SYSTEMATIC REVIEW & META-ANALYSIS

MARCH 30, 2023

Introduce meta-analysis

Conceptual overview

Purposes, why use meta-analysis

Understanding the systematic literature review process *(and how meta-analysis fits into it)*

Example

WHAT IS META-ANALYSIS?

- Meta-analysis refers to the **statistical methods** used to pool quantitative results from multiple research studies
- Statistical methods used in the empirical process of **research synthesis**
- Unit of analysis: Primary research studies
- Effect sizes are the outcomes (dependent variable) of interest

EFFECT SIZES

- Individual studies often use different measures to represent the **underlying construct**
- Meta-analysts **standardize findings** across similar studies in order to **compare results**
- Effect sizes represent the magnitude and direction of a quantity
  - Independent of sample size
- There are a variety of effect sizes
  - Univariate measures of central tendency, variation, or difference
  - Bivariate measures of associations

WHEN IS META-ANALYSIS APPROPRIATE?

- **If you want to synthesize findings from a research literature that:**
  - Uses similar constructs to measure some quantity of interest
  - Produce *quantitative results for some quantity of interest
  - Reports results that can be configured in comparable statistical formats (i.e., effect sizes)

WHY USE META-ANALYSIS?

- Results can provide more compelling evidence than the evidence from a single primary study
  - Results from primary studies are subject to sampling error and other idiosyncratic study-specific biases
  - Unwise to base policy or practice decisions based on the findings of a single primary study.
  - Statistical power often (but not always) exceeds that of the individual studies combined.

WHY USE META-ANALYSIS?

- **First, differentiating between types of reviews**
  - Research review
  - Research synthesis
  - Scoping review
  - Literature review
  - Systematic review
  - Narrative review
  - Meta-analysis
  - Meta-synthesis
  - Meta-analytic investigation/review

WHY USE META-ANALYSIS?

- **Some definitions:**
  - Literature review/research review/narrative review
    - Broad term for a product that reviews studies on a topic
  - Systematic review/research synthesis
    - Systematic process for identifying and retrieving a set of research studies
    - Systematic, transparent, and replicable
  - Meta-analysis
    - A set of statistical procedures for aggregating quantitative results from a body of studies

WHY USE META-ANALYSIS?

- **What about literature/narrative reviews?**
  - Overreliance on p-values (and thus sample size)
  - Often subjective, and lack explicit exclusion/inclusion criteria
  - Lack transparency, use haphazard methods that can lead to biased conclusions
  - Vulnerable to many sources of bias

WHY USE META-ANALYSIS?

- **Systematic reviews** attempt to minimize bias and error in the review process
  - Use systematic, empirical process that values transparency and replicability in the procedures to locate and analyze prior research
  - Use explicit exclusion and inclusion criteria
  - Document transparent search strategies
  - Inter-rater reliability on key data extraction decisions
  - Study quality/risk of bias assessments
  - Meta-analysis (when possible) to statistically synthesize results across studies

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Influences on Academic Talent Development of Black Girls in K-12: A Systematic Review

Brenda K. Davis[1]

Abstract

Black girls experience numerous challenges to their academic development. This study examines the literature from the last 30 years related to the influences on the academic talent development of school-aged Black girls. Environmental and intrapersonal influences to Black girls' academic talent development are explored. Using a systematic approach, 43 articles are reviewed and summarized. Thematic analysis conducted on the results and findings sections from each article reveal four major themes related to personal attributes, racial identity, relationships, and institutions. The themes expand the understanding of the complexity of talent development of Black girls and identify several intrapersonal and environmental influences that can promote or hinder academic achievement. Implications for future research are discussed.

Keywords

Black girls, achievement, systematic review, qualitative, talent development

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Multicultural Education Professional Development: A Review of the Literature

