

Rigor and Transparency to Enhance Reproducibility

Whiteley lab

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Outline

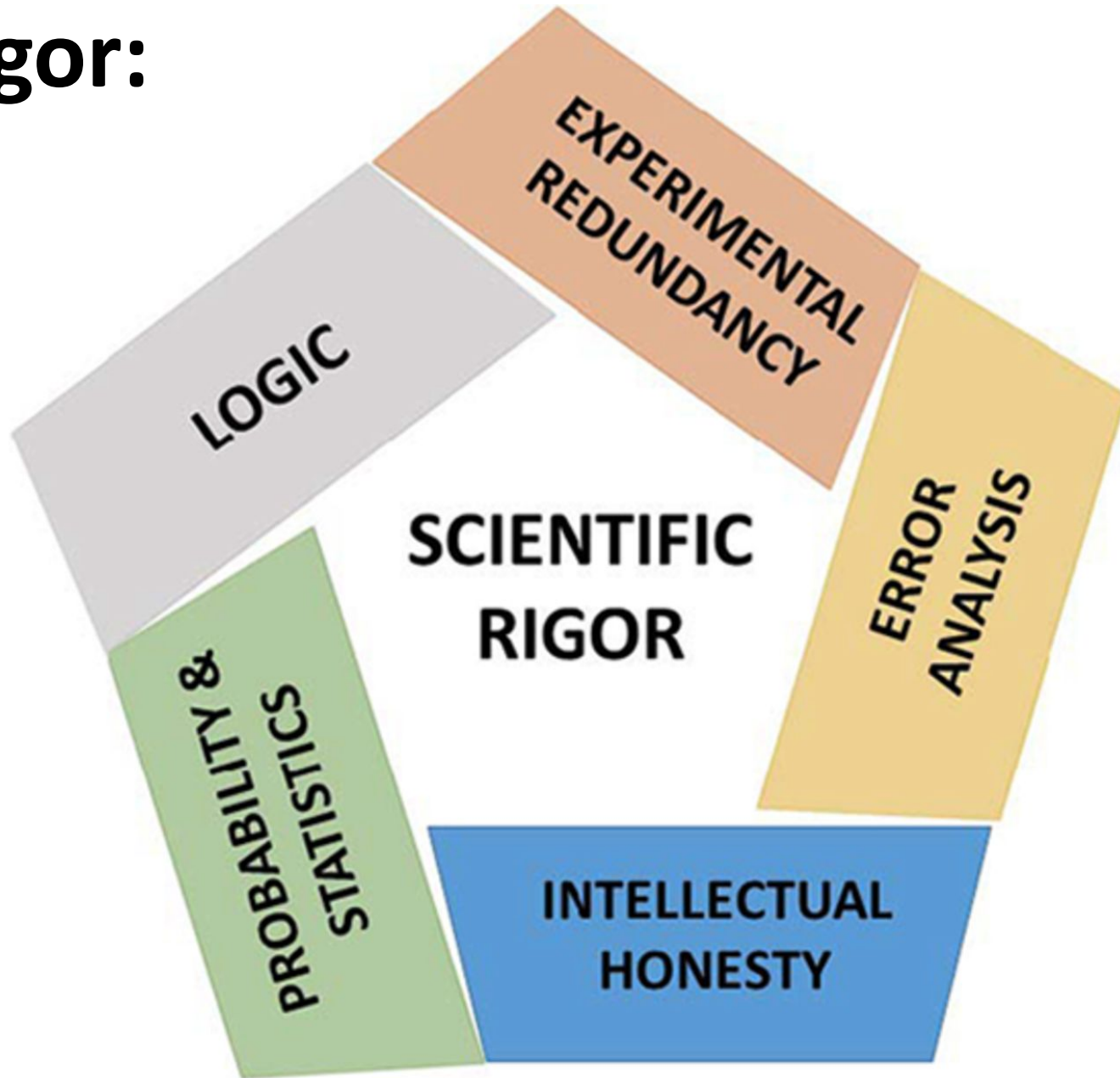
- Rigor and Transparency
- Statistical rigor
- Practical tips for running a lab

Rigor and Transparency in Science

- Rigor: the quality of being extremely thorough, exhaustive, or accurate.
- Transparency: the need to be explicit, clear, and open about the methods and procedures used.

