Resources for anyone (and everyone) to make their science more open

AKA: Things I Wish I Knew 5 Years Ago

Why do I care about open science

- 4th year PhD student in Neuroscience
- I've been interested in science from a young age

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- The process of discovery in science relies on "self-correction"
  - Without this self-correction, it is difficult to trust science as an institution

Me, doing science (2 years old)

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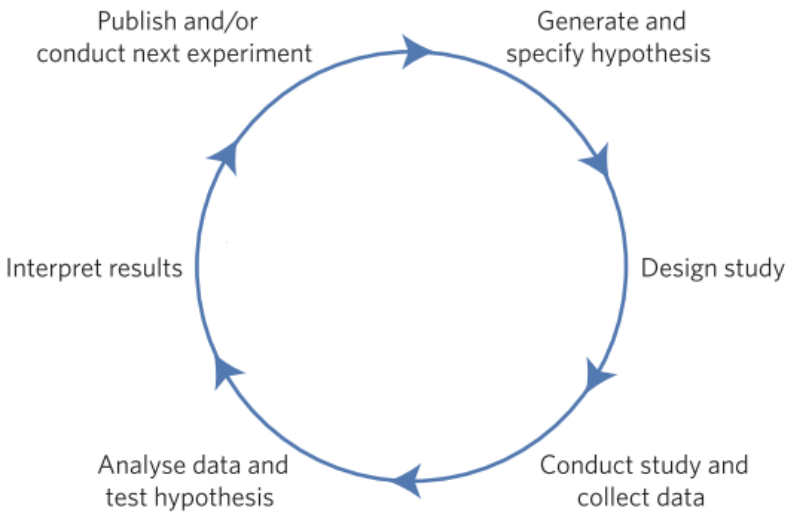
Why we need to make an effort to make science more open

Self correcting?



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Manufo et. al (2017). *Nat Hum Beh*

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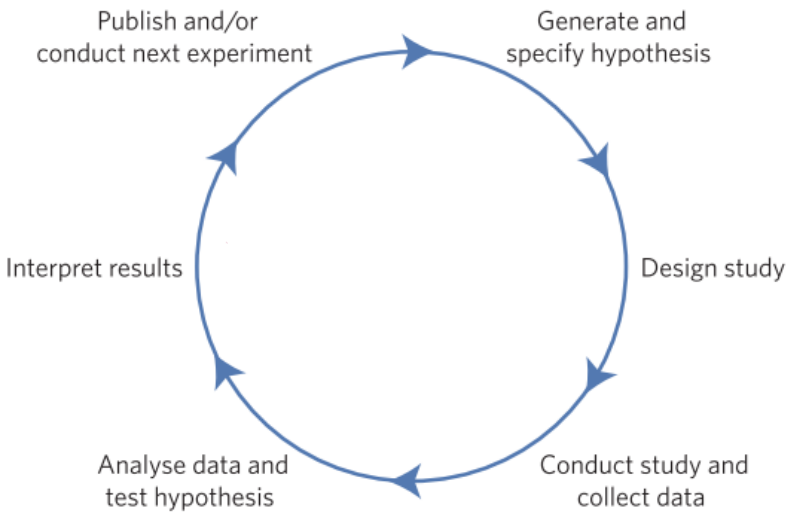

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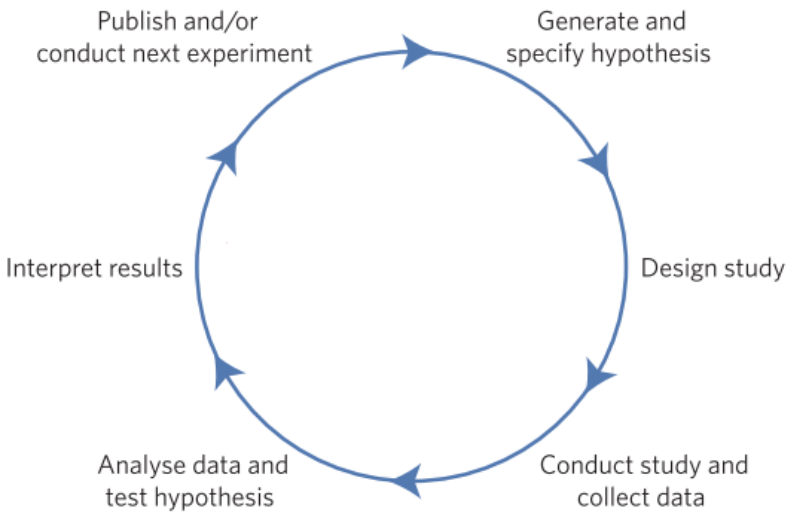