Hillary Parkhouse, Chu Yi Lu, and Virginia R. Massaro
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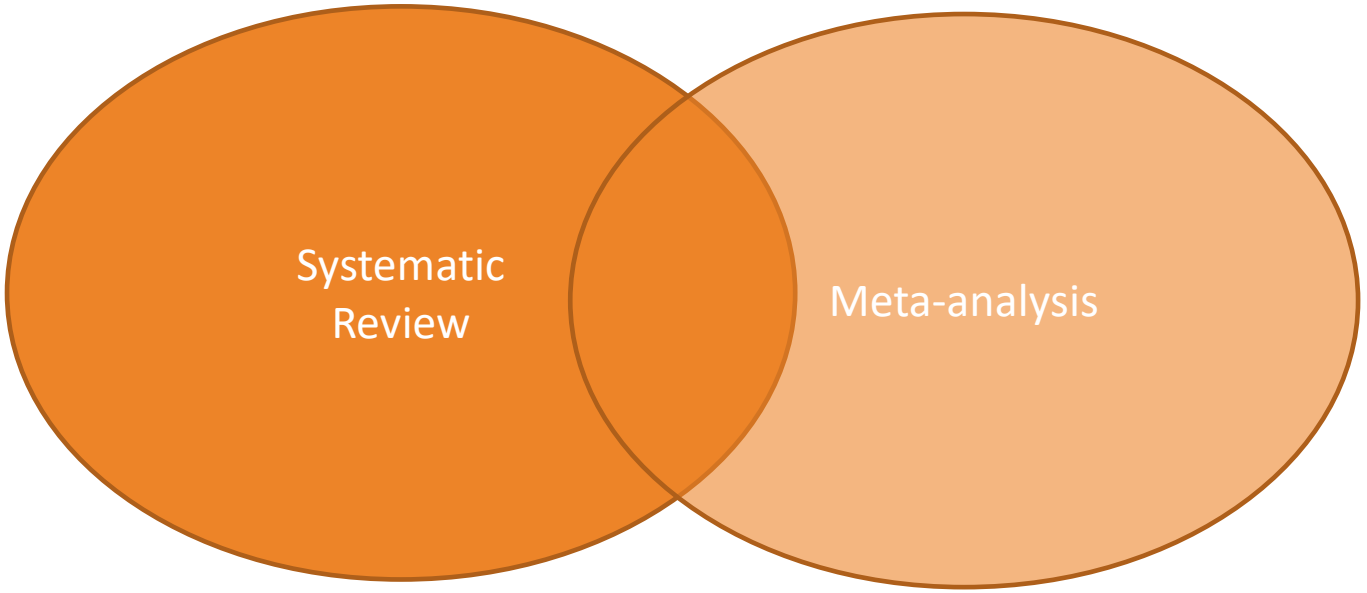
When their teachers are well equipped to foster inclusive and equitable classrooms, students from marginalized communities show higher rates of academic achievement, motivation, self-confidence, and self-efficacy. However, many teachers complete preparation programs feeling underprepared to work in culturally diverse classrooms, making high-quality professional development (PD) in this area crucial. We undertook a meta-ethnographic, systematic literature review of 40 studies of multicultural education–focused PD programs in order to better understand the forms and features of such programs that contribute to teachers' self-efficacy and success in working with culturally diverse students. We found a small literature base with too much variation across types of programs studied and outcomes analyzed to draw conclusions about the factors that contribute to effectiveness. However, the extant literature does point to important questions and considerations for both providers and researchers of multicultural education PD. One area for future research is how PD providers navigate tensions or challenges arising from resistance to discussions of diversity and equity. Another is locating the balance between providing specific knowledge about students' cultures and guarding against promoting stereotypes or broad generalizations. Researchers and PD developers should also pay close attention to their underlying theories related to both teacher learning and multicultural education.

KEYWORDS: literature review, multicultural education, professional development, cultural diversity