- What are the consequences research with no rigor?
 - Famous example: Structure of ribosomal proteins from *Science*.
- What are the consequences research with no transparency?
 - Famous example: STAP cells

Rigor:



Transparency: be honest



Will Hartwig @hartwig_bill · 1 Jul 2014

Reaction ran long due to extra time in World Cup game

[#overlyhonestmethods](#)



Mike Feigin @mikefeigin · 16 Nov 2017

Perfect western blot exposure time: however long it takes to drink 2 beers and bitch about grants with friends. [#overlyhonestmethods](#)



Fauna Yarza @micro_fauna · 25 Jul 2018

This experiment was done with 7 ticks because that is how many I could fit in the tube before freaking out. [#overlyhonestmethods](#)



Sarah McNulty @SarahMackAttack · 5 Feb 2017

"Cells were gently resuspended by dancing around the lab with tubes in hand when grad student had 2 much coffee" [#OverlyHonestMethods](#)

Transparency: Make methods complete

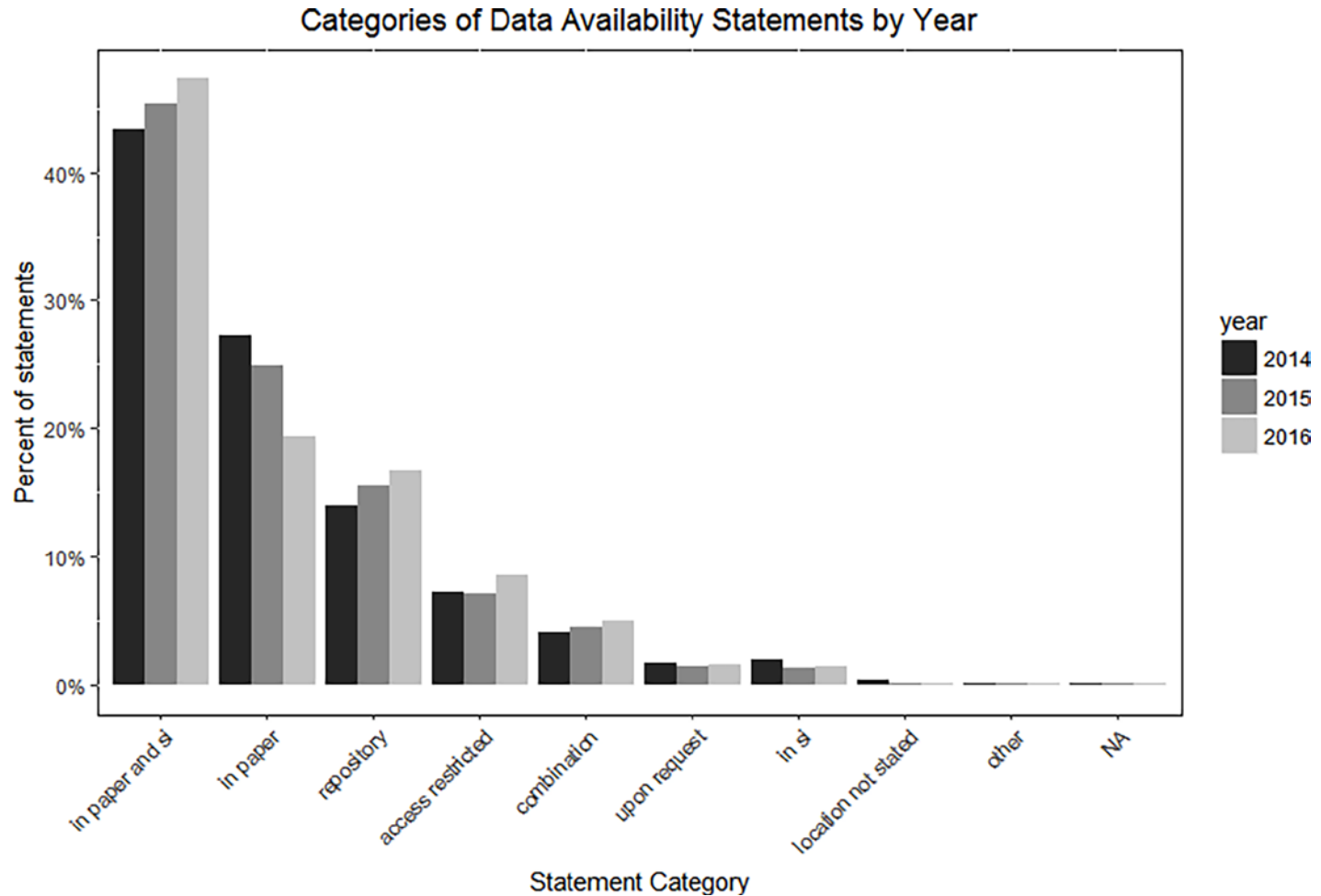
Mouse infections. VSV WT–mCherry and $\Delta 51$ –GFP were purified in an iodixanol gradient by high-speed centrifugation and used for intranasal inoculation of 4-week-old Balb/c (Charles River) females with approximately $0.5\text{--}1.0 \times 10^8$ FFU of pure WT, or a mixture of WT and $\Delta 51$ ($0.5\text{--}1.0 \times 10^8$ FFU each). The inoculum was administered by aspiration of $10\ \mu\text{l}$ through the nostrils. Animals infected with $\Delta 51$ /WT mixes or pure WT were kept in separate cages and inspected daily for symptoms of infection. Animals showing VSV-induced brain damage symptoms such as severely altered behaviour, abnormal motility or paralysis as well as other end-point criteria were euthanized by cervical dislocation or perfused for microscopy analysis. This

