

Meta-Analysis Workshop

Part 1: Introduction and Overview

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Overall Aim & Scope of the Workshop

- Conceptual introduction and overview into meta-analytics research methods
- Given the heterogeneous composition of participants:
 - No specific knowledge (beyond intro stats concepts) required
 - No programming skills / usage of specific programs required (e.g., R)

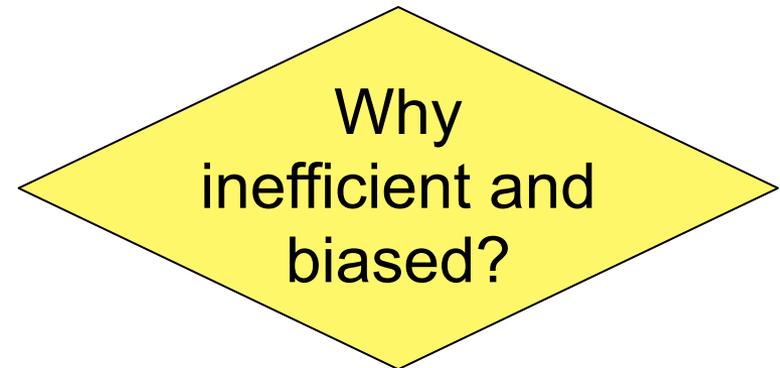
Evidence unclear?

	<i>r</i>	<i>N</i>	Sig.?	95% CI	
				-	+
Study 1	0,25	30	n.s.	-0,13	0,63
Study 2	-0,18	40	n.s.	-0,50	0,14
Study 3	0,41	50	*	0,12	0,70
Study 4	0,09	60	n.s.	-0,17	0,35
Study 5	0,28	70	*	0,04	0,52
Study 6	0,32	80	*	0,10	0,54
Study 7	0,11	90	n.s.	-0,10	0,32
Study 8	0,31	100	*	0,11	0,51

$r = .22$ (.13/.30); $Q = 11.45$, $df = 7$, $p = .13$

Non-Meta-Analytic Synthesis of Evidence

- Narrative Reviews
- Vote-Counting
- Stouffer-Method (p-value aggregation)