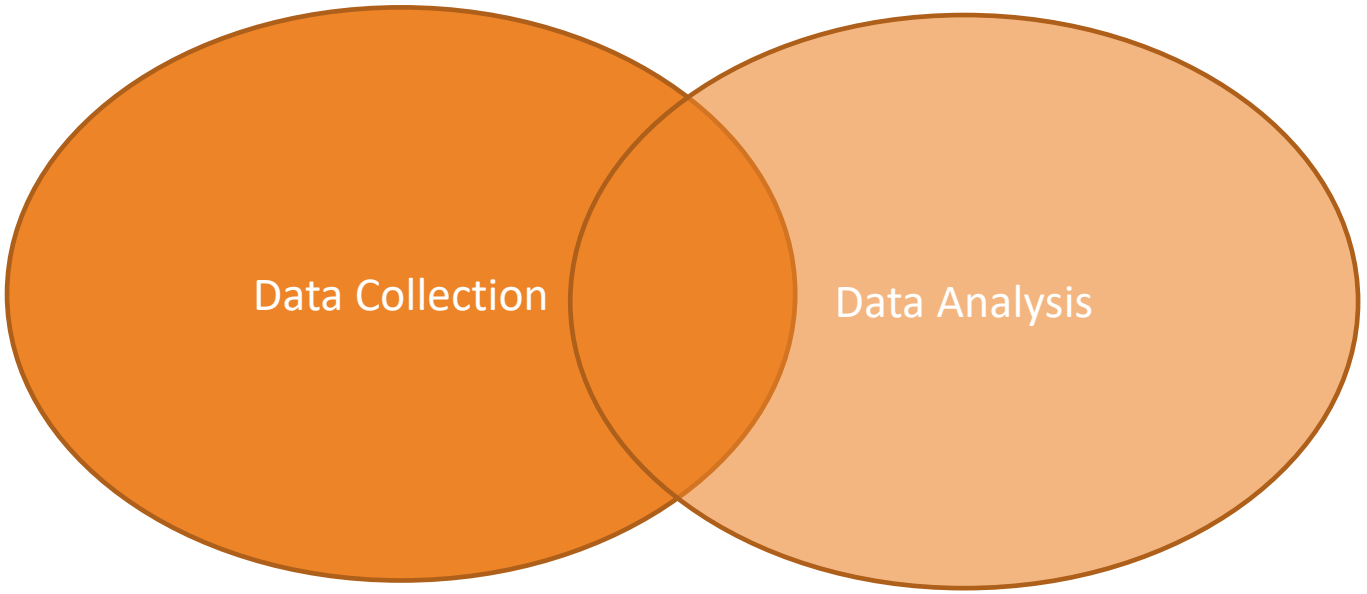
WHY USE META-ANALYSIS?

- Systematic reviews do not always include meta-analyses;
- Meta-analyses are not always based on a systematic review



FROM A DATA COLLECTION PERSPECTIVE…

- Data collection is not the same as data analysis, but the **research question and the data analysis method may influence your data collection procedures**



What is meta-analysis?

Why use meta-analysis?

Literature reviews vs. systematic reviews vs. meta-analysis

HOW ARE WE DOING?

QUESTIONS?

WHY USE META-ANALYSIS?

Even the most methodologically rigorous primary study can be subject to bias

(and hence the value of scientific replication)

Meta-analyses based on systematic reviews provide organized evidence that can be used for decision-making and guiding future research needs

Conducting new primary studies without an understanding of the existing evidence can results in unnecessary, inappropriate, irrelevant, or potentially unethical research

SYSTEMATIC REVIEW ORGANIZATIONS

There are organizations and agencies that support this!

- Agency for Healthcare Research and Quality
- **Campbell Collaboration**
- Centre for Reviews and Dissemination
- **Cochrane Collaboration**
- EPPI-Centre
- International Initiative for Impact Evaluation
- Joanna Briggs Institute
- **Centre for Evidence and Implementation**
- **Institute of Education Sciences**

Many more…

CRITICISMS OF META-ANALYSIS

- Often resource intensive
- Applies and oranges
- Garbage in, garbage out
- Limited external validity
- (usually) ignores qualitative data
- Reliance on published studies/data

- My view is that **this is normal**, understanding what these are, their consequences on your data, and how you interpret findings is the key

OKAY SO FAR:

- The goals of a **systematic review** are to summarize the existing empirical research to:
  1. Provide future directions for research
  2. Improve practice
  3. Inform policy

- ALL OF THIS helps limit the bias in the process by which we **identify**, **evaluate**, and **synthesize** research to address a specific research question.

STEPS IN A META-ANALYSIS

1. Problem formulation

- Selecting appropriate effect size metric
- Outlining explicit inclusion and exclusion criteria

2. Searching the Literature

3. Screening the Literature

4. Data Extraction: Coding Studies

- Estimating effect sizes from primary studies

5. Data Analysis

- Summarizing the studies (descriptive statistics)
- Synthesizing effect sizes (mean effect size)
- Estimating heterogeneity
- Explaining heterogeneity
- Assessing publication bias
- Sensitivity analyses

6. Interpretation of Findings

7. Presenting results

8. Dissemination

1. PROBLEM FORMULATION

Effectiveness	• How effective is an intervention or a group of interventions at changing a specific outcome?
Associations/relations	• How are two constructs related to each other? • How strong is an association between two things?
Prevalence	• How often or frequent does something occur?
Diagnostics	• How good is an assessment or test at identify or predict something?
Relative comparisons	• Comparing across interventions or associations to talk about relative strength