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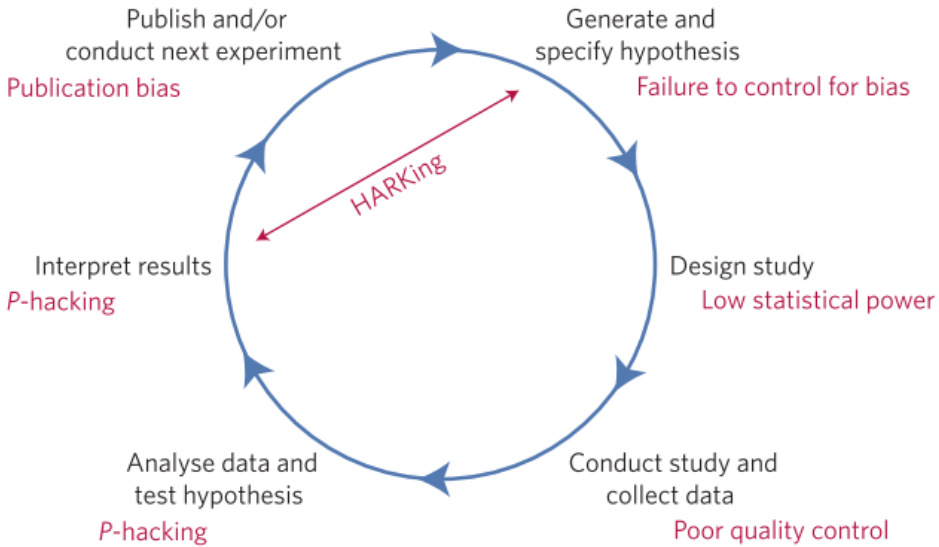

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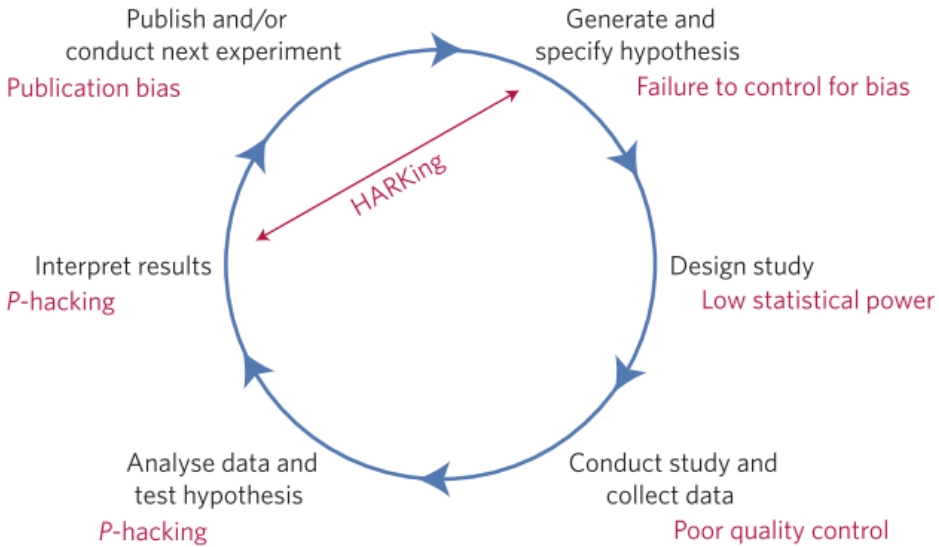
- This can (partially) be explained by common practices (Manufo et. al (2017). *Nat Hum Beh*)
- Ultimately this erodes trust in science, and makes progress slower



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What is open science?

Potential solutions to these problems now fit under a big umbrella called “open science”

https://www.talyarkoni.org/blog/2019/07/13/i-hate-open-science/

What is open science?

Potential solutions to these problems now fit under a big umbrella called “open science”

- Reproducibility (reporting clarity, appropriate statistics)
- Accessibility (preprints, open access journals)
- Incentive Alignment (publishing null results)
- Diversity (outreach)
- Metascience (reporting clarity)

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How can I be a responsible scientist and make my research as reproducible as possible, given that I am not in full control over incentive structures, and have minimal training in open science practices (statistics, sharing code, etc)?

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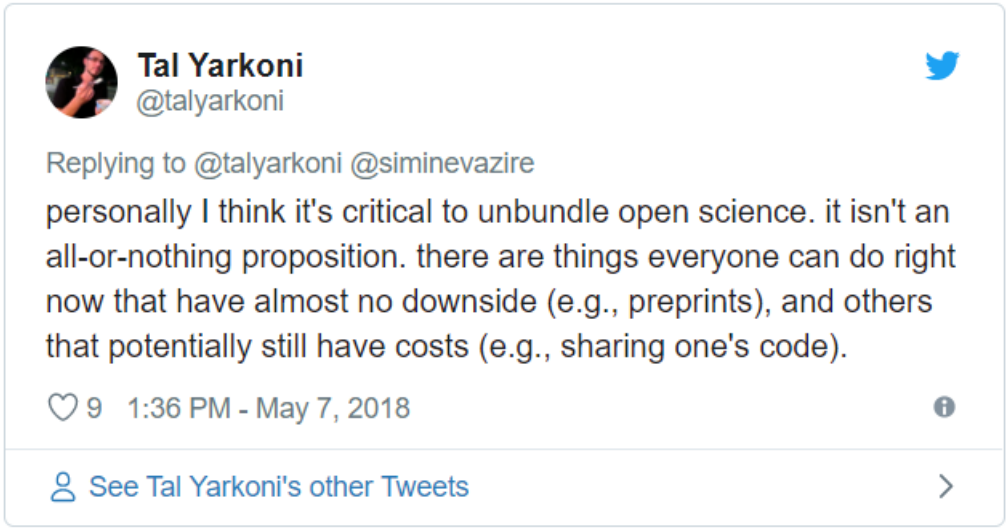
The point of this talk is going to be to share the resources I have accumulated from Twitter, peers, and advisors on ways to make your science more open that have minimal down sides.



