vernon Gayle, Roxanne Connelly, and Alasdair JG Gray. "Administrative Social Science Data: The Challenge of Reproducible Research:" *Big Data & Society*, December 1, 2016. https://doi.org/10.1177/2053951716684143.

Sweeney, Latanya, Simple Demographics Often Identify People Uniquely. Carnegie Mellon University, Data Privacy Working Paper 3. Pittsburgh 2000. https://dataprivacylab.org/projects/identifiability/paper1.pdf

8. Meta-analysis

**Borenstein, Michael, Larry V. Hedges, and Hannah Rothstein. *Introduction to Meta-Analysis*. meta-analysis.com, 2007. https://www.meta-analysis.com/downloads/Meta%20Analysis%20Fixed%20vs%20Random%20effects.pdf.

Cooper, Harris, Larry V. Hedges, and Jeffrey Valentine. *The Handbook of Research Synthesis and Meta-Analysis, Second Edition | RSF*. Accessed August 2, 2019. https://www.russellsage.org/publications/handbook-research-synthesis-and-meta-analysis-second-edition.

Ioannidis, John P. A., Daniele Fanelli, Debbie Drake Dunne, and Steven N. Goodman. "Meta-Research: Evaluation and Improvement of Research Methods and Practices." *PLOS Biology* 13, no. 10 (October 2, 2015): e1002264. https://doi.org/10.1371/journal.pbio.1002264.

**Russo, Mark W. "How to Review a Meta-Analysis." *Gastroenterology & Hepatology* 3, no. 8 (August 2007): 637–42.

9. Transparent Reporting and Disclosure

Grant, Sean, Evan Mayo-Wilson, Paul Montgomery, Geraldine Macdonald, Susan Michie, Sally Hopewell, David Moher, et al. "CONSORT-SPI 2018 Explanation and Elaboration: Guidance for Reporting Social and Psychological Intervention Trials." *Trials* 19, no. 1 (July 31, 2018): 406. https://doi.org/10.1186/s13063-018-2735-z.

Grant, Sean. "Proposed Reporting Items for Protocols of Social Intervention Trials." Open Society Framework, 2017. https://osf.io/x6mkb/.

Simera, Iveta, David Moher, Allison Hirst, John Hoey, Kenneth F. Schulz, and Douglas G. Altman. "Transparent and Accurate Reporting Increases Reliability, Utility, and Impact of Your Research:

Reporting Guidelines and the EQUATOR Network." *BMC Medicine* 8, no. 1 (April 26, 2010): 24. https://doi.org/10.1186/1741-7015-8-24.

Other Useful Resources

Textbook

Christensen, Garret, Jeremy Freese, and Edward Miguel. *Transparent and Reproducible Social Science Research*. University of California Press, 2019. We have mailed free hard copies to everyone who shared their mailing addresses. In case you want an *e-book*, use code 17M6662 at checkout to take advantage of 30% discount.

Manual of Best Practices

Christensen, Garret. 2018. "Manual of best practices in transparent social science research." Berkeley, CA: University of California.

BITSS Resource Library

We've compiled a wealth of tools and software, guidelines and templates, repositories, slide decks, and videos you may find useful in making your research more transparent and reproducible. We also list a growing number of blogs, commentary, and podcasts discussing challenges and innovations in the evolving open science movement. All content is searchable by type, topic (as it relates to the RT2 Roadmap), and discipline.

Accelerating Computational Reproducibility in Economics (ACRE) Guidelines & Platform

Computational reproducibility—the ability to reproduce the results and figures in a publication using the available data, code, and materials—is essential in ensuring that science is "self-correcting." Developed by BITSS, the ACRE Guidelines provide detailed steps and criteria for assessing and improving the computational reproducibility of published work in the social sciences. The Guidelines are paired with the Social Science Reproduction platform, where users can upload the results of reproductions (conducted as part of a coursework or independently) and contribute to the development of reproducibility measures for economics sub-fields and bodies of literature.

MetaArXiv

MetaArXiv is a preprint service managed by BITSS for work on all aspects of transparency and reproducibility, and metascience in general. We welcome submissions of working papers, pre-prints, post-prints, and other scholarly works.

"Transparent and Open Social Science Research" MOOC

Based on Professor Ted Miguel's UC Berkeley course on methods for transparent research, this 3-week, self-paced Massive Open Online Course (MOOC), explores the causes of the credibility crisis, as well as tools for making your own work more open and reproducible. You can access all of the course content on our website.