A Meta-Analysis of Family-School Interventions and Children's Social-Emotional Functioning: Moderators and Components of Efficacy

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University of Nebraska-Lincoln

S. Natasha Beretvas and Sunyoung Park
University of Texas-Austin

This meta-analysis examined the effects of family-school interventions on children's social-behavioral competence and mental health. One hundred and seventeen group design studies yielding 592 effect sizes constituted the current sample. Random effects models were estimated when calculating each pooled effect size estimate, and mixed effects models were calculated for each moderator analysis. The analyses yielded significant effects of family-school interventions on children's social-behavioral competence and mental health ($\bar{\delta}.s = 0.332$ and 0.391, respectively). Effects on children's mental health were moderated by race/ethnicity (effects were larger for African American students) and locale (effects were smaller in urban settings relative to nonurban/rural settings). Components found to be significantly related to positive outcomes included both interpersonal, relational processes (i.e., communication, collaboration, and parent-teacher relationship) and tangible, structural elements (i.e., home-based involvement, behavioral supports). These findings indicate the benefits of family-school interventions and have implications for tailoring interventions to family characteristics and communities.

Keywords: effect size, families, learning environments, meta-analysis, parents and families, social processes/development

A Systematic Review and Meta-Analysis of Cyber-Victimization and Educational Outcomes for Adolescents

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Adolescents' Internet use is increasingly mobile, private, and unsupervised, which raises concerns given that the Internet increasingly serves as a medium for experiencing victimization. Although it is widely recognized that in-person victimization has a deleterious effect on adolescents' educational outcomes, the extent to which cyber-victimization has similar effects is less well known. This systematic review and meta-analysis offers a synthesis of the relationship between cyber-victimization and educational outcomes of adolescents aged 12 to 17, including 25 effect sizes from 12 studies drawn from a variety of disciplines. A series of random-effects meta-analyses using robust variance estimation revealed associations between cyber-victimization and higher school attendance problems ($r = .20$) and academic achievement problems ($r = .14$). Results did not differ by provided definition, publication status, reporting time frame, gender, race/ethnicity, or average age. Implications for future research are discussed within context of theoretical, critical, and applied discussions.

KEYWORDS: cyber-victimization, victimization, meta-analysis, adolescents, academic achievement, school attendance

Prevalence of Autism Spectrum Disorder in Preterm Infants: A Meta-analysis

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abstract

CONTEXT: Evidence is emerging that preterm infants are at risk for autism spectrum disorder (ASD).

OBJECTIVES: To conduct a systematic review and meta-analysis to estimate the prevalence of ASD in preterm infants.

DATA SOURCES: Medline (via PubMed and Ovid), Embase, PsycINFO, and relevant conference proceedings were searched in May 2017.

STUDY SELECTION: Original studies in which researchers report on the prevalence of ASD using diagnostic tests in children born preterm were included. Studies in which researchers used only ASD screening tools were excluded.

DATA EXTRACTION: Relevant data were extracted independently by 3 authors.

RESULTS: Researchers in a total of 18 studies (3366 preterm infants) used ASD diagnostic tools. The median gestation, birth weight, and age at assessment were 28.0 weeks (range: 25.1–31.3 weeks), 1055 g (range: 719–1565 g), and 5.7 years (range: 1.5–21 years), respectively. Meta-analysis revealed that the overall prevalence rate for ASD was 7% (95% confidence interval: 4% to 9%). The funnel plot and Egger's test revealed that there was probably no evidence of publication bias.

LIMITATIONS: The limitations were significant heterogeneity and a lack of studies from middle- and low-income countries.

CONCLUSIONS: The prevalence of ASD is significantly high in the preterm population. Adequate resources are needed to improve the outcomes of these children.

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ORIGINAL PAPER

The Effects of Early Intervention on Social Communication Outcomes for Children with Autism Spectrum Disorder: A Meta-analysis

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Published online: 25 February 2019

Abstract

This meta-analysis examined the effects of early interventions on social communication outcomes for young children with autism spectrum disorder. A systematic review of the literature included 1442 children (mean age 3.55 years) across 29 studies. The overall effect size of intervention on social communication outcomes was significant ($g=0.36$). The age of the participants was related to the treatment effect size on social communication outcomes, with maximum benefits occurring at age 3.81 years. Results did not differ significantly depending on the person implementing the intervention. However, significantly larger effect sizes were observed in studies with context-bound outcome measures. The findings of this meta-analysis highlight the need for further research examining specific components of interventions associated with greater and more generalized gains.