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1. Reporting clarity
2. Statistics
3. Accessibility

(References and resources for all this and more at the end)

Reporting Clarity

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Clear reporting facilitates replication and evaluation

ECoG

All ECoG data were first resampled to 1000 Hz, low-pass filtered at 180 Hz, high-pass filtered at 0.5 Hz, and notch-filtered at 60 Hz and its harmonics. ECoG data were then examined by a

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Siapas, et. al *Neuron* (2005).

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LFP Filtering

Hippocampal LFP traces were band-pass filtered in the θ band (4–10 Hz) using digital filters constructed via the Parks-McClellan optimal equiripple FIR filter design. Transition bands were 4 Hz–4.5 Hz and 10 Hz–10.5 Hz. Maximal ripple was 0.05 in the stop bands and 0.01 in the pass band. In order to faithfully preserve the theta

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If your methods are not interpretable:

1. People can't replicate or use techniques from your work
2. It is difficult to include results in meta-analyses
3. It is difficult for reviewers to evaluate your methods

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In other words, it makes self correction difficult.

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Resources for writing a complete methods section

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Reporting guidelines for main study types

Randomised trials	CONSORT	Extensions
Observational studies	STROBE	Extensions
Systematic reviews	PRISMA	Extensions
Study protocols	SPIRIT	PRISMA-P
Diagnostic/prognostic studies	STARD	TRIPOD
Case reports	CARE	Extensions
Clinical practice guidelines	AGREE	RIGHT
Qualitative research	SRQR	COREQ
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See all 419 reporting guidelines

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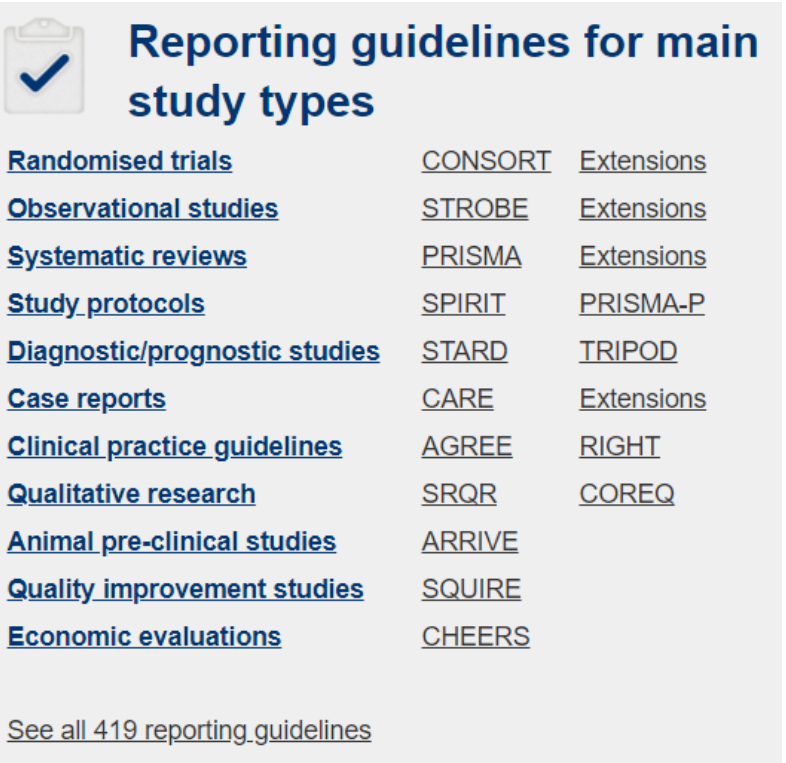

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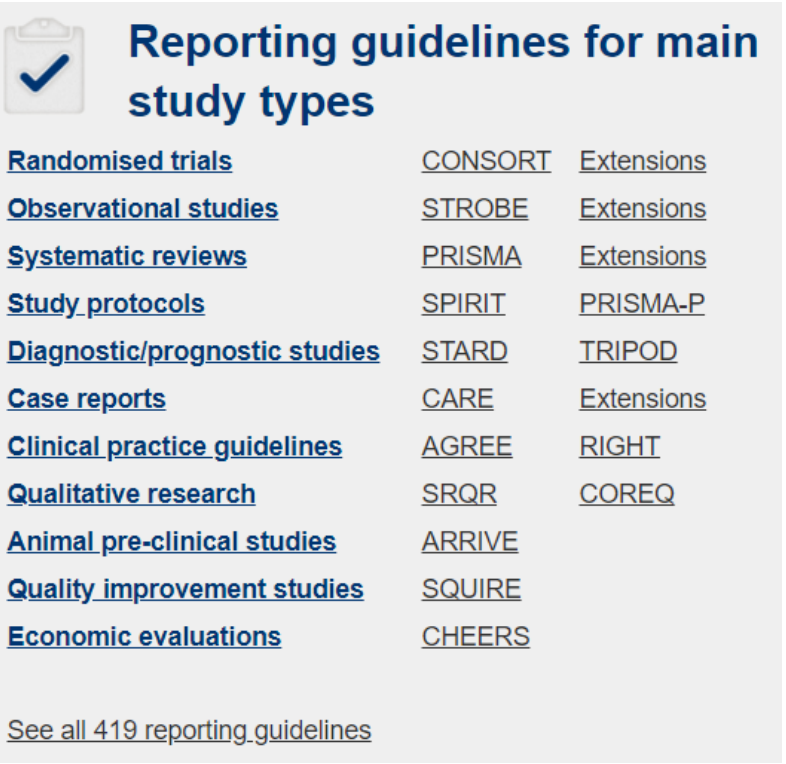
    3. There are many bureaucratic parts of science, but following methods guidelines is actually important