BITSS Registered Reports Resources and Services

In March, 2018-November, 2019, BITSS supported the *Journal of Development Economics* (JDE) in launching Registered Reports (RRs) a form of peer review where papers are selected for publication based on the merits of their research questions and methodological quality *before* the results are known. All editorial and author resources developed as part of this project are now available for use by other journals in the discipline and beyond, and BITSS can offer support to other journals interested in adopting the format. Learn more here.

BITSS Research Library

We invest in innovative meta-scientific research, as well as in the development and testing of new tools and methods to contribute to a growing body of evidence on problems and solutions in science. Our research portfolio includes work led by BITSS investigators, as well as by our partners and grantees of our Social Science Meta-Analysis and Research Transparency (SSMART) grants. The BITSS Research Library catalogs all research projects supported or led by BITSS. All research projects are categorized by i) program, ii) metascientific topic, and iii) discipline.

Best Practices for Transparent, Reproducible, and Ethical Research

In 2018, BITSS partnered with the Inter-American Development Bank (IDB), a leader in the generation of knowledge on economic development in Latin America, to formalize internal standards for improved transparency and reproducibility. "Best Practices for Transparent, Reproducible, and Ethical Research," the resulting technical note, recommends practices relevant for a variety of research activities including surveys, evaluations, economic analyses, and other applied research methods at the IDB. Though primarily developed for the IDB, the document provides useful guidance for other research organizations looking to formalize standards for transparent, reproducible and ethical practices.

Glossary

At RT2, you will learn about a range of innovative open science practices and tools. The following is a list of common definitions of terms and concepts.

Analysis plan	See *Pre-Analysis Plan.*
Data citation	The practice of citing a dataset, rather than just the paper in which a dataset was used. This helps other researchers find data, and rewards researchers who share data. Learn more here.
Data and code availability statement	Typically posted alongside a journal article, DCAS expand on and complement data citations. DCAS should provide sufficient details to access the data and code used in a paper for the purposes of replication or reproduction. Depending on the nature of the data and code, they may include: the exact location (DOI or URL, if no DOI available), access and use permissions, steps to obtain the data and/or code (if access is restricted), and other details. Learn more here.
Data mining	See *specification searching.*
Data sharing	Making the data used in an analysis widely available to others, ideally through a trusted public archive.
Disclosure	In addition to publicly declaring all potential conflicts of interest, researchers should detail all the ways in which they test a hypothesis, e.g., by including the outcomes of all regression specifications tested. This can be presented in appendices or supplementary material if room is limited in the body of the text.
False-positive	Incorrect rejection of the null hypothesis based on the outcome of a statistical test; a finding that provides support for a conclusion that is not true.
Fishing	See *specification searching.*
HARK-ing	Hypothesizing After the Results are Known.
Literate programming	Writing code to be read and easily understood by a human. This best practice can make a researcher's code more easily reproducible.
Multiple hypothesis correction	Statistically taking into account that multiple hypotheses have been tested. This tends to decrease the reported statistical significance of any individual test conducted. The oldest method – and quite conservative – the Bonferroni correction, simply divides the significance threshold by the number of tests.

Meta-analysis	Also called a "systematic review", a meta-analysis is the systematic combination of data or estimates across studies on a given topic.
Null-hacking	The complement to p-hacking, null-hacking, is the use of the same research practices to re-analyze open data to return a null finding, potentially leading to false negatives.
Open Access (OA)	Journals, articles, or other scholarly works that are freely available to the public, rather than only to those who pay for journal subscriptions. See HowOpenIsIt? for a detailed definition of the spectrum of openness.
Open Data	See *data sharing.*
p-hacking	See *specification searching.*
Statistical significance	A result has statistical significance when it is unlikely to have occurred if the null hypothesis is true. More precisely, a significance level (α) is the probability of rejecting the null hypothesis if it were true. In the social sciences, α is often defined as 0.05, though this threshold is up for debate.
p-value	The probability of obtaining a result at least as extreme, if the null hypothesis were true. A result is considered statistically significant when p is less than α.
Pre-Analysis Plan (PAP)	A document that details, ahead of time, the statistical analyses that will be conducted for a given research project. Expected outcomes, control variables, and regression specifications are all written in as much detail as possible. This serves to make research confirmatory in nature.
Preprint	A manuscript submitted to a dedicated repository, usually prior to peer review and formal publication. Preprints are typically published open access and include working papers, pre-prints (ready to publish), post-prints (published, but not typeset), and other scholarly works like dissertations, posters, reports, software package tutorials, and conference proceedings.
Pre-registration	See *registration.*
Pre-specification	Detailing the method of analysis before actually beginning data analysis; the same as pre-registration or writing a Pre-Analysis Plan.