If you had to reproduce this procedure, could you do it?

What information do the authors provide?

What do you want to know?

Transparency: Make data accessible



Transparency: Cite the right people



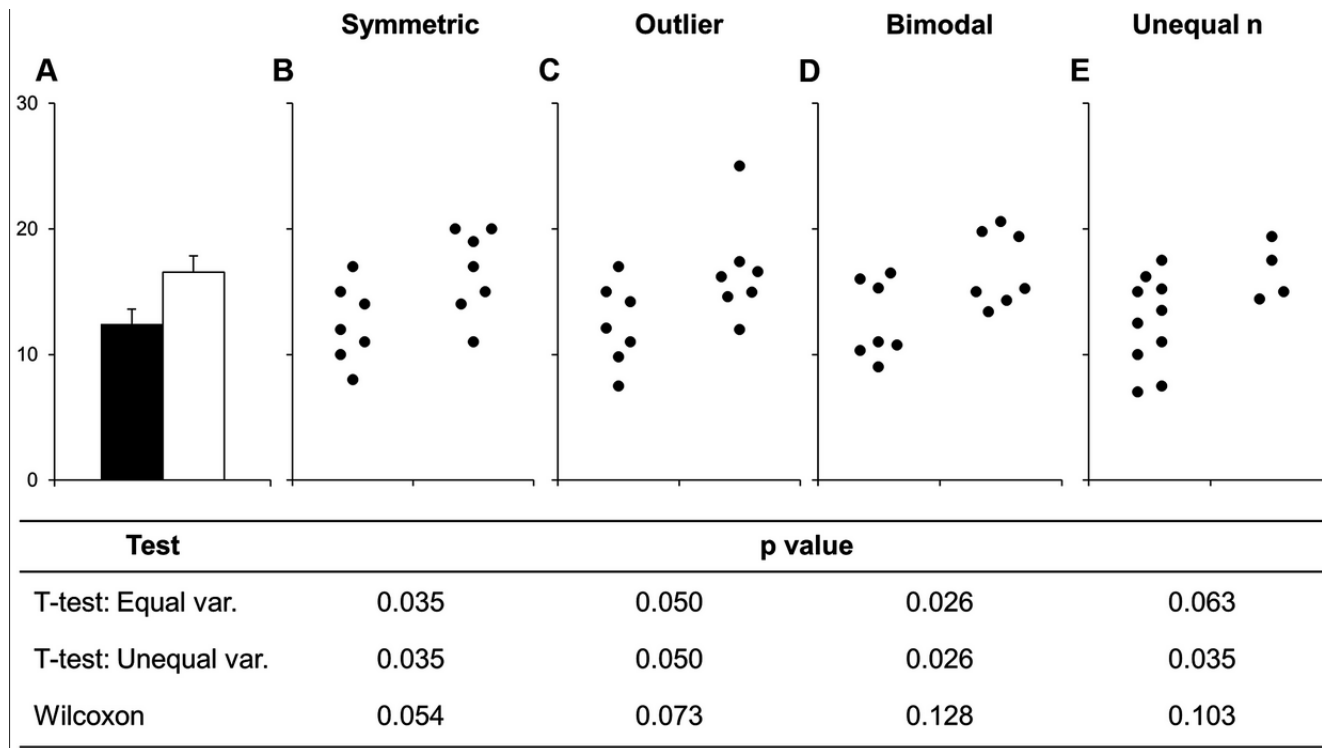