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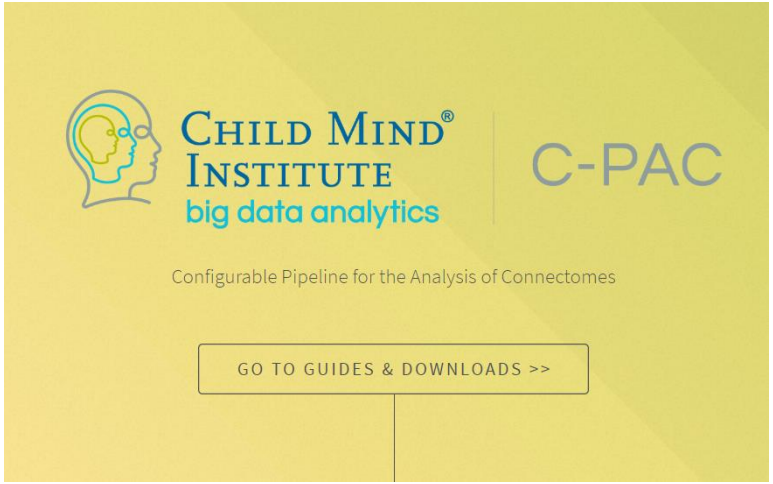

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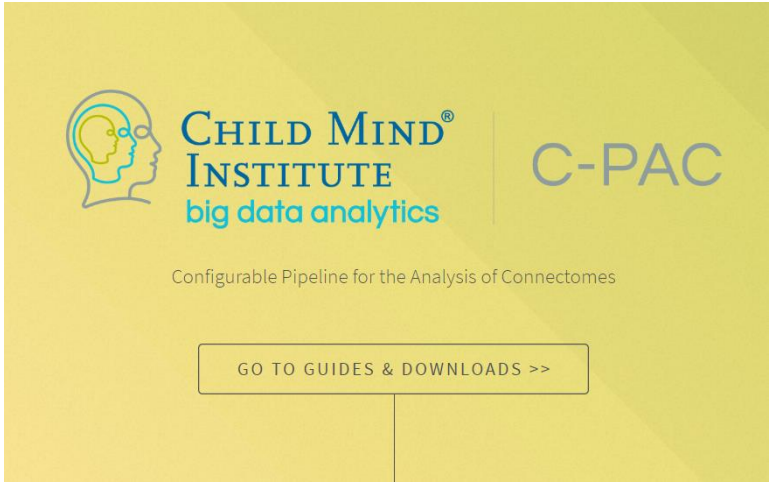

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Meta-analyses are becoming and increasingly popular and fruitful way to synthesize research from many smaller studies. Meta-analyses rely on full reporting in primary research

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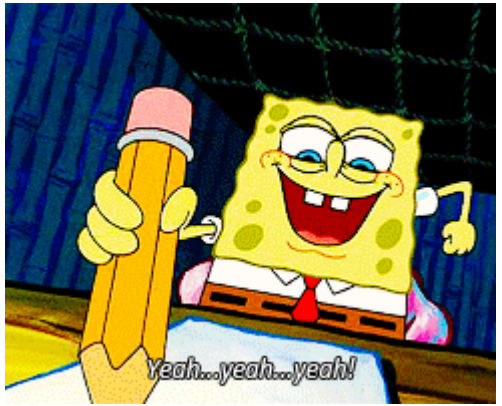

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Statistics

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Makin, et. al *eLife* (2019).

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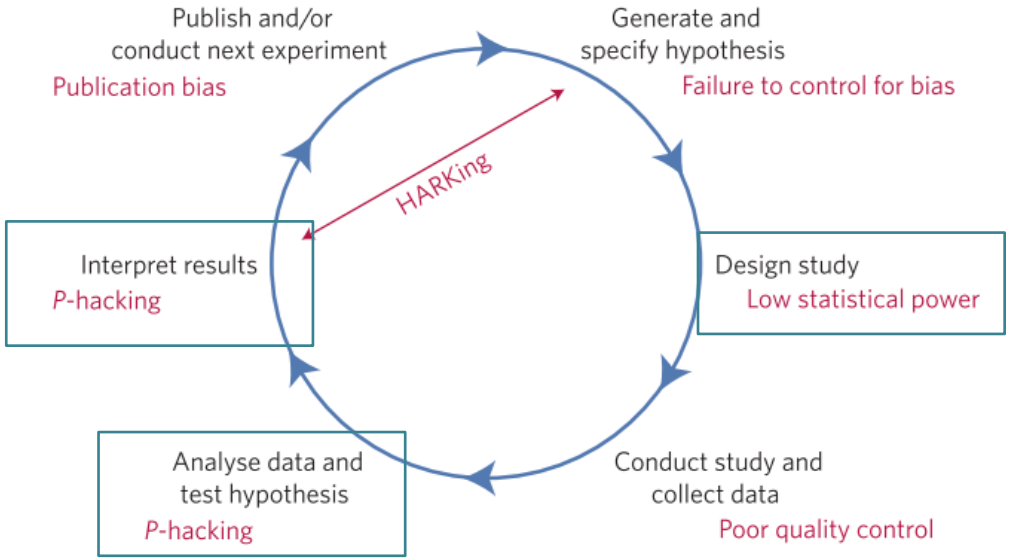