Keywords Autism spectrum disorders · Social communication · Early intervention · Meta-analysis

Table 1 Inclusion criteria and search terms

Inclusion criteria	Criteria	Corresponding search terms
Participants	Autism spectrum disorder, younger than 8	auti* OR ASD OR PDD OR Asperger
Intervention	Behavioral or developmental intervention, excluding pharmacological or dietary components	intervention OR therapy OR teach* OR treat*
Comparison	Treatment as usual, waitlist control, general information only, or referral to other services	assign* OR "control group" OR BAU OR "wait list" OR RCT OR random* OR quasi OR "treatment group" OR "intervention group" OR "group design" OR (before AND after) OR trial
Outcome	Social communication	"commun*" or "social interact*" or "social function*" or "joint attention" or "joint engagement" or "ESCS" or "CSBS"
Study Design	Group design study, including randomized control trial and quasi experimental design	
Language	English journals	La.exact(English)

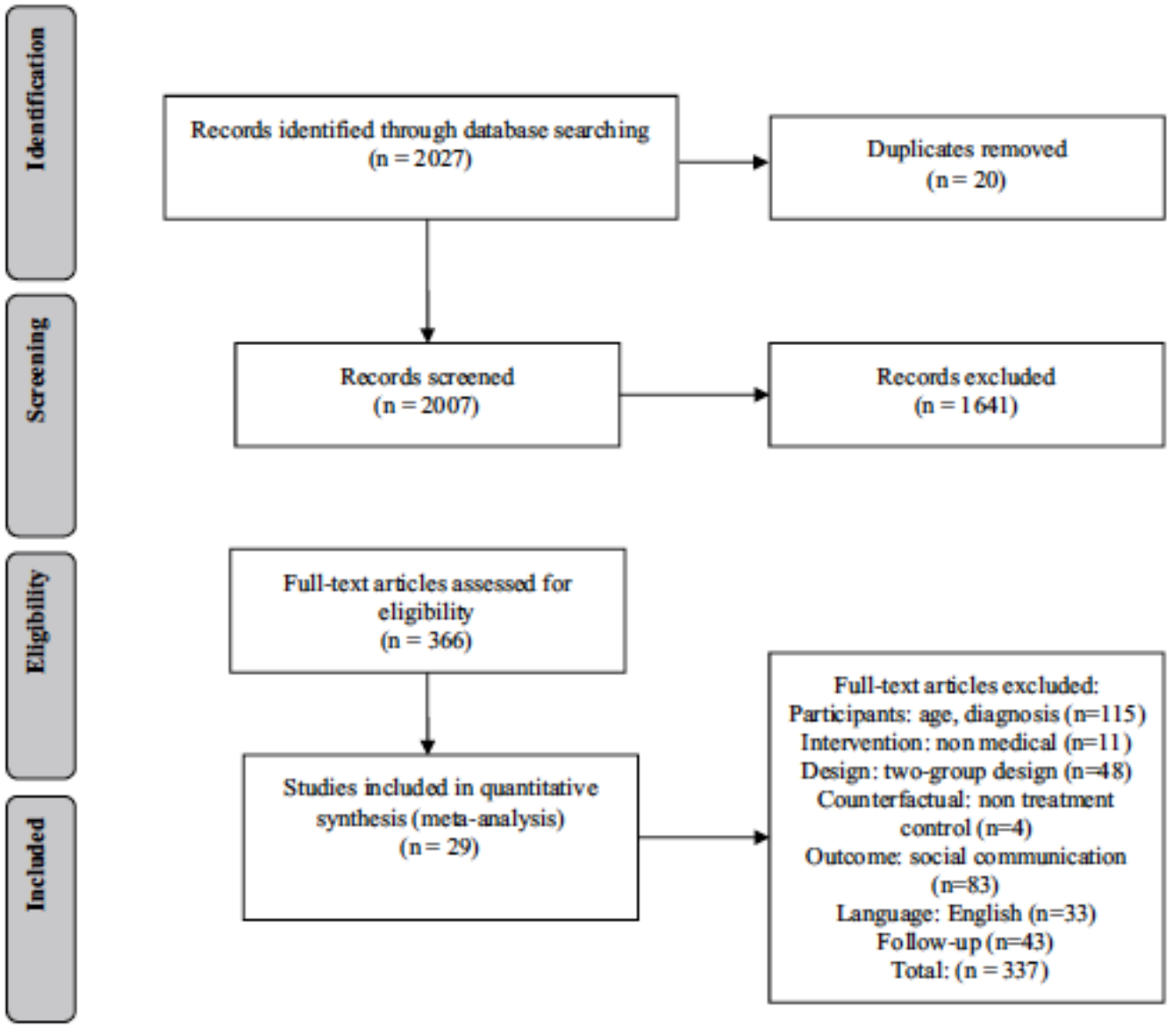
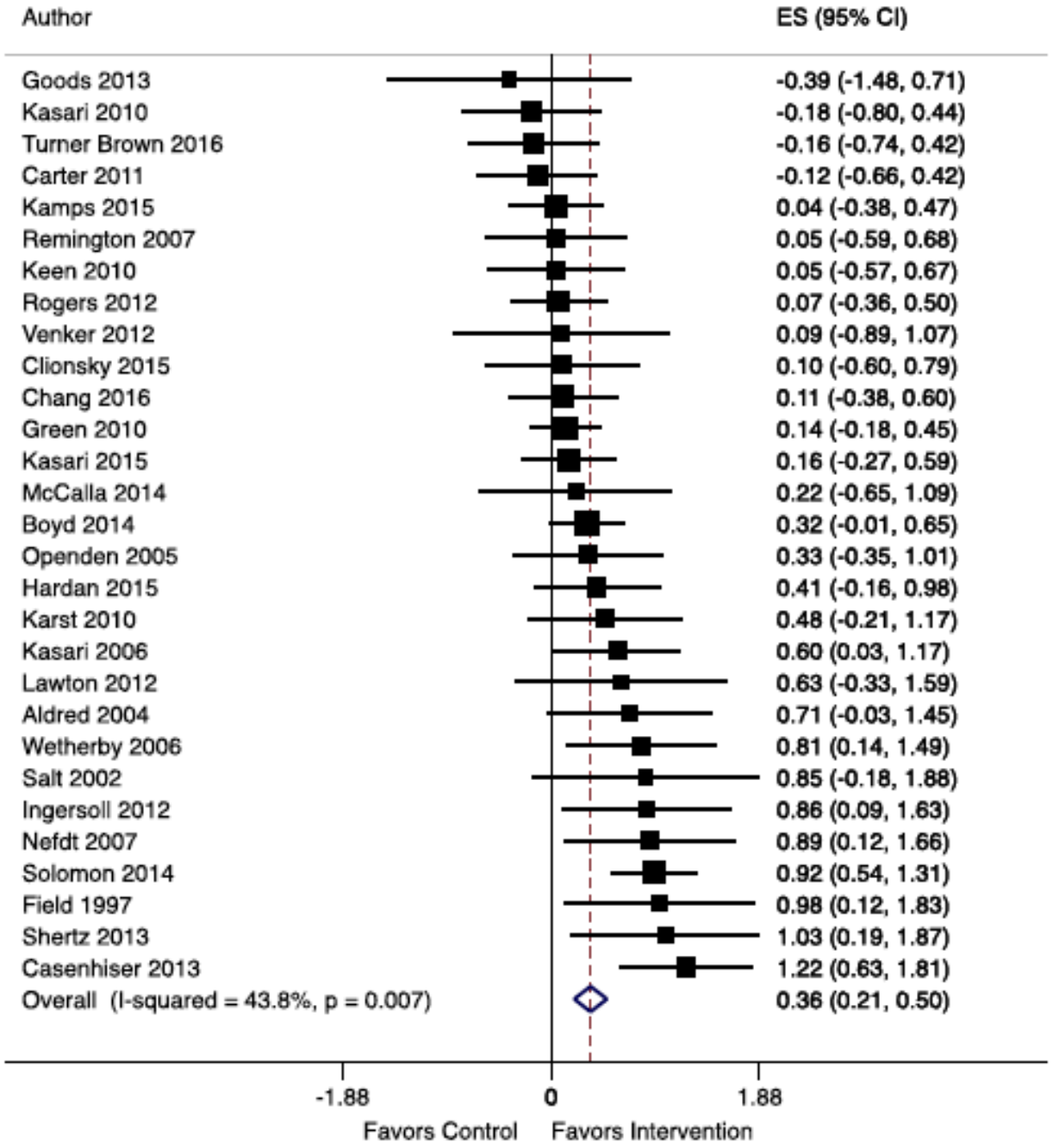


