RDM in the Context of Bias and Reproducibility

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RDM Jumpstart
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Are Mendel's Data Reliable?

How would we establish if Mendel's data are reliable?

You can read a brief summary of this debate in: Weeden, NF. (2016). Are Mendel's Data Reliable? The Perspective of a Pea Geneticist. Journal of Heredity. 7 (7). https://doi.org/10.1093/jhered/esw058

Measuring Bias

- How does one measure or evaluate for bias in a study?
  - From Proxy to Reproducibility
- What is required for Reproducibility
  - Depends on definition of reproducibility

Types of Bias

- Structural
  - Who gets hired, published, promoted, etc.
- Cognitive
  - Conscious and unconscious
- Systemic
  - Error due to complex systems, measurement, etc.

Reproducibility & Replicability

- Four categories
  - Computational
  - Study results
  - Methods
  - Generalization

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Computational Reproducibility

- Same data, same analysis tool, same analysis pipeline to derive the same results
  - Cleaned data
  - Documentation (readme, data dictionary)
  - Analysis protocols (step by step, scripts, etc.)
  - Tests and parameters used (thresholds, etc.)

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  - Enabled by code and interoperable formats

Study Results Replicability

- Same data, same hypothesis.
  - Data (potentially cleaned)
  - Documentation (readme, data dictionary)
  - Hypothesis being tested
- Helps to address analytical choices made in the study.
  - Researcher degrees of freedom
  - Border line p-values and small effect sizes are often contradicted or invalidated in these replications.

Methods Replicability

- Research protocol
  - Research Question
  - Hypothesis being tested
  - Data collection plan
  - Data analysis plan
- Attempts to replicate a study as designed.
  - Same methods, but with new data and a new sample from the same population
  - Helps to address choices related to study implementation including measurement error and sampling bias.

Example Interlude

"[S]cientific findings were confirmed in only 6 (11%) cases."

Begley, C., Ellis, L. Raise standards for preclinical cancer research. Nature 483, 531–533 (2012). https://doi.org/10.1038/483531a

"An analysis of past studies indicates that the cumulative (total) prevalence of irreproducible preclinical research exceeds 50%, resulting in approximately US$28,000,000,000 (US$28B)/year spent on preclinical research that is not reproducible—in the United States alone."

Freedman LP, Cockburn IM, Simcoe TS (2015) The Economics of Reproducibility in Preclinical Research. PLoS Biol 13(6): e1002165. https://doi.org/10.1371/journal.pbio.1002165

"We conducted replications of 100 experimental and correlational studies published in three psychology journals using high-powered designs and original materials when available…Thirty-six percent of replications had significant results."

Open Science Collaboration. Estimating the reproducibility of psychological science. Science 349 ,aac4716 (2015). DOI:10.1126/science.aac4716

Study Generalizability

- Same research question, but a novel perspective
  - Re-considering choices related to study design including how to measure and how to define the population Hypothesis being tested
  - may also involve re-evaluating choices related to how the question will be approached, impacting choice of over all study design

Replication & RDM

- Who are you?
- Paradigm or Framework

- What's your plan?
- Research Question
- Hypothesis being tested
- Data collection plan
- Data analysis plan

- What was your final analysis plan?
- Data (potentially cleaned)
- Documentation
- Hypothesis being tested

- Can I follow your final recipe?
- Cleaned data
- Documentation
- Analysis
- Tests and parameters

Evaluation to Practice

- Just as we need this level of transparency to evaluate a given study, we should strive to provide this same level of transparency for our peers and to enhance our research practices.

Full circle to Mendel with the social habits of spiders.

What to do when you don’t trust your data anymore

- Kate Laskowski - https://laskowskilab.faculty.ucdavis.edu/2020/01/29/retractions/o enhance our research practices.

Questions?