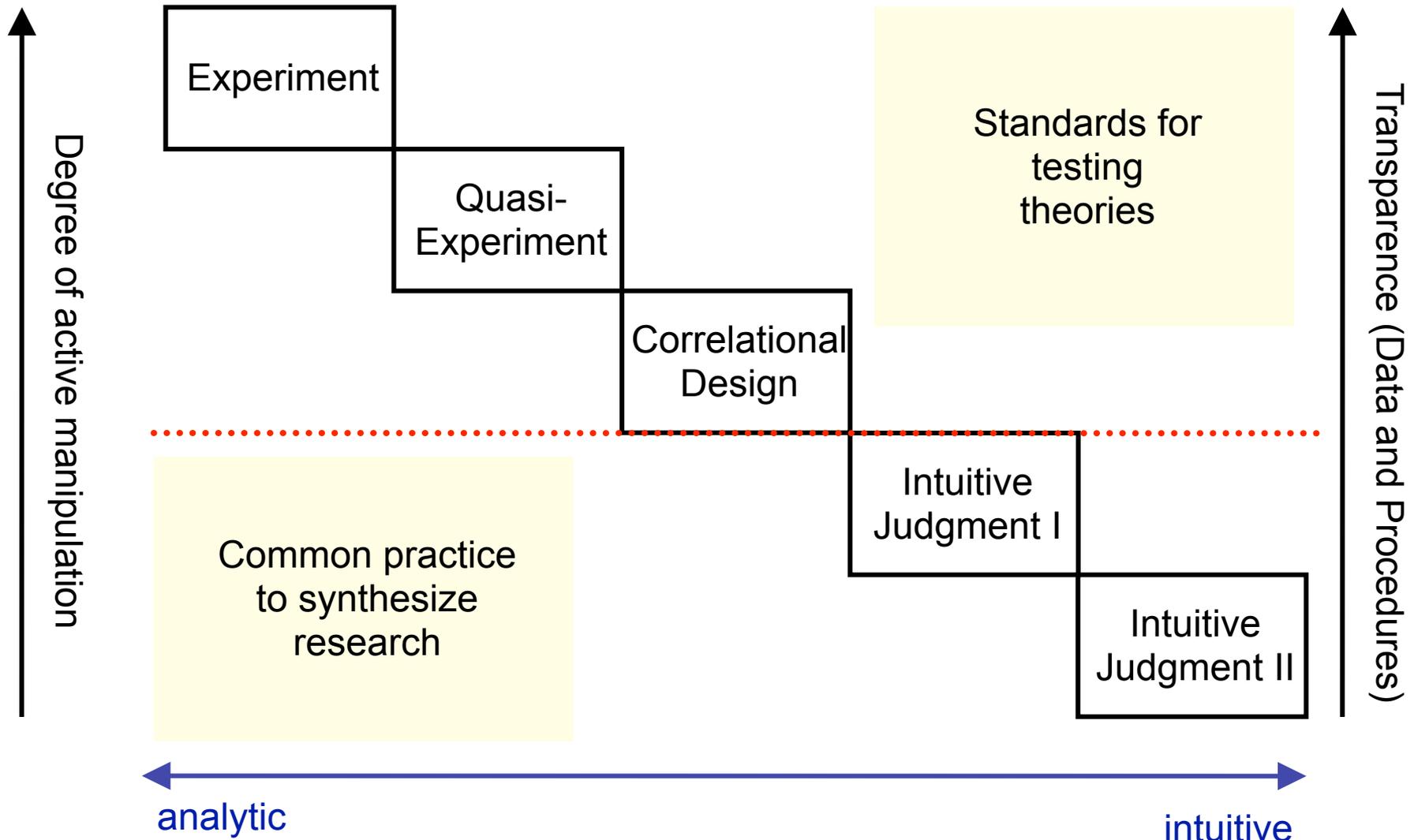
$$Z_s = \frac{\sum_{i=1}^k z_{p(i)}}{\sqrt{k}}$$

z-transformed p-values
of research finding i

k No of research
findings

Proposed by Stouffer et al. (1949), used by Rosenthal (1979) to compute his version of the 'fail-safe-N'.

Theory Testing vs Research Synthesis



Brief History

1904: Karl Pearson

1932: Ronald A. Fisher

1952 f.: Hans Eysenck

1970-er f.: 'Explosion' of (partly contradictory) empirical studies

1976 f.: Gene Glass coined the term „meta-analysis“, parallel development of meta-analytic models by:

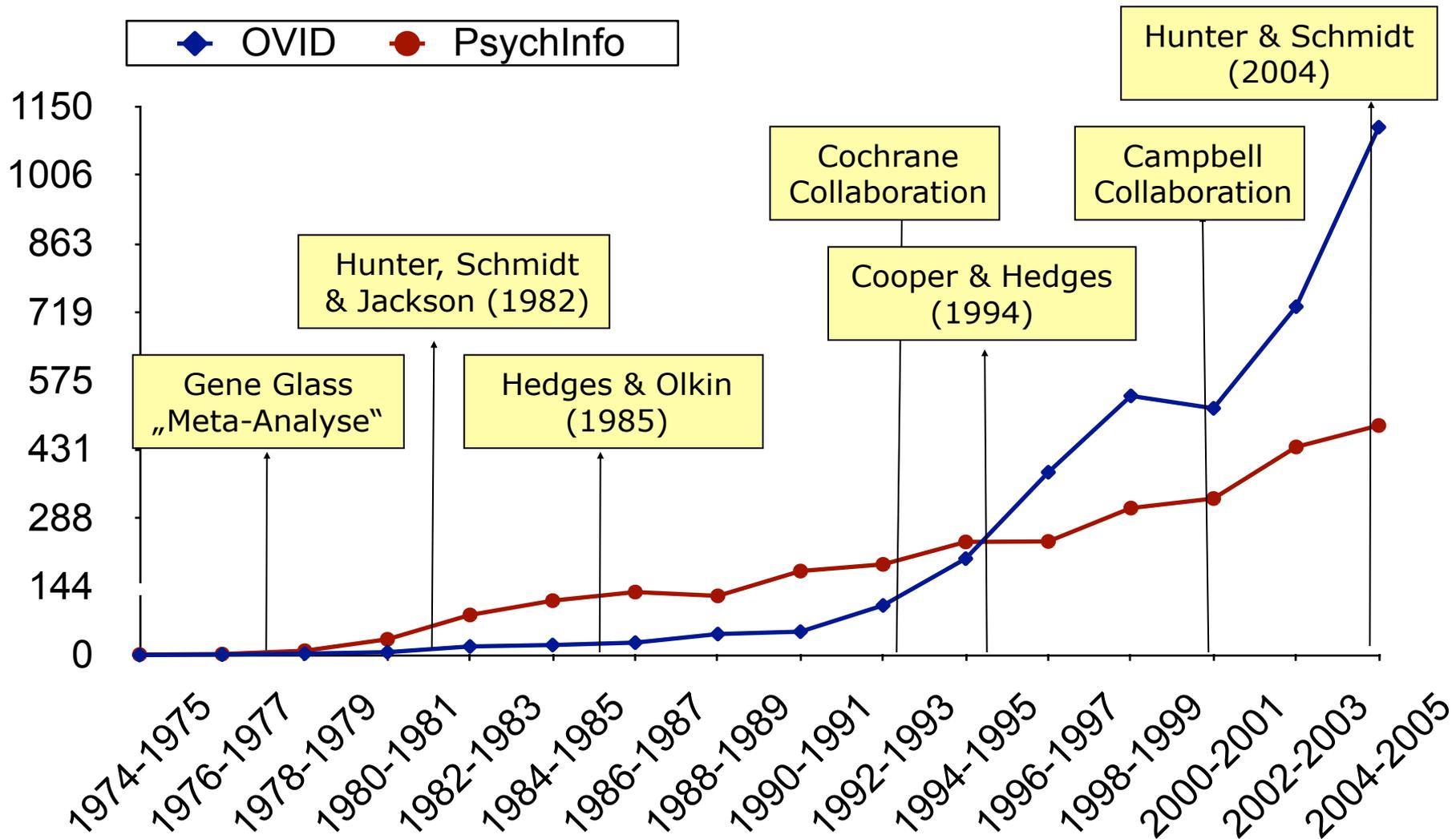
- Jack Hunter und Frank Schmidt
- Robert Rosenthal
- Thomas Chalmers
- Archibald Cochran

1980 ff.: Institutionalisation and first textbooks

1993: Cochrane Collaboration established

2000: Campbell Collaboration established

No of Published Meta-Analyses by Year



Impact of Meta-Analyses

Nissen, S. E., & Wolski, K. (2007). Effect of Rosiglitazone on the risk of myocardial infarction and death from cardiovascular causes. *New England Journal of Medicine*, 356, 2457-2471.

The NEW ENGLAND
JOURNAL *of* MEDICINE

ESTABLISHED IN 1812

JUNE 14, 2007

VOL. 356 NO. 24

Effect of Rosiglitazone on the Risk of Myocardial Infarction
and Death from Cardiovascular Causes

Steven E. Nissen, M.D., and Kathy Wolski, M.P.H.

Impact of Meta-Analyses

- 1.43 times higher risk of myocardial infarction in treated groups ($p = .03$)
- 1.64 times higher risk of death from cardiovascular causes ($p = .06$)
- article published online on May 21, 2007

Impact of Meta-Analyses

GlaxoSmithKline plc (ADR) (Public, NYSE:GSK) - [Add to Portfolio](#) - [Discuss GSK](#)

52.35

-0.40 (-0.76%)

