Conducting Systematic and Meta-Analytic Reviews: Basics for Early Career Researchers

Presented by
Endia J. Lindo, Ph.D.
Michael Faggella-Luby, Ph.D.
Amy Elleman, Ph.D.

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Professional Reading & Writing, is...

- a way for the field to catalog where it is, where it as been, and where it might go!
Professional Reading & Writing, is...

- a way for the field to **disseminate** information from research to practice (and in **reciprocal** form from practice to research!)
Professional Reading & Writing, is...

• organized around a pre-agreed and consistent form of written language, rules, and grammar
Professional Reading & Writing, is...

• an important step to master along your professional path
Systematic Review of the Literature: An Overview
Systematic Reviews of the Literature

- Critical evaluations of material already published
- Synthesizing existing ideas into one research review or meta-analysis
- Reviews:
  - Define and Clarify a Problem
  - Summarize Previous Investigations
  - Identify Relations and Inconsistencies in Literature
  - Suggest Novel Approaches
- May include IES practice guides
- Stand alone as publications, more than just an introduction
What is the Systematic Review Process?

1. Select a Topic
2. Search the Literature
3. Develop the Argument
4. Survey the Literature
5. Critique the Literature
6. Write the Review
Step 1: Select a Topic

- Interest in a practical or theoretical problem
- Desire to learn more for teaching your students or solve a challenge in your school
- Examine textbooks, articles, future goals
- **Stated as a question accessible to an academic discipline**
  - Use specific language
  - Refine the focus of interest
  - Select the academic vantage point
Step 2: Search the Literature

• Go find the information to support your thesis!
• Preview the data
• Select the data
• Organize the data
• Catalog the data
• Requires skimming, scanning, and mapping!
Step 3: Develop the Argument

• **Form** your case from the data
  ▫ Arrange your claims logically

• **Present** your case from the data
  ▫ Organize the relevant data into a body of evidence that explains what is known about the topic
Step 4: Survey the Literature

• Assemble, synthesize and analyze the data

• Goal: Form an argument about the current knowledge of the academic discipline on the topic
  ▫ Data is used to establish evidence that creates logical and defensible conclusions (or claims)
  ▫ Claims provide basis for answering research question
Step 5: Critique the Literature

- Interprets the current understanding of the topic
- Analyzes how the previous knowledge answers the research question
- Note quality indicators for different types of research
Step 6: Write the Review

- Transform the research project into a document for others
- Requires writing, auditing and editing
The Systematic Review Model

Machi & McEvoy, 2009, Figure 1.3, p. 5
What are quality indicators of Systematic Reviews?

• Provide a conceptual context for the research and state clear research questions and objectives.

• Develop and report eligibility criteria

• Report search procedures used to identify potentially eligible research studies

• Report procedures for retrieving studies and document the proportion of potentially eligible studies retrieved

• Describe methods used to screen studies for inclusion and document reasons particular studies were not included

See Talbott, Maggin, Van Acker & Kumm (2017)
Quality indicators of Systematic Reviews (continued)

- Develop a **coding system** that addresses critical aspects of the research.
- Describe adherence to key indicators of **study quality**.
- Describe the **research participants and contexts** included across the studies.
- Describe the **variables under study** to evaluate the consistency of operational descriptions and data collection methods used.
- Develop a **data analysis plan** to address the research questions.
- **Interpret the results** considering the research findings, study quality, and conditions to which the research might generalize.

See Talbott, Maggin, Van Acker & Kumm (2017)
Example Systematic Review Publications

- **Adolescent Literacy**

- **Postsecondary Education for Students with Disabilities**
Example Meta-Analytic Reviews


- **Lindo, E., Park, N., & Nix, S.** (In progress). Parents as Trainers: A synthesis of the literature examining the impact do parent-implemented academic interventions with students in grades 3-12.


Meta-Analysis

- What is it?
- Why use it?
- How to do it?
- Challenges and benefits?
- Current trends?
What is meta-analysis?