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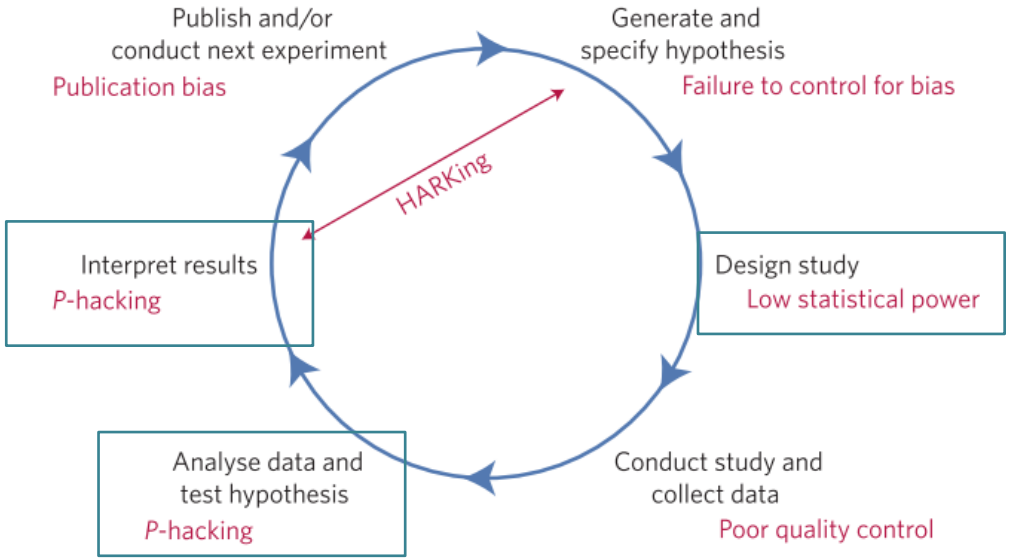
This decreases trust in science, and slows discovery.



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Science Forum: Ten common statistical mistakes to watch out for when writing or reviewing a manuscript

Tamar R Makin, Jean-Jacques Orban de Xivry
University College London, United Kingdom; KU Leuven, Belgium

FEATURE ARTICLE Oct 9, 2019

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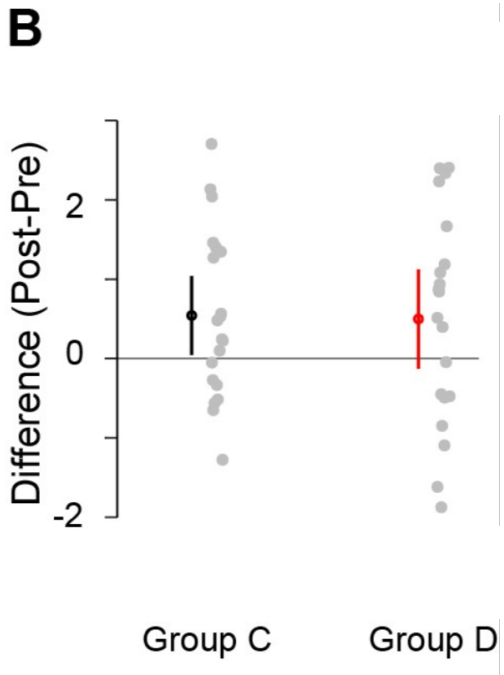

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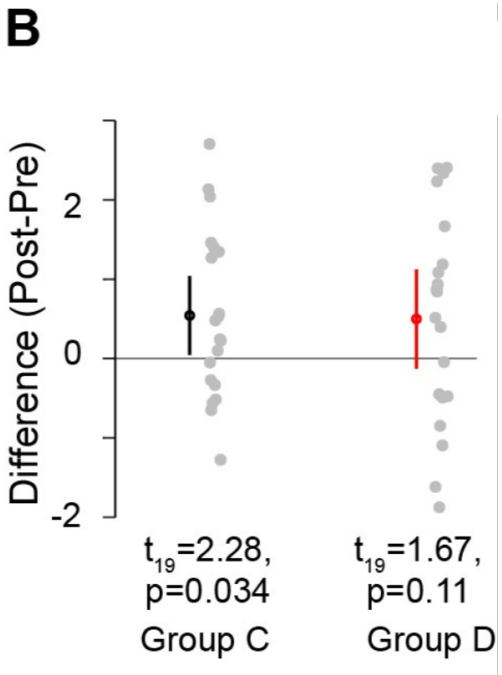

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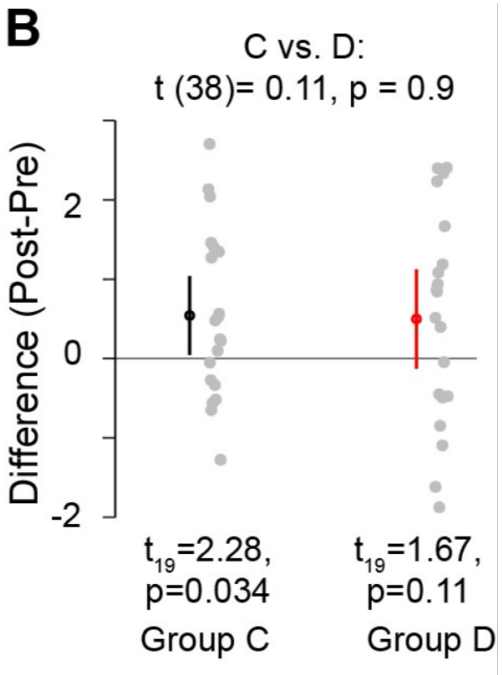
    4. No, we need to directly compare the two group with and ANOVA or non-parametric test (Leys and Schumann, 2010)