Articles (include patents) Case law

Stand on the shoulders of giants

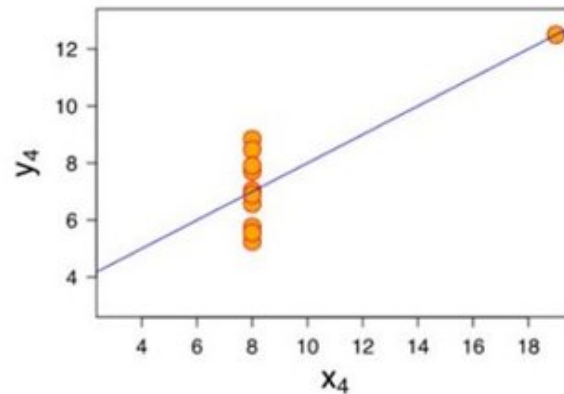
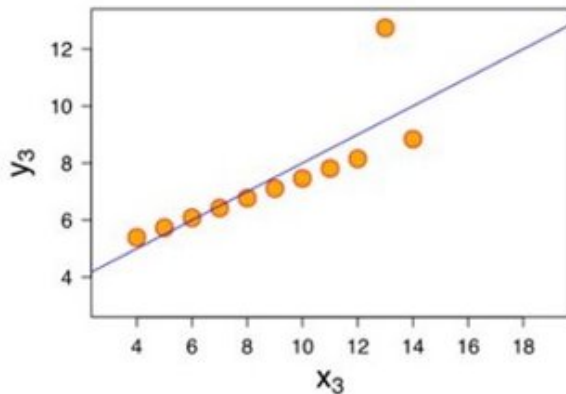
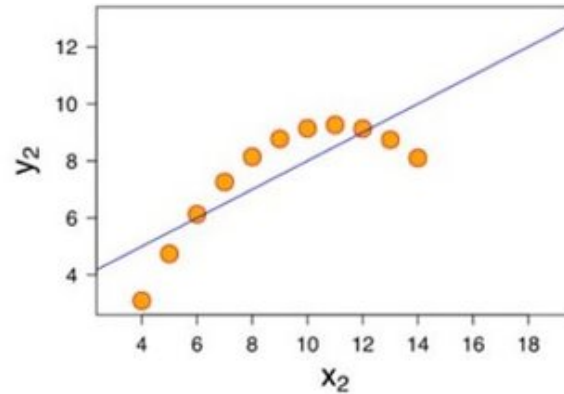
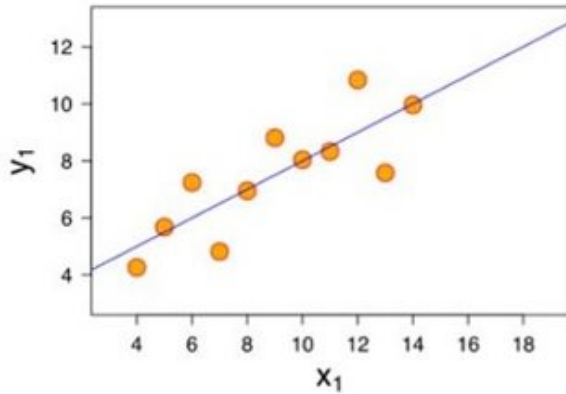
Statistical Rigor