- Meta-analysis is a statistical technique for analyzing the results of a collection of independent studies, on a related topic, in order to determine an overall estimate of treatment effect.
Hierarchy of evidence

Cumulative number of publications about meta-analysis over time, until 17 December 2009 (results from Medline search using text "meta-analysis")

Why use meta-analytic technique?

- Single studies are not sufficient to determine the utility of an intervention or a hypothesis’ validity.
  - Ex. ‘The Great Debate’ on Psychotherapy’s effectiveness (1952-1978)

- Applies structure and affords less subjectivity than traditional narrative reviews.
  - Can integrate a much larger sample of studies.

- Used as original publications, but also serve as introductions of topics or justification for grant proposals.
When Can You Do Meta-analysis?

Meta-analysis is applicable to collections of research that

- Are empirical, rather than theoretical
- Produce quantitative results, rather than qualitative findings
- Examine the same constructs and relationships
- Have findings that can be configured in a comparable statistical form (e.g., as effect sizes, correlation coefficients, odds-ratios, proportions)
- Are “comparable” given the question at hand

Source: Practical Meta-Analysis -- D. B. Wilson
How do you conduct a meta-analysis?

- Specifying the problem
- Establish inclusion and exclusion criteria
- Identify and retrieve research reports
- Develop coding protocol and code reports
- Determine and compute appropriate effect sizes

- Analyze and integrate outcomes
  - Aggregating effect sizes
  - Assessing heterogeneity
  - Test moderators
- Interpret evidence
  - Address strengths and limitations
  - Assess for publication bias
- Present results/Publish
Specifying the problem (One example)

• Need: to determine what constitutes evidence-based practice in regards to approaches to address the stress experienced by parents of individuals with moderate to severe developmental disabilities.

Research Questions:

➢ What interventions have been effective in reducing the stress levels of parental caregivers of children with developmental disabilities?

➢ Are these effects moderated by treatment, parent or child characteristics?
Identification of Reports

**Search far & wide**
(Not just peer reviewed)

- Search in electronic reference databases.
- Search reference list of previous reviews and pertinent primary studies on your topic.
- Hand search journals that frequently publish on the topic.
- Contact experts who have published on your topic.
- Check reference list of each study included in your review.

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**PRISMA 2009 Flow Diagram**

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

- # of records identified through database searching
- # of additional records identified through other sources
- # of records after duplicates removed
- # of records screened
- # of records excluded
- # of full-text articles assessed for eligibility
- # of full-text articles excluded, with reasons
- # of studies included in qualitative synthesis
- # of studies included in quantitative synthesis (meta-analysis)

**Year of publication**
Finding Reports of Parental Stress Management Interventions...

Terms: Parent Stress AND intervention AND Disab*

- Consider other potential terms:
  - Parent Stress: OR Parental stress OR caregiver stress
  - Intervention: OR Support OR therapy
  - Disab*: OR Disabilities OR autism OR delay OR intellectual disability

- Search references of key reports and other literature reviews
  - Hastings & Beck, 2004
  - Singer, et al., 2007
Parental Stress Management Interventions...

**Inclusionary criteria**

- Present an intervention targeted at relieving the stress of parents of individuals with moderate to profound cognitive/developmental disabilities.

- Employ a outcome measuring parental stress; NOT depression

- Use an experimental or quasi-experimental design reporting data that permits calculation of a numeric effect size for at least one eligible outcome. (Single Subject Excluded)

- Reported in English and conducted in North America.

**Electronic searches of ERIC, PsychInfo, Professional Development Collection**

- (support OR intervention) AND (disab*) AND (parent stress)

**Electronic searches of Academic Search Complete, AgeLine, AltHealth Watch, Educational Source, Family and Society Studies Worldwide, Health source, Professional Development Collection, PsycArticles, PsychInfo and SocIndex**

- (parental OR caregiver stress) AND (disabilities OR autism OR delay OR intellectual disability) AND (intervention OR therapy)
Coding of Reports

• Develop coding protocol
  ▫ Establish inclusionary and exclusionary criteria
  ▫ Clearly define variables
  ▫ Use previous reviews and key studies as guides for other predictor variables (potential moderators) to code.