Delayed: 02:01PM ET

Compare ▾

Settings ▾

Open: 52.53

High: 52.66

Low: 52.33

Vol: 803,900.00

Mkt Cap: 149.46B

52Wk High: 59.98

52Wk Low: 50.58

Avg Vol: 3.40M

P/E: 13.98

F P/E: 11.66

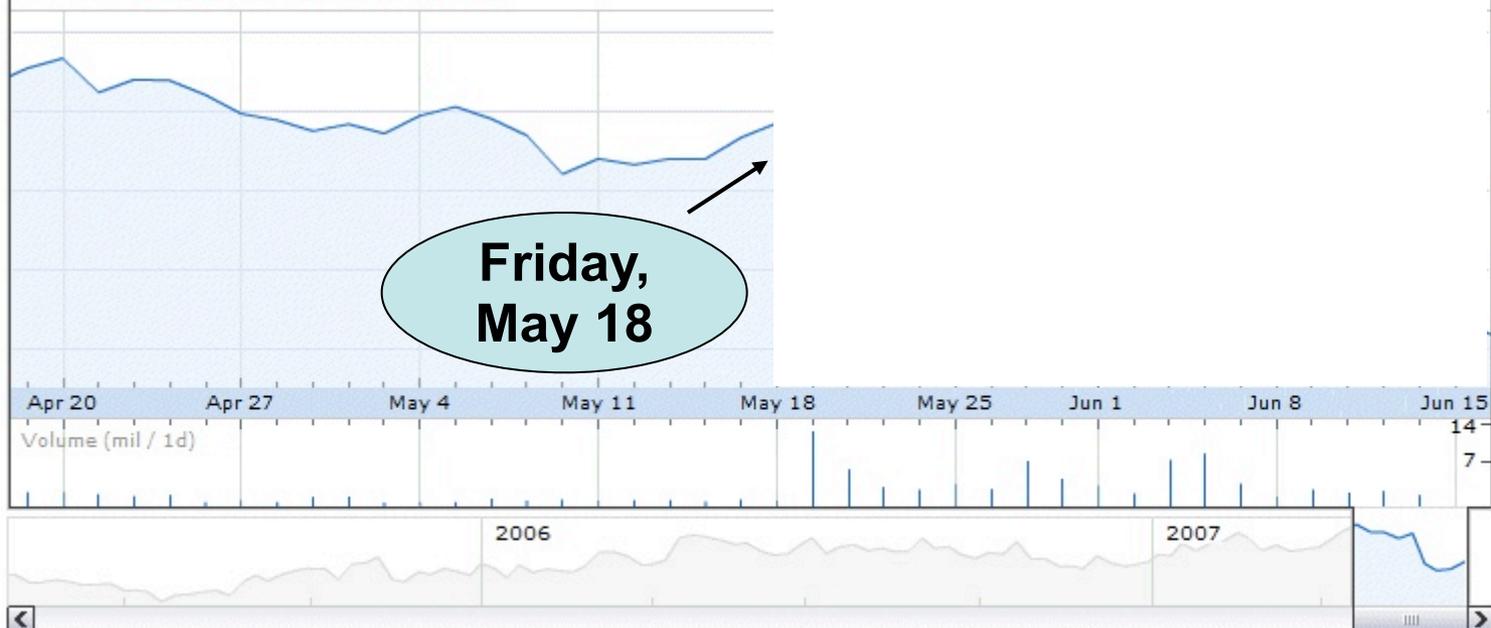
Beta: 0.19

EPS: 3.74

[Historical prices](#)

Charts can now display extended hours trading - [Learn more](#) | [Settings](#)

Zoom [1d](#) [5d](#) [1m](#) [3m](#) [6m](#) [YTD](#) [1y](#) [5y](#) [10y](#) [Max](#)



Tip: You can drag the chart.

NYSE data delayed by 20 min. - [Disclaimer](#)

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Agenda

- **Core Concepts and Prerequisites**
- Meta-Analysis: Conceptual Basics
- HO-Approach Illustrated
- HS-Approach Illustrated
- Recent Trends (Selection)
- Associations
- Recommended Textbooks
- Web-Resources

Core Concepts and Prerequisites I

- Effect size (ES)?
- Sampling distribution?
- Sampling error vs standard error?
- Computation of standard errors for different effect size estimates?
- Standard error of the effect size estimate: $SE(i)$
= standard deviation of the ES sampling distribution
- **Important** to separate from a meta-analytic concept introduced later: $SE(ES)$
= standard error of the *MEAN effect size estimate*
= standard error of the mean effect size estimate distribution