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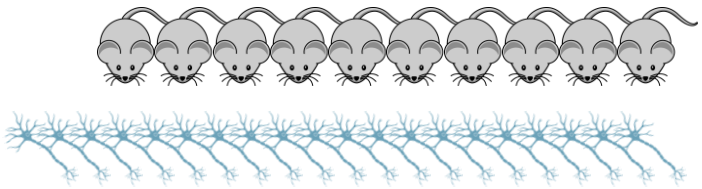

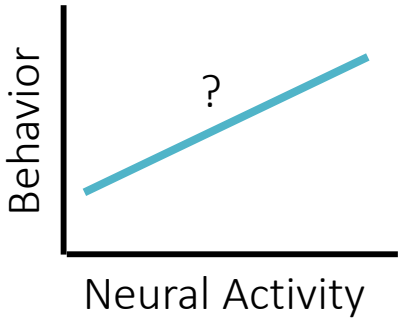

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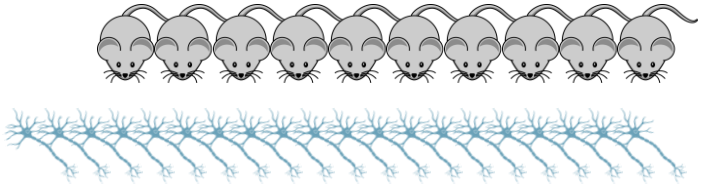

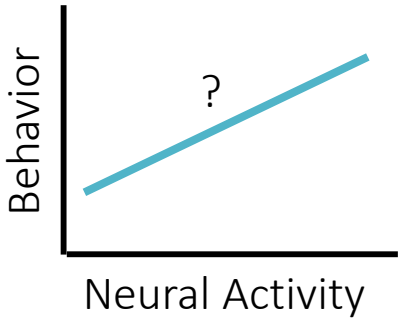

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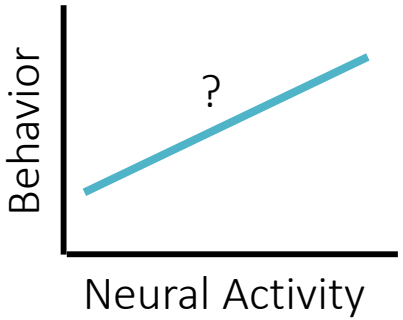

N = 10	N = 20
df =	df =
Critical *R* =	Critical *R* =

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Makin, et. al *eLife* (2019).

Check for common statistical errors

1. Interpreting differences between groups without directly comparing them
2. Non-independent units of analysis
    1. In this example we have 10 mice, with 2 neural recording sessions each. We want to ask if some feature of the neural recording correlates with some feature of behavior
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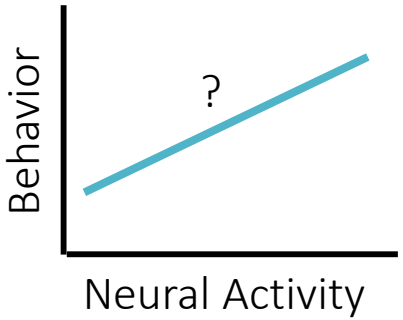

N = 10	N = 20
df = 8	df = 18
Critical *R* =	Critical *R* =

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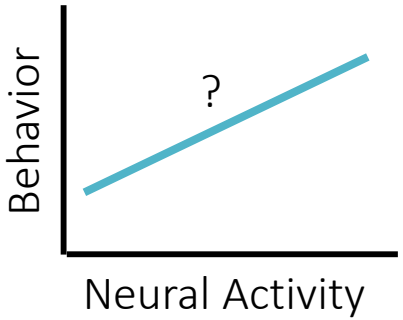

N = 10	N = 20
df = 8	df = 18
Critical *R* = 0.63	Critical *R* = 0.44

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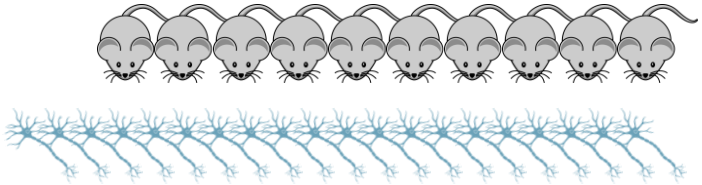
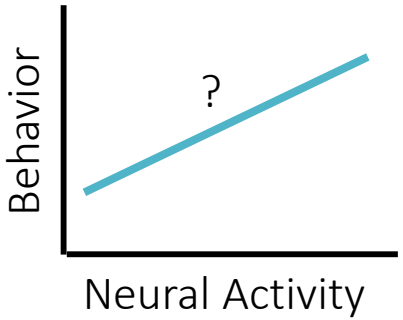
Check for common statistical errors

1. Interpreting differences between groups without directly comparing them
2. Non-independent units of analysis
    1. In this example we have 10 mice, with 2 neural recording sessions each. We want to ask if some feature of the neural recording correlates with some feature of behavior
    2. The independent unit is mice (not neurons) , and treating the neurons as independent can lead to lower thresholds for significance
    3. This should be tested using linear-mixed effects models, or by summarizing across neurons





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Check for common statistical errors