Protocol	A document that provides a detailed description of a research project, ideally written before the project takes place and in enough detail that other researchers may reproduce the project on their own. Often used in the context of human subjects Institutional Review Board (IRB) protocols, but increasingly used in connection with pre-analysis plans.
Publication Bias	Publication bias exists when published literature is not representative of all completed studies on a given topic, and tends toward those with statistically significant results. Reviewers or journal editors may consider a null finding to be of less interest, or a researcher may fail to write up a null result even if it is a true outcome.
Registration	Publicly declaring that a hypothesis is being, has been, or will be tested, regardless of publication status. Registrations are time-stamped. When done prior to data collection and/or analysis, it is referred to as "pre-registration."
Registry	A database of registered studies or trials, for example the AEA RCT Registry or clinicaltrials.gov. Some of the largest registries only accept randomized trials, hence the frequent discussion of "trial registries."
Registered Reports	An alternative publication method wherein the design of a prospective research paper is evaluated before data is collected. Well-designed studies are given "in-principle acceptance" and will be published even if a null result is obtained. See this page, managed by the Center of Open Science, for journals practicing this form of peer review. This is often the preferred term in psychology, cognitive science, and behavioral science. The *Journal of Development Economics* uses the term 'pre-results review.' See also *Results-blind Review*.
Replication	Conducting an existing research project again. A subtle taxonomy exists and there is disagreement, as explained in Hamermesh, 2007 and Clemens, 2015. ***Pure Replication, Reproduction, or Verification (of computational reproducibility)*** – Re-running existing code, with error-checking, on the original dataset to check if the published results are obtained. ***Scientific Replication*** – Attempting to reproduce the published results with a new sample, either with the same code or with slight variations on the original analysis.
Reproducible	Whether or not a study can be repeated by another researcher to produce the same results as the original. "Computational reproducibility" refers to the ability to reproduce tables, figures, and results within a reasonable margin of error (generally 10%) using the available data, code, and materials.

Researcher degrees of freedom	Flexibility a researcher has in data analysis, whether consciously abused or not. This can take a number of forms, including specification searching, covariate adjustment, or selective reporting.
Results-blind review	A close cousin of registered reports, results-blind review features work that has already been conducted but is reviewed, as the name suggests, without knowledge of the results.
Specification searching	Searching blindly or repeatedly through data to find statistically significant relationships. While not necessarily inherently wrong, if done without a plan or without adjusting for multiple hypothesis testing, test statistics and results no longer hold their traditional meaning, can result in false positives, and thus impede replicability.
Trusted digital repository	An online platform where data can be stored such that it is not easily manipulated, and will be available into the foreseeable future. Storing data here is superior to simply posting on a personal website since it is more easily accessed, less easily altered, and more permanent.
Version control	The act of tracking every change made to a computer file. This is quite useful for empirical researchers who may edit their programming code often.

Meet the RT2 Faculty and BITSS!

The RT2 curriculum was developed and will be delivered by academic leaders in the open science movement. We present RT2 faculty and BITSS staff members in order of appearance in the RT2 Agenda.

Katie Hoeberling (*BITSS Program Manager*; Introduction to RT2)

Katie manages BITSS, leading fundraising, partnership development, training initiatives, and the Catalyst program. She previously served as a Borlaug Fellow in Global Food Security studying savings-led microfinance and farmer-centered innovation in Cambodia, supported an environmental impact assessment of California almonds and the revision of the Urban Forest Project Protocol for the California carbon market, and worked with the Food Chain Workers Alliance and the Los Angeles Food Policy Council. Katie has an MSc in International Agricultural Development from UC Davis and a BSc in Environmental Science from UCLA.