• Establish procedures for managing data.

• Assess inter-coder agreement and check data entry.
## Sample Coding

<table>
<thead>
<tr>
<th>APA Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Characteristics</td>
</tr>
<tr>
<td>Age/Grade</td>
</tr>
<tr>
<td>SES</td>
</tr>
<tr>
<td>Reading Ability</td>
</tr>
<tr>
<td>Ethnicity</td>
</tr>
<tr>
<td>Rural/Urbn</td>
</tr>
<tr>
<td>Gender</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental, quasi-experimental, pre-post only w/no control group</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intervention Characteristics (Independent Variable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Length of study (in days/weeks)</td>
</tr>
<tr>
<td># of hours</td>
</tr>
<tr>
<td># of sessions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who administered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training of teacher/researcher</td>
</tr>
<tr>
<td>Fidelity reported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent Variables (Outcome Measures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>Standard Norm-Referenced or Custom</td>
</tr>
<tr>
<td>Reliability reported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Analysis Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
</tr>
<tr>
<td>Significance</td>
</tr>
<tr>
<td>ES</td>
</tr>
<tr>
<td>Authors’ conclusions</td>
</tr>
<tr>
<td>Alignment of methods, results, and authors’ conclusions</td>
</tr>
</tbody>
</table>

| Notes |
Coding

Training Coders

• Regular meetings (develops normative understandings)
• Annotate coding manual

Common Mistakes

• Not understanding or planning the analysis prior to coding
• Underestimating time, effort, and technical/statistical demands
• Using a spreadsheet for managing a large review
• Variable names not on coding forms
• Not breaking apart difficult judgments
• Over-coding—Trying to extract more detail than routinely reported**
Comments on Managing the Bibliography

- Major activity
- Information you need to track
  - source of reference (e.g., PsychLit, Dissertation Abs.)
  - retrieval status
    - retrieved, requested from ILL, etc.
  - eligibility status
    - eligible
    - not eligible
    - relevant review article
  - coded status
- Word processor not up to the task
- Spreadsheets are cumbersome
- Use a database of some form

Source: Wilson
Approaches to coding

For analysis

- Gender:
  (0) All Females
  (1) More Females
  (2) Equal
  (3) More Males
  (4) All Males
  (999) can’t tell

- Percentage of males in sample:
  (0) 0-24%
  (1) 25-49%
  (2) 50-74%
  (3) 75-100%
  (4) Unspecified
  (5) Not reported

For descriptive report

- Gender:
  - Female: n = 100
  - Male: n = 75

Same for variable like ethnicity, risk status, SES, etc.
Approaches to coding (con’t)

Unless item occurs in consistent units avoid creating a category for each

- Intervention
  1 = 2 weeks
  2 = 6 weeks
  3 = 12 weeks (and so)

Better
- Intervention
  1 = <6 weeks
  2 = 6-12 weeks
  3 = >12 weeks (etc.)

Do not code as if only for the studies you found. Typically coding planned first. Also, you may find other studies that go beyond your current range.
## Approaches to coding (con’t)

<table>
<thead>
<tr>
<th>One option</th>
<th>Another option</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School Prep</strong></td>
<td>• School prep: 0= not discussed, 1= discussed</td>
</tr>
<tr>
<td>0= not discussed</td>
<td>• Visual system (cueing)</td>
</tr>
<tr>
<td>1= visual system (cueing)</td>
<td>▫ 0=no, 1= yes</td>
</tr>
<tr>
<td>2= social skills training</td>
<td>• Social skill training</td>
</tr>
<tr>
<td>3 = vocational training</td>
<td>▫ 0=no, 1= yes</td>
</tr>
<tr>
<td>4 = strength-based planning- including academic</td>
<td>etc. . .</td>
</tr>
<tr>
<td>5 = goal setting</td>
<td></td>
</tr>
<tr>
<td>6 = self-advocacy</td>
<td></td>
</tr>
<tr>
<td>7 = counseling &amp; guidance</td>
<td></td>
</tr>
<tr>
<td>8 = mentoring</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>----</td>
<td>--------</td>
</tr>
<tr>
<td>1</td>
<td>School Prep</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

