

# **Opportunities for Doing Social-Environmental Research with Little to No Funding: Meta-analysis**

Larry V. Hedges

Department of Statistics and Data Sciences

Northwestern University, USA

# What is Meta-analysis?

*Meta-analysis is the analysis of the results of statistical analyses for the purposes of drawing general conclusions (Glass, 1976)*

Meta-analysis is the use of statistical methods to combine estimates from different sources (e.g., different studies) to draw conclusions

Special statistical methods are needed for meta-analysis (e.g., Cooper, Hedges, and Valentine, 2019)

Meta-analyses can address different purposes (research questions)

The statistical methods used must suit the purposes of the meta-analysis

Substantive knowledge of the research area is more crucial than statistical methods

# History

The term “meta-analysis” may have been invented in 1976, but this has long been a fundamental scientific activity

- 1805** Legendre invented least squares to solve the problem of combining astronomical data across observatories (Stigler, 1986)
- 1904** Karl Pearson used meta-analysis to combine evidence from 5 studies of typhoid vaccine (*British Medical Journal*)
- 1929** Raymond Birge used meta-analysis to establish values of fundamental constants of mathematical physics (*Physical Review*)
- 1958** The Particle Data Group begins producing biannual compendia of meta-analyses of elementary particle properties (*Reviews of Modern Physics*)

# Purposes of Meta-analyses

## 1. Establishing that a controversial effect exists

Expectancy effects in experiments (Rosenthal & Rubin, 1978)

## 2. Estimating an average effect

The effects of psychotherapy (Glass & Smith, 1977)

Establishing values of the fundamental physical constants (Birge, 1929)

Harms (side effects) of drugs or medical procedures (many)

## 3. Estimating patterns (e.g., differences) in effects

The interaction between competition and predation in ecology (Gurevitch, Morrison, & Hedges, 2000)

# Purposes of Meta-analyses

## 4. Estimating variation and generalizability of effects

Generalization of employment test validities across job sites (e.g., Schmidt & Hunter, 1977)

## 5. Studying replication and replicability

Recognize that designing a study of replication **is** experimental design

But read the statistical literature first! (e.g., Hedges & Schauer, 2019, Schauer & Hedges, 2020)

## 6. Substituting for a comprehensive data collection

Isotope hydrology (Bam & Hedges, in press)

# Purposes of Meta-analyses

## 7. Prospective meta-analyses

Many data collections could be performed by a single lab with enough funding, but could be conducted by collaboratives of investigators

(Klein, et al., *Social Psychology*)

## 8. Systematic reviews without meta-analysis

Evidence maps identifying gaps in the empirical research base

(Miake-Lye, et al., *Systematic Reviews*)

# References

- Birge, R. T. (1929). Probable values of the general physical constants. *Physical Review*, 35 (Supplement 1), 1-37.
- Borenstein, M., Hedges, L. V., Higgins, J. P. T. & Rothstein, H. R. (2021). *Introduction to meta-analysis (2<sup>nd</sup> edition)*. Hoboken, NJ: John Wiley.
- Cooper, H., Hedges, L. V. & Valentine, J. (2019). *The handbook of research synthesis and meta-analysis (3<sup>rd</sup> edition)*. New York: Russell Sage Foundation.
- Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher*, 5, 3-8.
- Glass, G. V. & Smith, M. L. (1977). The meta-analysis of psychotherapy outcome studies. *American Psychologist*, 32, 752-760.
- Gurevitch, J., Morrison, J. A., & Hedges, L. V. (2000). The interaction between competition and predation: A meta-analysis of field experiments. *American Naturalist*, 155, 435-453.
- Hedges, L. V. & Schauer, J. (2019). More than one replication study is needed for unambiguous tests of replication. *Journal of Educational and Behavioral Statistics*, 44, 543-570.
- Klein, R. A., Ratliff, K. A., Vianello, M., Adams, R. B., Bahník, Š., Bernstein, M. J., . . . Nosek, B. A. (2014). Investigating variation in replicability: A “many labs” replication project. *Social Psychology*, 45, 142–152.
- Legendre (1805). *Nouvelles méthodes pour la détermination des orbited des comètes*. Paris: Courcier.

# References (cont.)

Miake-Lye, I.M., Hempel, S., Shanman, R. *et al.* What is an evidence map? A systematic review of published evidence maps and their definitions, methods, and products. *Systematic Reviews*, 5, 28 (2016).  
<https://doi.org/10.1186/s13643-016-0204-x>

Pearson, K. (1904a). Antityphoid inoculation. *British Medical Journal*, 2, 1667-1668.

Pearson, K. (1904b). Report on certain enteric fever inoculation statistics. *British Medical Journal*, 2, 1667-1668.

Rosenfeld, A. H. (1975). The particle data group: growth and operations. *Annual Review of Nuclear Science*. 555-599.

Rosenthal, R. & Rubin, D. T. (1978). Interpersonal expectancy effects: The first 345 studies. *The Behavioral and Brain Sciences*, 3, 377-386.

Schauer, J. & Hedges, L. V. (2020). Assessing heterogeneity and power in replications of psychological experiments. *Psychological Bulletin*, 146. 701-719.

Schmidt, F. L. & Hunter, J. (E. 1977). The development of a general solution to the problem of validity generalization. *Journal of Applied Psychology*, 62, 529-40.

Stigler, S (1986). *The history of statistics*. Cambridge: Harvard University Press.