Edward Miguel (*BITSS Faculty Director*; The Scientific Ethos, Misconduct, and Transparency; Mertonian Norms + Pre-registration and Pre-analysis Plans)

Edward "Ted" Miguel is the Oxfam Professor of Environmental and Resource Economics and Faculty Director of the Center for Effective Global Action and Berkeley Initiative for Transparency in the Social Sciences (BITSS) at the University of California, Berkeley, where he has taught since 2000. Ted co-founded the Center for Effective Global Action (CEGA) in 2007, and co-founded BITSS in 2012. He has also served as the Co-organizer (with Dan Posner of UCLA) of the Working Group in African Political Economy (WGAPE) since 2002. His research focuses on African economic development and includes work on the economic causes and consequences of violence; the impact of ethnic divisions on local collective action; interactions between health, education, environment, and productivity for the poor; and methods for transparency in social science research.

Aleksandar Bogdanoski (*BITSS Senior Program Associate*; Lightning Talk: BITSS Scholarly Communication Innovations)

Aleks's work at BITSS facilitates the introduction of transparency norms in journals and research organizations. He also supports MetaArXiv, communications, and event coordination. Before joining CEGA and BITSS, Aleks worked as a research consultant on anti-corruption research projects with the United Nations Development Program (UNDP) and US Agency for International Development (USAID). He holds a master's degree in Public Policy from the University of York and Central European University.

Graeme Blair (Improved Specification I and II)

Graeme Blair is an Assistant Professor of Political Science at UCLA. He is a co-founder of the **Project on Resources and Governance** and an affiliate of the Center for Effective Global Action (CEGA), and Evidence in Governance and Politics (EGAP). Graeme uses experiments and field research to study the causes and consequences of violence in developing countries – and what we can do about them. Graeme leads the EGAP six-country "metaketa" study of community policing and co-leads the DeclareDesign project, which develops tools to enable researchers to learn about the properties of research designs before implementing them. Graeme is a 2016 Leamer-Rosenthal Prize Recipient.

Cecilia Mo (Improved Specification II)

Cecilia Hyunjung Mo is an Associate Professor of Political Science at University of California, Berkeley and an Associate Professor of Public Policy (by courtesy) at UC Berkeley's Goldman School of Public Policy. Her research interests include significant contemporary challenges to development and moral issues of today like cultivating democratic citizenship, understanding and addressing the negative consequences of rising inequality, combatting modern day slavery, and reducing prejudice. She was recognized with APSA's Emerging Scholar in Elections, Public Opinion and Voting Behavior (EPOVB) Award in 2020 and has received numerous prizes for her research.

Benjamin Daniels (Version Control for beginner users)

Benjamin Daniels is a Data Coordinator in the Development Impact Evaluation team at the World Bank. He works with DIME Analytics to create tools that improve the quality and reproducibility of development research. There, he supports best practices in econometrics, statistical programming, and research reproducibility across the DIME portfolio. This work comprises code and process development, research personnel training, and direct support for data analysis and survey development. These tools include software products like the World Bank Stata GitHub, ietoolkit and iefieldkit, and research resources like the DIME Wiki. As an independent researcher, Benjamin's work focuses on the delivery of high-quality primary health care in developing contexts.

Fernando Hoces de la Guardia (*BITSS Project Scientist*; Version Control for beginner users; Dynamic Documents in R)

Fernando Hoces de la Guardia is a Project Scientist at BITSS, and an affiliate of the Berkeley Institute for Data Science (BIDS). Fernando works on bridging research-to-policy gaps in regards to transparency and reproducibility, and supports BITSS trainings. He received his PhD in Policy Analysis from the Pardee RAND Graduate

School where his research focused on increasing the transparency and reproducibility of policy analysis as a way to strengthen the connection between policy and evidence. Before RAND, he studied economics and conducted impact evaluations and economic analyses of various social policies. Fernando has also supported BITSS-led trainings in the past and led a series of Catalyst trainings in South America in 2017.

Katherine Koziar (Version Control for advanced users)

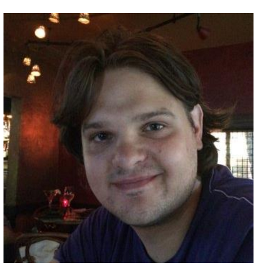
Katherine "Kat" Koziar is a Data Librarian at the University of California Riverside. As a member of the University Library's Research Services Department, she provides research assistance, specializing in a variety of topics related to research data, including data management, visualization, and data science. She received a Master of Science in Library Science from University of North Texas, and a Master of Science in Engineering with a specialization of Data Science from UCR.