1. Interpreting differences between groups without directly comparing them
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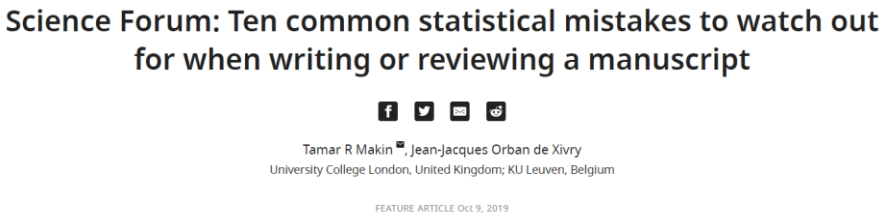
3. Read the paper for more (spurious correlations, underpowered studies, circular analyses, p-hacking…)



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Check for common statistical errors

1. Interpreting differences between groups without directly comparing them
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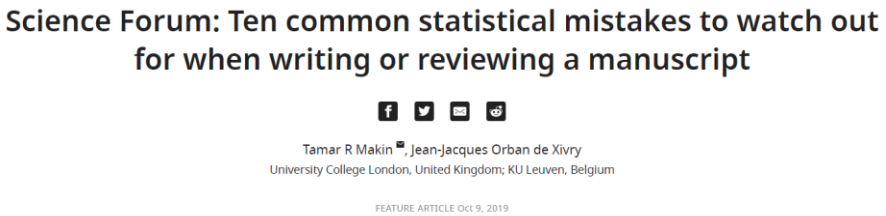
4. Fully report whatever tests you use so people can evaluate your choices (standardized effect sizes, *p*-values, confidence intervals, number of samples)



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Makin, et. al *eLife* (2019).

Accessibility and Outreach

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Places to share your science

Increased accessibility is good for science

It facilitate collaborations, diverse feedback, and advancement

Diversity is beneficial for collaborative teams (not just science)

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https://www.wiley.com/network/societyleaders/open-science/an-illustrated-history-of-open-science

Places to share your science

1. Preprints: make your science accessible to researchers everywhere
    1. arXiv, bioarXiv, psyarXiv, etc.

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https://www.aje.com/arc/benefits-of-preprints-for-researchers/

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Preprints are freely available full manuscripts that have not yet been subject to peer review. Posting a preprint will give you credit for the project, give scientists a platform to give you feedback

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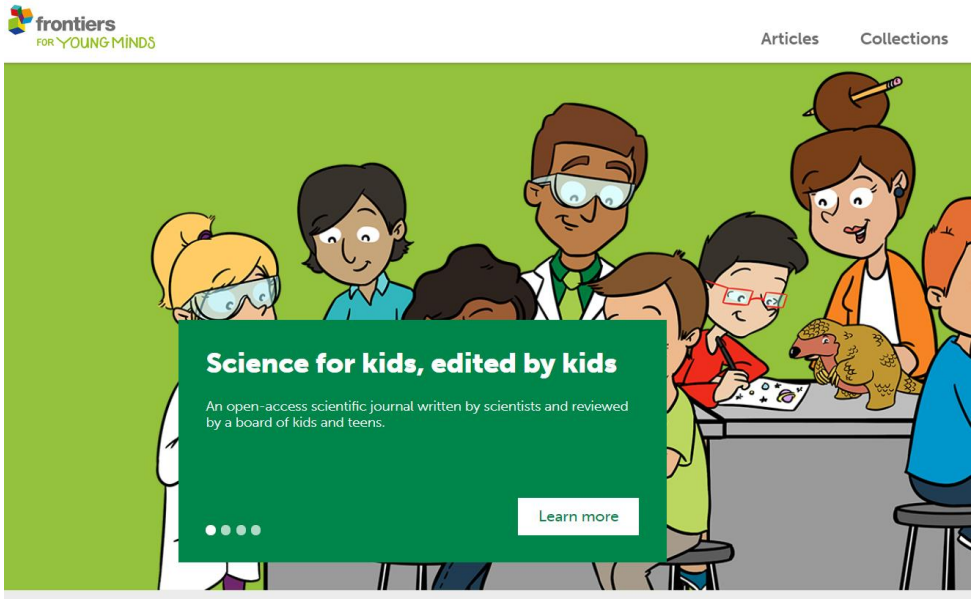

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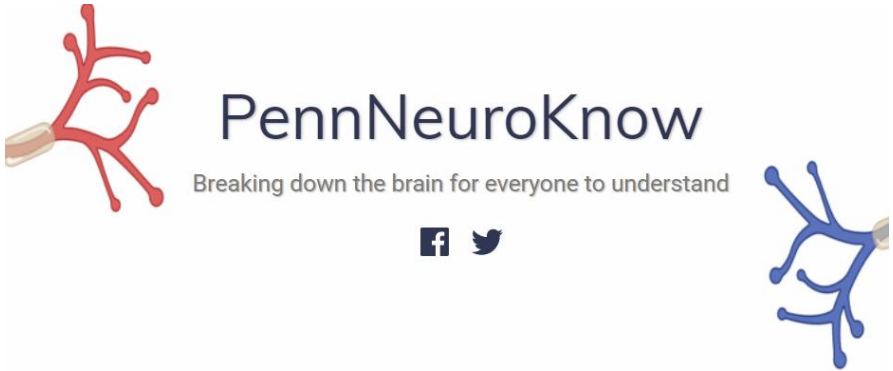
3. Blogging
    1. PennNeuroKnow, Brains in Briefs, The Conversation



Penn has some science communication opportunities, including PennNeuroKnow, where you summarize a topic in science,