Report raw data

- Summary statistics can be misleading
- Lets other people reproduce your analysis!



Very different distributions can have the same summary statistics!

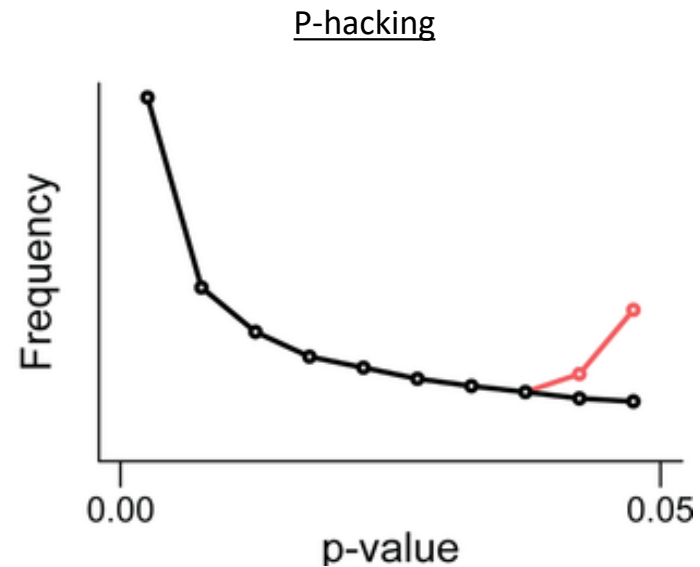
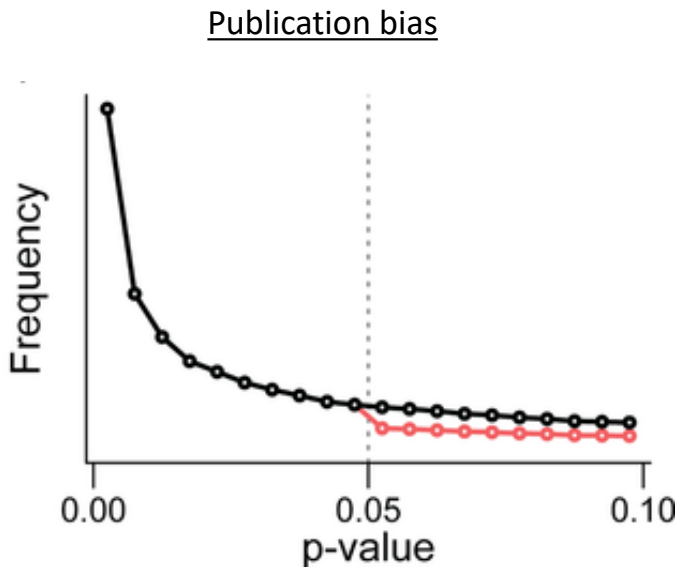


Mean of x	9
Mean of y	7.5
Sample variance of x	11
Sample variance of y	4.13
Correlation between x and y	0.82