Tim Dennis (Version Control for advanced users)

Tim Dennis is the Director of the UCLA Libraries Data Science Center, where he provides data services, including instruction, one-on-one consulting, and community building. He uses R, Python, SQL and command-line tools and has extensive experience helping researchers and students with these tools. Tim is also an instructor with Software Carpentry, a volunteer organization whose goal is to make scientists more productive and their work more reliable by teaching them basic computing skills.

Luiza Cardoso de Andrade (Dynamic Documents in Stata)

Luiza Andrade is a Data Coordinator in the Impact Evaluation department of the Development Research Group (DIME), where she is part of the DIIME Analytics team. Her work focuses on disseminating best practices for data management and use of statistical software, particularly R and Stata. Luiza has a BA and an MA in Economics from the University of Sao Paulo, Brazil.



Aleksandr Michuda (Dynamic Documents in Python)

Aleksandr Michuda is a PhD candidate in Agricultural and Resource Economics at UC Davis in California, USA. His research focuses on using machine learning techniques in developing country contexts, land privatization policies and their political economy, relying on modern modeling techniques and structural estimation. His passions go from political philosophy and symbolic logic. He attended RT2 in London in 2017.

Dena Plemmons (Embedded Ethics: Practice Meets Dialogue)

Dena Plemmons is the Director of the Research Ethics Education Program at the University of California, Riverside. The program looks to encourage proactive approaches to research integrity and professional conduct through collaborative engagement in training and education efforts. Dena is the Editor in Chief of the journal *Science and Engineering Ethics,* an Executive Board Member for the Association for Practical and Professional Ethics, and an Editorial Board Member for *Accountability in Research.*

Jennifer Sturdy (Responsible Data Sharing)

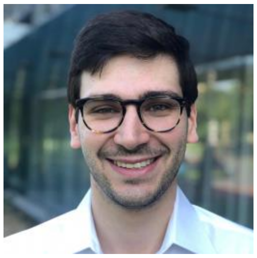
Jen Sturdy works on program evaluation initiatives at the Millennium Challenge Corporation (MCC), including several transparency initiatives such as the establishment of the MCC Evaluation Catalog and the MCC Disclosure Review Board for releasing public and restricted-access data. She also instituted several internal protocols for strengthening oversight of the MCC independent evaluation portfolio. Before MCC, she spent over six years as a consultant for the World Bank, working on several large-scale impact evaluations in the health and WASH sectors. Jen is a member of the BITSS Advisory Board and served as Director (2015-2016) and Advisor (2016-2018) at BITSS.

Lars Vilhuber (Practices for Data Transparency and Reproducibility)

Lars Vilhuber is a faculty member at the Department of Economics at Cornell University, a Senior Research Associate at the ILR School at Cornell University, and the Executive Director of ILR's Labor Dynamics Institute. Since 2018, he has been serving as the American Economic Association's Data Editor, and Co-Chair of the Innovations in Data and Experiments for Action (IDEA) Initiative at the Abdul Latif Jameel Poverty Action Lab (J-PAL). He is also an advisory board member for French and Canadian restricted-access research data centers and the Managing (executive) Editor at the *Journal of Privacy and Confidentiality*. His research interests include the dynamics of the labor market.

Daniel Benjamin (The Strength of Evidence)

Dan Benjamin is a Professor at the Anderson School of Management and David Geffen School of Medicine at UCLA. He researches behavioral economics (which incorporates ideas and methods from psychology into economic analysis) and genoeconomics (which incorporates genetic data into economics). His current research interests include understanding errors people make in statistical reasoning; exploring how best to use survey measures of subjective well-being (such as happiness and life satisfaction) to track national well-being and evaluate policies; and identifying genetic variants associated with outcomes such as educational attainment and subjective well-being. Dan's other ongoing work addresses how economic behavior relates to cognitive ability and social identity (ethnicity, race, gender, and religion).



Ben Sprung-Keyser (Transparent and Reproducible Evidence Synthesis: *Lessons from Welfare Analysis*)

Ben Sprung-Keyser is a PhD student at the Department of Economics at Harvard University. His current research is in the fields of public economics and labor economics. At RT2, he wil be presenting "A United Welfare Analysis of Government Policies", joint work with Nathaniel Hendren (Harvard University), which examines 113 historical welfare policy changes in the U.S. in terms of the benefit that each policy provides to its beneficiaries and its cost to the government.