School Prep (Prevalent model)
0= not discussed
1= visual system (cueing)
2= social skills training
3 = vocational training
4 = strength-based planning - including academic
5 = goal setting
6 = self-advocacy
7 = counseling & guidance
8 = mentoring

School Prep (all applicable)
0= not discussed
1= visual system (cueing)
2= social skills training
3 = vocational training
4 = strength-based planning - including academic
5 = goal setting
6 = self-advocacy
7 = counseling & guidance
8 = mentoring

Visual system
0= no
1= yes

Social Skills Training
0= no
1= yes

Goal Setting
0= no
1 = yes
## Synthesizing Research

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Recurring themes across reports.</td>
<td>• Vote counting</td>
</tr>
<tr>
<td></td>
<td>▫ Emphasis on direction of findings</td>
</tr>
<tr>
<td></td>
<td>▫ 0= not significant,</td>
</tr>
<tr>
<td></td>
<td>▫ 1= significant in unexpected direction.</td>
</tr>
<tr>
<td></td>
<td>▫ 2= significant in expected direction</td>
</tr>
</tbody>
</table>

*This approach has issues. Significance tests highly influenced by sample size.*

|                                                                             | • Measuring direction and strength of relationship (Effect sizes: d, r, Odds Ratio)                                                      |
|                                                                             |   ▫ Reporting range found                                                                                                                |
|                                                                             |   ▫ Computing average                                                                                                                    |
Calculating Effect Sizes

- An effect size (ES) is a measure of the magnitude of a relationship between two variables or a difference between groups.

- Main types of effect sizes are based on:
  - means (Cohen’s d, Hedge’s g, raw unstandardized difference)
  - binary data (risk ratio, odds ratio, risk difference)
  - correlations (Pearson’s correlations, Fisher’s Z)
  - survival data (hazard ratio)

- Compute ES and its variance, standard error, and confidence interval to provide an estimate of the precision of an ES.

- Only 1 ES per study in an analysis (select 1 or aggregate).
### Interpreting Effects

#### Cohen’s “Rules-of-Thumb”
- **standardized mean difference effect size**
  - small = 0.20
  - medium = 0.50
  - large = 0.80
- **correlation coefficient**
  - small = 0.10
  - medium = 0.25
  - large = 0.40
- **odds-ratio**
  - small = 1.50
  - medium = 2.50
  - large = 4.30

#### Practically important effects
- WWC = 0.25
- Hattie = 0.4

### Annual Reading and Math Growth

<table>
<thead>
<tr>
<th>Grade Transition</th>
<th>Reading Growth</th>
<th>Math Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>K - 1</td>
<td>1.29sd</td>
<td>0.93sd</td>
</tr>
<tr>
<td>1 - 2</td>
<td>0.97</td>
<td>1.03</td>
</tr>
<tr>
<td>2 - 3</td>
<td>0.61</td>
<td>0.89</td>
</tr>
<tr>
<td>3 - 4</td>
<td>0.36</td>
<td>0.52</td>
</tr>
<tr>
<td>4 - 5</td>
<td>0.39</td>
<td>0.56</td>
</tr>
<tr>
<td>5 - 6</td>
<td>0.32</td>
<td>0.41</td>
</tr>
<tr>
<td>6 - 7</td>
<td>0.23</td>
<td>0.30</td>
</tr>
<tr>
<td>7 - 8</td>
<td>0.26</td>
<td>0.32</td>
</tr>
<tr>
<td>8 - 9</td>
<td>0.24</td>
<td>0.19</td>
</tr>
<tr>
<td>9 - 10</td>
<td>0.19</td>
<td>0.22</td>
</tr>
<tr>
<td>10 - 11</td>
<td>0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>11 - 12</td>
<td>0.06</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Lipsey (2006) *Effect sizes found in meta-analyses of educational interventions.* (Note: Based on 126 distinct meta-analysis, 777 mean ESs reported.)
Aggregating and Analyzing the Data

Fixed v. Random Effects

Fixed Effect assumes studies identified are the entire population of relevant studies.