Anscombe's quartet

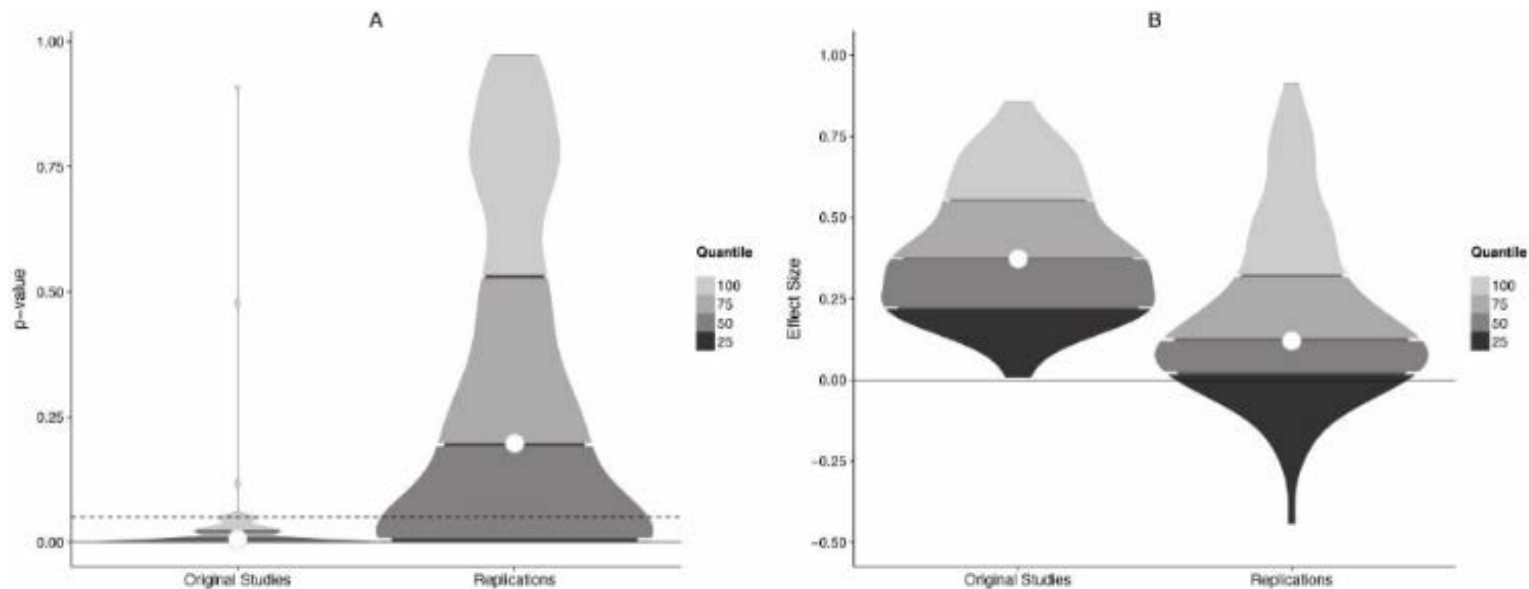
P-values, publication bias, and "p-hacking"

- P-value is the likelihood of falsely concluding there is an effect (rejecting the 'null hypothesis'), even if there is no effect
- Often 0.05 is used as a hard cutoff for significance (0.051 is not significant, but 0.049 is). Leads to:
 - Publication bias
 - Only reporting results that have p-values of under 0.05
 - P-hacking
 - Not controlling for (or reporting) multiple statistical tests



A case study: "a reproducibility crisis in psychology"

- A collaboration of 270 authors to repeat 100 published experimental and correlational psychological studies (*Science*, 2015).
- Only 35 of the 97 studies claiming to have significant results were successfully replicated.



Whiteley lab practices

How to promote rigor and transparency in your lab

Practices to promote rigor and transparency in:

1. Daily lab work

- Peer reviews
- Writing groups

2. Analyzing and presenting data

3. Grant writing

Peer reviews

1. Split lab in groups of 2-3 people
2. Each month one person talks in detail about progress made in current projects, issues/concerns about technique and experimental design and future directions
3. Rest of the group asks questions and provides feedback
4. Report written for the advisor.

Writing groups

- Similar to peer reviews, but with papers, grants, abstracts.
- People in writing group provide thorough feedback to ensure both readability and scientific soundness of research (relevance and logical progression)

NIH Authentication Plan

Key resources that require validation are likely to:

- Differ from laboratory to laboratory, or over time
- Vary in qualities or qualifications that could influence the research data