Appendix A: OSF Pre-Registration

Prepared by Erica Baranski (UC Riverside)

Study Information

1. Title
   1.1. Provide the working title of your study. It may be the same title that you submit for publication of your final manuscript, but it is not a requirement.
2. Authorship
3. Research Questions
   3.1. Please list each research question included in this study.
4. Hypotheses
   4.1. For each of the research questions listed in the previous section, provide one or multiple specific and testable hypotheses. Please state if the hypotheses are directional or non-directional. If directional, state the direction. A predicted effect is also appropriate here.

Sampling Plan

In this section we will ask you to describe how you plan to collect samples, as well as the number of samples you plan to collect and your rationale for this decision. Please keep in mind that the data described in this section should be the actual data used for analysis, so if you are using a subset of a larger dataset, please describe the subset that will actually be used in your study.

5. Existing data
   5.1. Preregistration is designed to make clear the distinction between confirmatory tests, specified prior to seeing the data, and exploratory analyses conducted after observing the data. Therefore, creating a research plan in which existing data will be used presents unique challenges. Please select the description that best describes your situation. Please do not hesitate to contact us if you have questions about how to answer this question (prereg@cos.io).
      5.1.1. Registration prior to creation of data: As of the date of submission of this research plan for preregistration, the data have not yet been collected, created, or realized.
      5.1.2. Registration prior to any human observation of the data: As of the date of submission, the data exist but have not yet been quantified, constructed, observed, or reported by anyone - including individuals that are not associated with the proposed study. Examples include museum specimens that have not been measured and data that have been collected by non-human collectors and are inaccessible.

5.1.3. Registration prior to accessing the data: As of the date of submission, the data exist, but have not been accessed by you or your collaborators. Commonly, this includes data that has been collected by another researcher or institution.

5.1.4. Registration prior to analysis of the data: As of the date of submission, the data exist and you have accessed it, though no analysis has been conducted related to the research plan (including calculation of summary statistics). A common situation for this scenario when a large dataset exists that is used for many different studies over time, or when a data set is randomly split into a sample for exploratory analyses, and the other section of data is reserved for later confirmatory data analysis.

5.1.5. Registration following analysis of the data: As of the date of submission, you have accessed and analyzed some of the data relevant to the research plan. This includes preliminary analysis of variables, calculation of descriptive statistics, and observation of data distributions. Studies that fall into this category are ineligible for the Pre-Reg Challenge. Please contact us (prereg@cos.io) and we will be happy to help you.

6. Explanation of existing data

6.1. If you indicate that you will be using some data that already exist in this study, please describe the steps you have taken to assure that you are unaware of any patterns or summary statistics in the data. This may include an explanation of how access to the data has been limited, who has observed the data, or how you have avoided observing any analysis of the specific data you will use in your study. The purpose of this question is to assure that the line between confirmatory and exploratory analysis is clear.

7. Data collection procedures.

7.1. Please describe the process by which you will collect your data. If you are using human subjects, this should include the population from which you obtain subjects, recruitment efforts, payment for participation, how subjects will be selected for eligibility from the initial pool (e.g. inclusion and exclusion rules), and your study timeline. For studies that don't include human subjects, include information about how you will collect samples, duration of data gathering efforts, source or location of samples, or batch numbers you will use.

8. Sample size

8.1. Describe the sample size of your study. How many units will be analyzed in the study? This could be the number of people, birds, classrooms, plots, interactions, or countries included. If the units are not individuals, then describe the size requirements for each unit. If you are using a clustered or multilevel design, how many units are you collecting at each level of the analysis?

9. Sample size rationale

9.1. This could include a power analysis or an arbitrary constraint such as time, money, or personnel.

10. Stopping rule

    10.1. If your data collection procedures do not give you full control over your exact sample size, specify how you will decide when to terminate your data collection.

Variables

In this section you can describe all variables (both manipulated and measured variables) that will later be used in your confirmatory analysis plan. In your analysis plan, you will have the opportunity to describe how each variable will be used. If you have variables that you are measuring for exploratory analyses, you are not required to list them, though you are permitted to do so.

11. Manipulated variables

    11.1. Describe all variables you plan to manipulate and the levels or treatment arms of each variable. For observational studies and meta-analyses, simply state that this is not applicable.