Core Concepts and Prerequisites II

Fundamentals of inferential statistics and hypothesis testing:

H_0 kept, if $|\text{Test Statistic}| \leq (\text{critical value})$
 H_0 rejected, if $|\text{Test Statistic}| > (\text{critical value})$

Test Statistic =
 (Size of Effect) * (Size of Study)

Synthesized by MA

Effect
 sizes
 (ES): *Types?*

Used for weighting
 indiv. ES: *Why?*

Supplement: Cooper_Hedges_1994_Table16_1.pdf

Core Concepts and Prerequisites III

- **Systematic biases** > reduce/attenuate validity aspects of a research design, such as (according to Cook & Campbell, 1979; see also Shadish, Cook & Campbell, 2002) :
 - internal validity
 - external validity
 - time
 - subjects/persons
 - situations/settings
 - construct validity
 - statistical conclusion validity
- **Unsystematic biases** > measurement error(s) in iVs and/or dVs > affect reliability > underestimation of 'true' effect(s)

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Meta-analysis : Basics

- Generic term, encompassing a comprehensive set of specific research synthesis/analysis techniques and approaches.
- **Overall process** of systematically retrieving, synthesizing, and analyzing the results of thematically related studies.
- Effect sizes are being synthesized and analysed, such as:
 - measures of association ("*r family*")
 - mean differences ("*d family*")
 - ratios and ratio differences
 - Effect sizes for dichotomous measures, such as relative risks, odds ratio and derivatives.