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JULY 27, 2018 · NEURODEGENERATION, ALS

THERE'S A NEW JANITOR IN TOWN: CLEANING UP THE MESS IN ALS

or, technically,

Optineurin is an autophagy receptor for damaged mitochondria in parkin-mediated mitophagy that is disrupted by an ALS-linked mutation *[See the original abstract on PubMed]*

Penn has some science communication opportunities, including *PennNeuroKnow*, where you summarize a topic in science, or *Brains in Briefs,* where you write a lay summary of a specific paper

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Places to share your science

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2. Frontiers for Young Minds: write a review of your works and have it reviewed by kids
3. Blogging
    1. PennNeuroKnow, Brains in Briefs, The Conversation

Outside of Penn, you can submit write-ups of your work to publishers like *The Conversation*, that publish accessible scientific articles written by researchers themselves

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Places to share your science

1. Preprints: make your science accessible to researchers everywhere
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2. Frontiers for Young Minds: write a review of your works and have it reviewed by kids
3. Blogging
    1. PennNeuroKnow, Brains in Briefs, The Conversation
4. Twitter: make accessible summaries for scientists, and lay people

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https://hub.jhu.edu/2017/01/19/reading-tweeting-science-intersession/

Conclusion

Scientists at every level can find ways to make their science easier for the scientific community to use responsibly, and more accessible to everyone

Specifically, everyone can:

1. Accurately report their science
2. Make inferences that are appropriate to the statistics used
3. Share your science

(For resources about registered reports, github best practices, see extra slides)

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Thanks!

Slides (with resources will be on my website! http://www.jenniferstiso.com/talks/)

Bassett Lab Slack Channel

Complex Systems

Dani Bassett

Tim Lucas

Ursula Tooley (@UTooley)

Other people on Twitter:
@siminevazire (Simine Vazire)
@tal_yarkoni (Tal Yarkoni)
@kirstie_j (Kirstie Whitaker)
@BrianNosek (Brian Nosek)
@hardsci (Sanjay Srivastava)

References and Resources

Replication Crisis

- https://www.nature.com/news/over-half-of-psychology-studies-fail-reproducibility-test-1.18248
- Camerer, C. F. *et al.* Evaluating the replicability of social science experiments in Nature and Science between 2010 and 2015. *Nat. Hum. Behav.* **2**, 637–644 (2018).
- Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science, 349*(6251), aac4716. Doi: 10.1126/science.aac4716
- Nosek, B. A. & Errington, T. M. Making sense of replications. *Elife* **6**, 4–7 (2017).

Intro to Open Science

- Spellman, B. A., Gilbert, E. A. & Corker, K. S. Open Science : What, Why, and How. *PsyArXiv* (2017).
- Gilmore, R. O., Diaz, M. T., Wyble, B. A. & Yarkoni, T. Progress toward openness, transparency, and reproducibility in cognitive neuroscience. *Ann. N. Y. Acad. Sci.* 5–18 (2017). doi:10.1111/nyas.13325
- Munafò, M. R. *et al.* A manifesto for reproducible science. *Nat. Hum. Behav.* **1**, 1–9 (2017).
- talyarkoni.org/blog/2019/07/13/i-hate-open-science/

General Resources and Best Practices

- Software capentry (free classes and workshops): https://software-carpentry.org/about/
- Research software experts: https://researchsoftware.org/
- This Twitter thread asking for resources: https://twitter.com/andreafarnham/status/1184456096322334720
- Miriam Alys resources for organizing research: https://osf.io/mdh87/wiki/Coding%2C%20fMRI%2C%20and%20Stats%20Help/

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References and Resources

Preregistration and Preprints

- https://journals.sagepub.com/doi/full/10.1177/1475725719875844
- Twitter thread on why pre-prints are useful: https://twitter.com/dsquintana/status/962214636312461312?ref_src=twsrc%5Etfw%7Ctwcamp%5Etweetembed%7Ctwterm%5E962214636312461312&ref_url=https%3A%2F%2Fwww.aje.com%2Farc%2Fbenefits-of-preprints-for-researchers%2F

Statistics

- Friston, K. NeuroImage Ten ironic rules for non-statistical reviewers Author ' s personal copy. **61**, 1300–1310 (2012).
- Makin, et. al *eLife* (2019).
- Andy fields statistics hell https://www.discoveringstatistics.com/statistics-hell-p/
- Russ Poldrack's statistics textbook: http://statsthinking21.org/, and https://github.com/poldrack/psych10-book

Methods Templates

- Transparency and Openness Promotion https://cos.io/top/
- Consolidated Standards of Reporting Trials: http://www.consort-statement.org/
- Making Methods Clearer (2013). *Nat Neurosci*
- List of more methods templates: http://www.equator-network.org

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References and Resources

Social Media

- Social media for scientists. *Nat. Cell Biol.* **20**, 1329 (2018).
- How to use twitter for science: https://hub.jhu.edu/2017/01/19/reading-tweeting-science-intersession/

GitHub

- Git introduction: http://swcarpentry.github.io/git-novice/
- .gitignore templates https://github.com/github/gitignore
- Good examples of git repos: https://github.com/ContextLab/timecorr-paper
- Structuring a repository for a python module: https://docs.python-guide.org/writing/structure/#modules

R Markdown

- Recommendations for organizing projects with r markdown: https://cran.r-project.org/web/packages/summarytools/vignettes/Recommendations-rmarkdown.html
- Example from Julia Leonard: https://osf.io/2bkdy/

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