Fig. 1 PRISMA description of exclusion process. The process of screening and excluding articles is explained

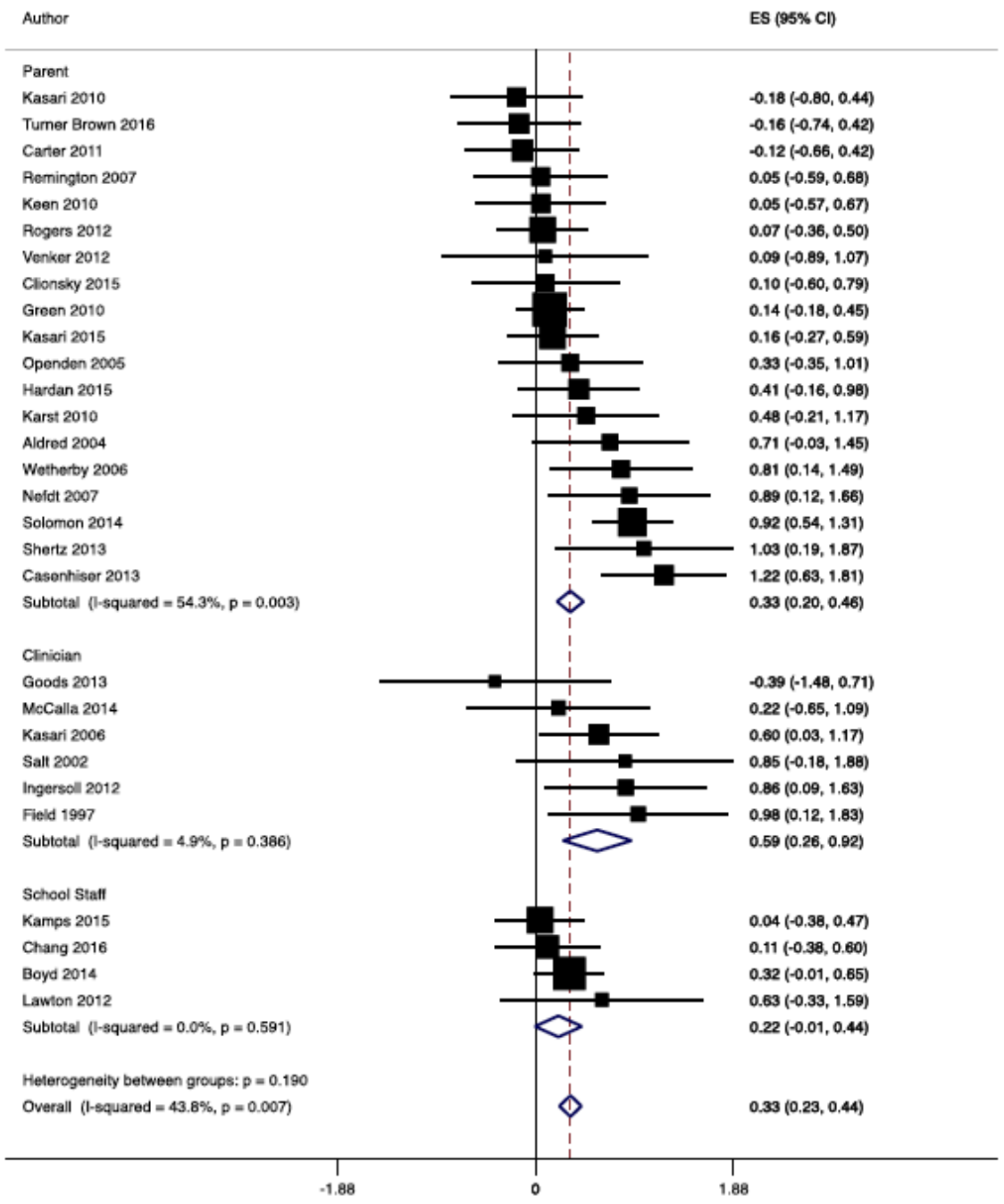
VISUAL OF THE RES (FOREST PLOT)