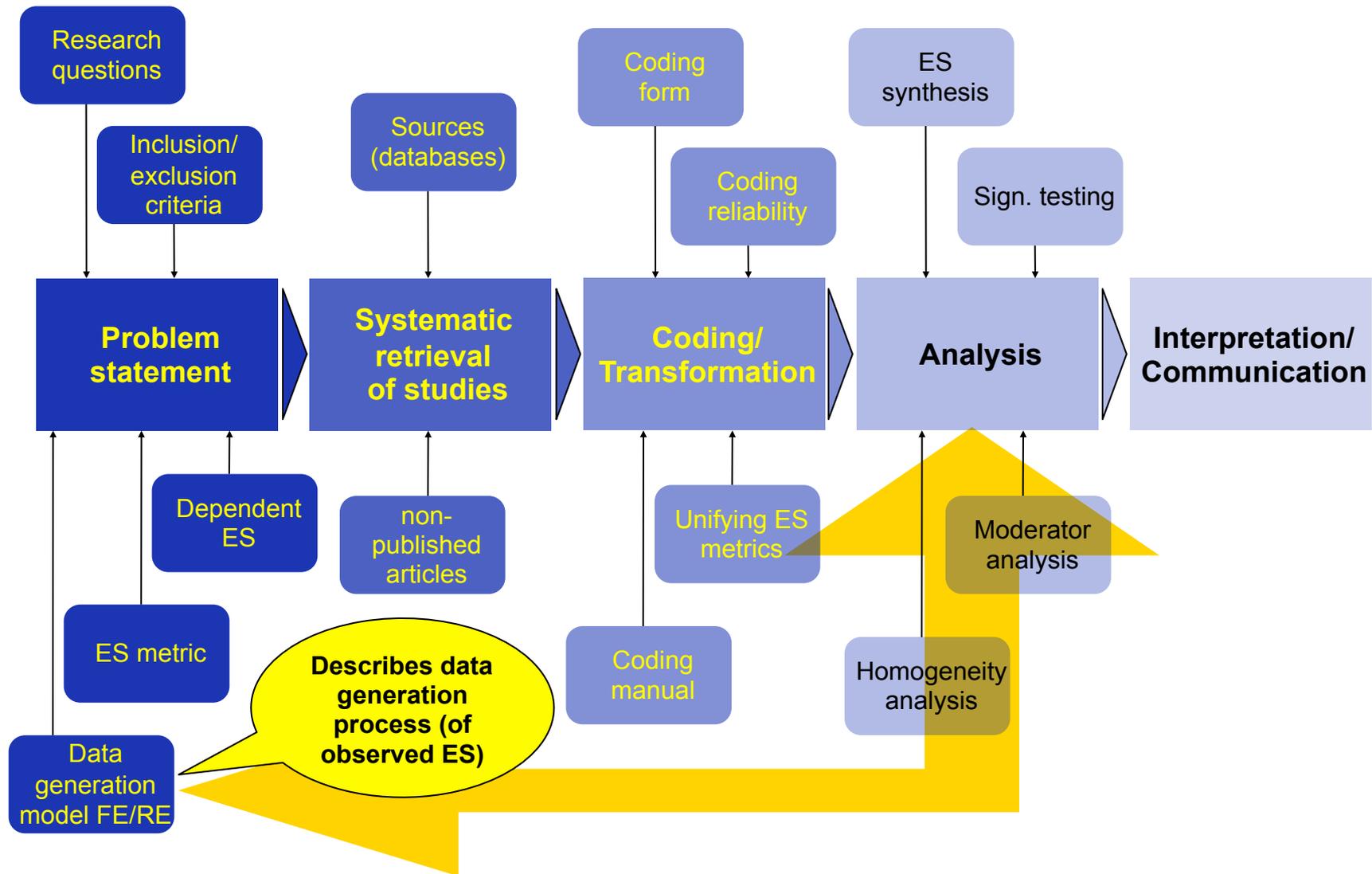
Meta-Analysis : Objectives

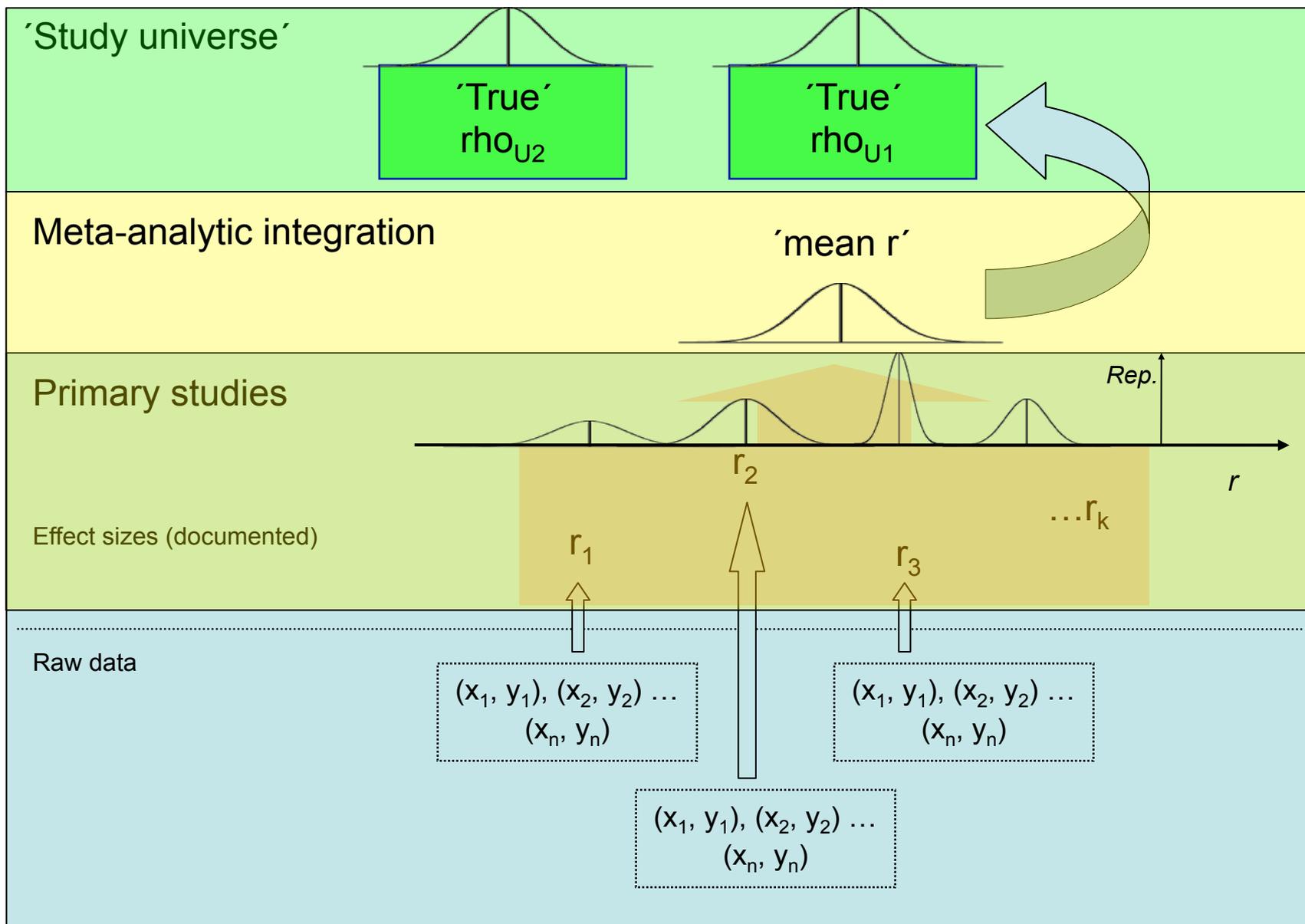
Estimation of a 'true' effect, characterized by a higher precision and validity compared to primary studies.