Random Effect Assumes variability reflects both population effects and sampling error.

Homogeneity Analyses
- Is the variance due only to sampling error?
- Q statistic: Interpreted like a chi square, establishes if there is significant heterogeneity across studies.

Moderator Analysis
Analyze excess between study (ES) variability
- categorical variables with the analog to the one-way ANOVA
- continuous variables and/or multiple variables with weighted multiple regression

Programs for Analysis

- Excel (😊)
- Effect Size calculator
  https://campbellcollaboration.org/efect-size-calculato.html
- SPSS, STATA, or SAS Macros
  http://mason.gmu.edu/~dwilsonb/ma.html
- Comprehensive Meta-Analysis
  http://www.meta-analysis.com
Assessing Publication Bias

- funnel plot
- Egger’s linear regression method
- Begg and Mazumdar’s rank correlation method
- Duval and Tweedie’s Trim and Fill method
- Rosenthal’s Fail-safe N
Reporting Standards

- Meta-Analysis Reporting Standards (MARS).

- Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)
  - [http://prisma.thetacollaborative.ca/](http://prisma.thetacollaborative.ca/)

- Campbell Collaboration
  - [https://campbellcollaboration.org/research-resources/writing-a-campbell-systematic-review.html](https://campbellcollaboration.org/research-resources/writing-a-campbell-systematic-review.html)

- Meta-analysis of Observational Studies in Epidemiology (MOOSE)
  - Stroup et al., JAMA 2000
  - [www.consort-statement.org/Media/Default/Downloads/Other Instruments](www.consort-statement.org/Media/Default/Downloads/Other Instruments)
Benefits of Meta-analysis

- Imposes a discipline on the process of summing up research findings
- Represents findings in a more differentiated and sophisticated manner than conventional reviews
- Capable of finding relationships across studies that are obscured in other approaches
- Protects against over-interpreting differences across studies
- Can handle a large numbers of studies (this would overwhelm traditional approaches to review)

Source: Practical Meta-Analysis -- D. B. Wilson
Challenges of Meta-analysis

- Takes significant effort
- Not all studies provide adequate data for inclusion and analysis
- Mechanical aspects don’t lend themselves to capturing more qualitative distinctions between studies
- “Apples and oranges” criticism
- Heterogeneity of study populations
- Most meta-analyses include “blemished” studies to one degree or another (e.g., a randomized design with attrition)
- Publication bias poses a continual threat
- Requires advanced statistical techniques
Current Trends and Extensions of the Approach

- Continued increases in number of meta-analyses conducted.

- Quickly becoming the norm for published literature syntheses.

- Multi-level meta-analyses
  - Ex. Marsh et al. (2009)

- Meta-analysis of meta-analyses

Source: Hattie (2009)
Select References


Select References

Training Videos

• David Wilson, The Campbell Collaboration
  • Effect size calculation and basic meta-analysis, https://www.youtube.com/watch?v=nkcZFAmmKeE

• Michael Borenstein, Comprehensive Meta-Analysis
  • Meta-Analysis 001: https://www.youtube.com/watch?v=xWiXeKR3dB4
  • Basic Level 3: https://www.youtube.com/watch?v=O6qDlov5-ls
  • Meta-Analysis | Common mistakes and how to avoid them | Fixed effect vs. random effects https://www.youtube.com/watch?v=3_sbitgMeUg
  • Meta regression using Comprehensive Meta-Analysis https://www.youtube.com/watch?v=39PKfU4cRBc
Suggested Publication Outlets

- Learning Disability Quarterly (LDQ)
- Learning Disabilities Research and Practice (LDR&P)
- Journal of Learning Disabilities (JLD)
- Review of Educational Research (RER)
- Journal of Educational Psychology (JEP)
Contact Information

- Endia Lindo  e.lindo@tcu.edu
- Michael Faggella-Luby  m.faggella-luby@tcu.edu
- Amy Elleman  Amy.Elleman@mtsu.edu

Thanks for joining us today!