EPSY 6800. Meta-analysis

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1 Introduction

A hypothetical survey of the literature:

- Let X be an intervention based on your favorite theory.

- Let Y be an outcome that you think is important.

- Now suppose:

  - Henson (1996) finds that X affects Y ($t_{42} = 3.01, p < 0.01$).

  - Hull (2005) finds no effect of X on Y ($t_{50} = -0.95, p = 0.35$)

  - Uanhoro (2018) finds positive effect ($t_{100} = 3.00, p < 0.01$).

  - Lee (2021) finds weak evidence of an effect ($t_{45} = 1.67, p = 0.10$).

- *What are we supposed to conclude about the effect of intervention X?*

"Findings are mixed."

Or, are they?   See Figure 1.1.

Pattern of findings is consistent with a reliable effect of X on Y ($d = 0.55$, 95% CI [0.42, 0.68]).

To make sens of the findings, we need to look across _____ *of evidence* and account for _____ (statistical noise).

1.1 Replication and research synthesis

Scientific literature are cluttered with repeated studies of the same (or, comparable) phenomena.
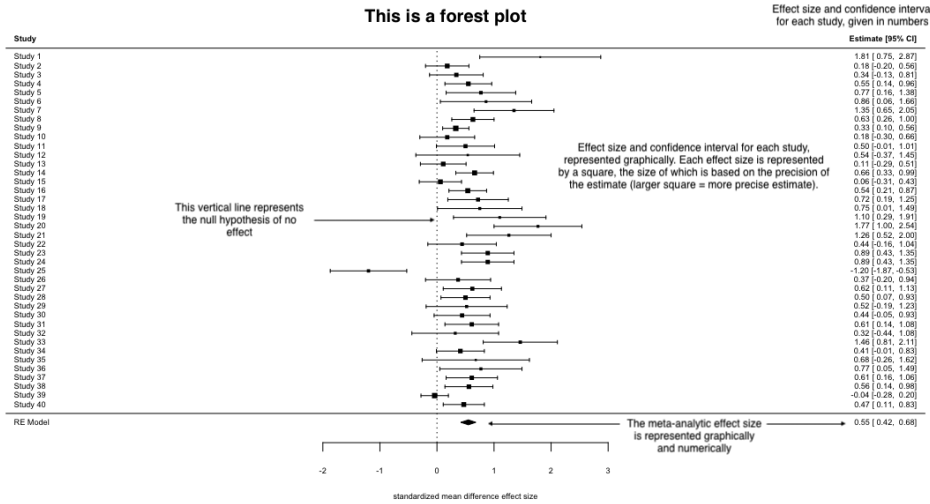
- "No two bricks are exactly alike."

Figure 1.1: Example forest plot (OLI p. 183)

What should scientists do when study results differ?

* Two primary goals of research synthesis: (1) to promote transparency and (2) replication (*reproducibility*).

Could you replicate this search? What are the changes you would end up with the same final body of studies?

1.2   Meta-analysis

: *A set of statistical procedures used to synthesize findings (quantitative data) from two or more studies (multiple sources of evidence).*

1.2.1 The potential of meta-analysis

- Formal, structured, systematic method for integrating and summarizing research findings.

- Understand variation (heterogeneity) in research findings.

- Identify predictors of effect magnitude.

- Monitor and critique the process of evidence production.

- Inform evidence-based practice and policy guidance.

- Inform research needs, further research directions.

- *Read Maynard (2024)

[**Example**] Patall, Cooper, & Robinson (2008) conducted a meta-analysis on the effect of choice on intrinsic motivation among children and adults in instructional settings.

- 41 studies (46 samples) and 290 effect size estimates

- Positive overall effects of choice: $d = 0.30$, 95% CI [0.25, 0.35], under a fixed-effects model, with substantial heterogeneity.

- Examined 12 moderators to explain heterogeneity in effect size estimates. For example, publication type, choice type, number of options per choice, ...

1.3 Terminology

_____ : The systematic integration of empirical research for the purpose of creating generalizations (Cooper & Hedges, 2019).

_____ : A literature review that uses clearly defined inclusion criteria and systematic search techniques to identify a body of relevant evidence.

_____ : A set of statistical procedures used to synthesize findings (quantitative data) from two or more studies (multiple sources of evidence). The statistical tools that support research synthesis activities.

- _____ analysis: the original analysis of raw data (from participants)

- _____ analysis: the re-analysis of data used in primary analyses although using a different perspective or model

- Meta-analysis: analysis of the descriptive and/or inferential statistics provided in relevant studies without using the original raw data.

  - "Analysis of analyses"

  - Unit of analysis is *the study*.

  - Goals: (1) Estimate the mean (pooled) effect size across studies, (2) Estimate the variation in effect size across studies, and (3) Estimate models of effect size variation (- do studies vary as a function of study characteristics?).