12. Measured variables

    12.1. Describe each variable that you will measure. This will include outcome measures, as well as any predictors or covariates that you will measure. You do not need to include any variables that you plan on collecting if they are not going to be included in the confirmatory analyses of this study.

13. Indices

    13.1. If any measurements are going to be combined into an index (or even a mean), what measures will you use and how will they be combined? Include either a formula or a precise description of your method. If you are using a more complicated statistical method to combine measures (e.g. a factor analysis), you can note that here but describe the exact method in the analysis plan section.

Design Plan

In this section, you will be asked to describe the overall design of your study. Remember that this research plan is designed to register a single study, so if you have multiple experimental designs, please complete a separate preregistration.

14. Study type

    14.1. Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

    14.2. Observational Study - Data is collected from study subjects that are not randomly assigned to a treatment. This includes surveys, natural experiments, and regression discontinuity designs.

    14.3. Meta-Analysis - A systematic review of published studies.

    14.4. Other - please explain.

15. Blinding

15.1. Blinding describes who is aware of the experimental manipulations within a study. Mark all that apply.

15.1.1. No blinding is involved in this study.

15.1.2. For studies that involve human subjects, they will not know the treatment group to which they have been assigned.

15.1.3. Personnel who interact directly with the study subjects (either human or non-human subjects) will not be aware of the assigned treatments.

15.1.4. Personnel who analyze the data collected from the study are not aware of the treatment applied to any given group.

16. Study design

16.1. Describe your study design. Examples include two-group, factorial, randomized block, and repeated measures. Is it a between (unpaired), within-subject (paired), or mixed design? Describe any counterbalancing required. Typical study designs for observation studies include cohort, cross sectional, and case-control studies.

17. Randomization

17.1. If you are doing a randomized study, how will you randomize, and at what level?

Analysis Plan

You may describe one or more confirmatory analysis in this preregistration. Please remember that all analyses specified below must be reported in the final article, and any additional analyses must be noted as exploratory or hypothesis generating.

A confirmatory analysis plan must state up front which variables are predictors (independent) and which are the outcomes (dependent), otherwise it is an exploratory analysis. You are allowed to describe any exploratory work here, but a clear confirmatory analysis is required.

18. Statistical models

18.1. What statistical model will you use to test each hypothesis? Please include the type of model (e.g. ANOVA, multiple regression, SEM, etc) and the specification of the model (this includes each variable that will be included as predictors, outcomes, or covariates). Please specify any interactions that will be tested and remember that any test not included here must be noted as an exploratory test in your final article.

19. Transformations

19.1. If you plan on transforming, centering, recoding the data, or will require a coding scheme for categorical variables, please describe that process.

20. Follow-up analyses

20.1. If not specified previously, will you be conducting any confirmatory analyses to follow up on effects in your statistical model, such as subgroup analyses, pairwise or complex contrasts, or follow-up tests from interactions. Remember that any analyses not specified in this research plan must be noted as exploratory.

21. Inference criteria

    21.1. What criteria will you use to make inferences? Please describe the information you will use (e.g. p-values, Bayes factors, specific model fit indices), as well as cut-off criterion, where appropriate. Will you be using one or two tailed tests for each of your analyses? If you are comparing multiple conditions or testing multiple hypotheses, will you account for this?

22. Data exclusion

    22.1. How will you determine what data or samples, if any, to exclude from your analyses? How will outliers be handled?

23. Missing data

    23.1. How will you deal with incomplete or missing data?

24. Exploratory analysis (optional)

    24.1. If you plan to explore your data set to look for unexpected differences or relationships, you may describe those tests here. An exploratory test is any test where a prediction is not made up front, or there are multiple possible tests that you are going to use. A statistically significant finding in an exploratory test is a great way to form a new confirmatory hypothesis, which could be registered at a later time.

Script (Optional)

The purpose of a fully commented analysis script is to unambiguously provide the responses to all of the questions raised in the analysis section. This step is not common, but we encourage you to try to create an analysis script, refine it using a modeled dataset, and use it in place of your written analysis plan.

25. Analysis scripts (Optional)

    25.1. (Optional) Upload an analysis script with clear comments. This optional step is helpful in order to create a process that is completely transparent and increase the likelihood that your analysis can be replicated. We recommend that you run the code on a simulated dataset in order to check that it will run without errors.

Other

26. Other

    26.1. If there is any additional information that you feel needs to be included in your pre-registration, please enter it here.