Fig. 2 Main effect of intervention on social communication outcomes. Random effect meta-regression of social communication outcomes from 29 included studies. Weighted effect sizes of included studies are represented by black boxes and standard errors are represented by black bars. Hedges' *g* effect sizes and confidence intervals are reported



HETEROGENEITY

-PARENT
-CLINICIAN
-SCHOOL STAFF

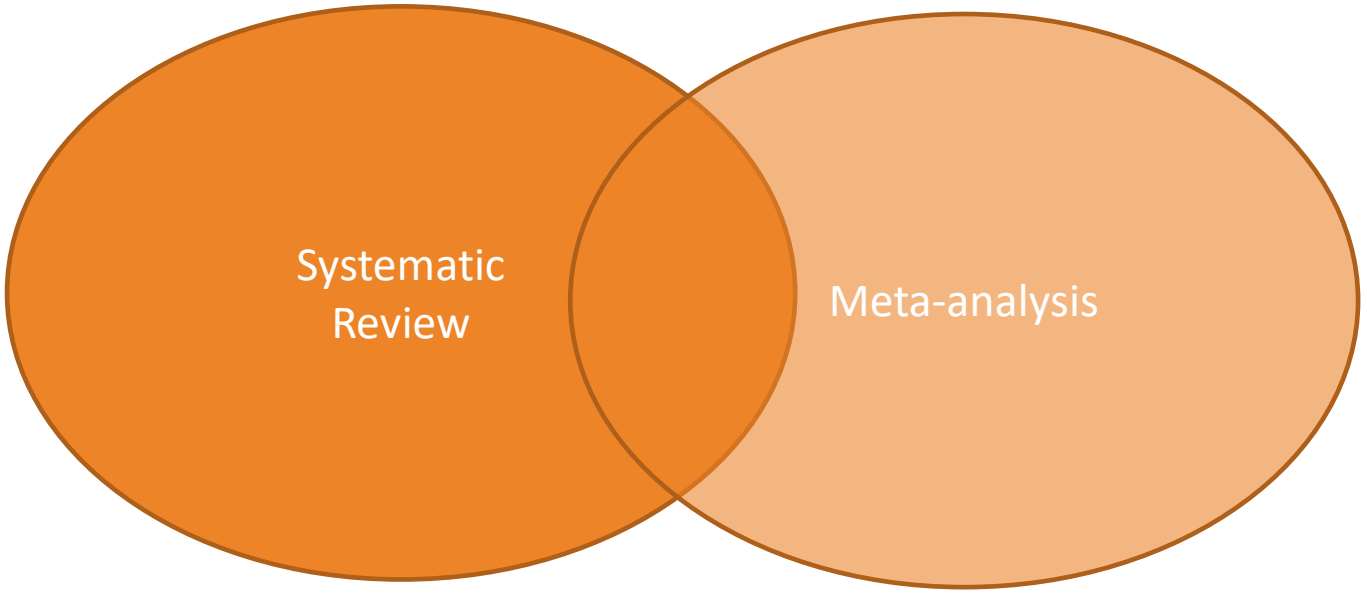


PARALLELS BETWEEN META-ANALYSIS AND PRIMARY DATA ANALYSIS

Meta-analysis	Primary data analysis
1. Descriptive analysis (examine study qualities, samples, and intervention characteristics)	1. Descriptive analysis (examine frequencies, distributions of variables)
2. Pool effect sizes across studies (weighted mean)	2. Estimate measures of central tendency for outcomes
3. Estimate heterogeneity in effect sizes	3. Estimate measures of variability in outcomes
4. Explain variability in outcomes	4. Explain variability in outcomes
5. Conduct sensitivity analysis to explore robustness of findings	5. Conduct sensitivity analysis to explore robustness of findings

REMEMBER

- Systematic reviews do not always include meta-analyses;
- Meta-analyses are not always based on a systematic review



AN INFORMED UNDERSTANDING IS KEY!

1. A working knowledge of meta-analysis
2. The ability to critically analyze the methodology to provide guidance for interpretation of findings.
    1. Policy
    2. Curriculum/Practice
    3. Research
3. Potential basis for a project
4. ***Responsible consumer of systematic review and meta-analysis***