* Littell J. H. (2018). Conceptual and practical classification of research reviews and other evidence synthesis products. Campbell systematic reviews, 14(1), 1–21. https://doi.org/10.4073/cmdp.2018.1

1.4   Disciplines that rely on research synthesis

- Medicine (Cochrane Collaboration)

- Education (What Works Clearinghouse)

- Psychology

- Social policy (justice, welfare, ...; Campbell Collaboration)

- Ecology, environmental sciences

- Physical sciences

- Economics, international development ...
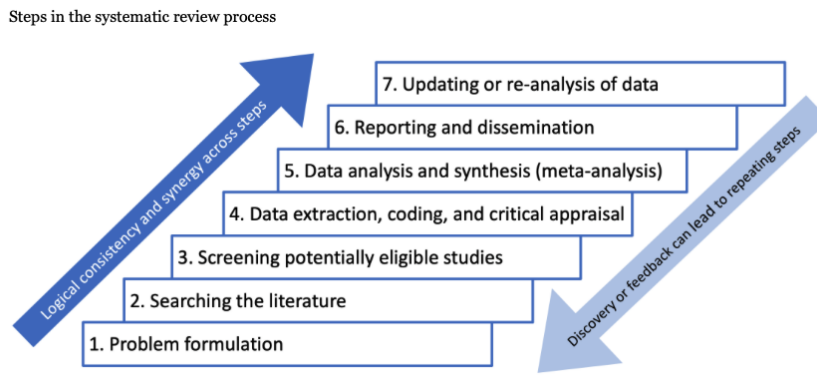
1.5   Research synthesis process

Figure 1.2: OLI p. 7

* *Feedback can lead to repeating any or all steps.*

1.6   A failure of meta-analysis?

Theory of ego depletion: "Self-control is a finite resource that determines capacity for effortful control over dominant responses and, once expended, leads to impaired self-control task performance, known as ego depletion." (Hagger, Wood, Stiff, & Chatzisarantis, 2010)

- Hagger et al. (2010) finds ego depletion effects are large:

  – 83 studies, 198 experiments

  – Overall average effect: $d = 0.62$, 95% CI [0.57, 0.67]

- Large, multi-lab replication study (Hagger et al., 2016):

  – $d = 0.04$, 95% CI [-0.07, 0.15]

  – Provide evidence that "if there is any effect, it is close to zero."

[**Exercise for brain**] Read the two articles and compare the procedures. Why do you think the two meta-analyses results and conclusions are different?

Table 1.2 Research Synthesis Conceptualized as a Research Process

Step in Research Synthesis	Research Question Asked at This Stage of the Synthesis	Primary Function Served in the Synthesis	Procedural Variation That Might Produce Differences in Conclusions
Formulating the problem	What research evidence will be relevant to the problem or hypothesis of interest in the synthesis?	Define the variables and relationships of interest so that relevant and irrelevant studies can be distinguished	Variation in the conceptual breadth and distinctions within definitions might lead to differences in the research operations deemed relevant and/or tested as moderating influences
Searching the literature	What procedures should be used to find relevant research?	Identify sources (such as reference databases, journals) and terms used to search for relevant research	Variation in searched sources might lead to systematic differences in the retrieved research
Gathering information from studies	What information about each study is relevant to the problem or hypothesis of interest?	Collect relevant information about studies in a reliable manner	Variation in information gathered might lead to differences in what is tested as an influence on cumulative results, in coder training might lead to differences in entries on coding sheets, or in rules for deciding what study results are independent tests of hypotheses might lead to differences in the amount and specificity of data used to draw cumulative conclusions
Evaluating the quality of studies	What research should be included in the synthesis based on the suitability of the methods for studying the synthesis question or problems in research implementation?	Identify and apply criteria that separate studies conducted in ways that correspond with the research question from studies that do not	Variation in criteria for decisions about study methods to include might lead to systematic differences in which studies remain in the synthesis
Analyzing and integrating the outcomes of studies	What procedures should be used to condense and combine the research results?	Identify and apply procedures for combining results across studies and testing for differences in results between studies	Variation in procedures used to summarize and compare results of included studies (such as narrative, vote count, averaged effect sizes) can lead to differences in cumulative results
Interpreting the evidence	What conclusions can be drawn about the cumulative state of the research evidence?	Summarize the cumulative research evidence with regard to its strength, generality, and limitations	Variation in criteria for labeling results as important and attention to details of studies might lead to differences in interpretation of findings
Presenting the results	What information should be included in the report of the synthesis?	Identify and apply editorial guidelines and judgment to determine aspects of methods and results readers of the report will need to know	Variation in reporting might lead readers to place more or less trust in synthesis outcomes and influence others' ability to replicate results

SOURCE: Authors' compilation.

Figure 1.3: See Cooper, Hedges, & Valentine, 2019, p. 9

References

Hagger, M. S., Chatzisarantis, N. L., Alberts, H., Anggono, C. O., Batailler, C., Birt, A. R., ... others (2016). A multilab preregistered replication of the ego-depletion effect. *Perspectives on Psychological Science*, *11*(4), 546–573.

Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. (2010). Ego depletion and the strength model of self-control: a meta-analysis. *Psychological bulletin*, *136*(4), 495.