Evidence-based ...

- ... description of a thematic area (also to identify *gaps in research*),
- ... theory testing,
- ... theory development/refinement,
- ... conclusions on the benefit / harm of an intervention.

Generic Procedure





Two Common Approaches (in Psychology)

- "HO"-Meta-Analysis (Hedges/Olkin)
 - Data generation model: True effects are confounded by (up to two different types of) sampling error
 - Approx. 75% of all meta-analyses published in *Psychological Bulletin* are HO meta-analyses (fixed effects model)
- Psychometric MA (Hunter/Schmidt)
 - Data generation model : 'True' effects are attenuated by sampling error and systematic artifacts
 - Approx. 80% of all meta-analyses in IO Psychology
- No(t) (more) popular in Psychology:
Glass meta-analysis, p-value aggregation according to Rosenthal, Bayesian approaches

Agenda

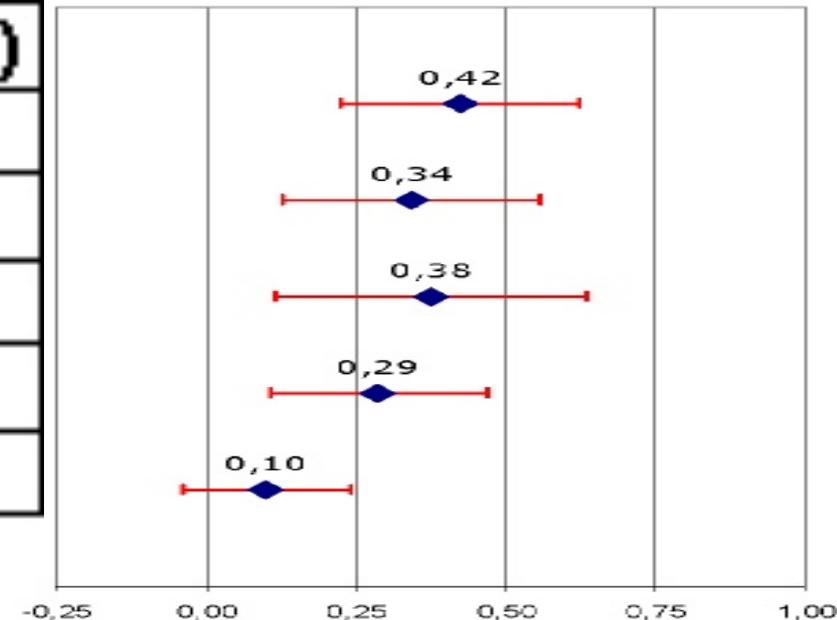
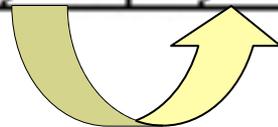
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HO-Meta-Analysis: Synthesis & Analysis

Step 1:
Z[r] Transformation

$$ES_i = Zr_i = \frac{1}{2} \ln \left[\frac{1 + r_i}{1 - r_i} \right]$$

	N	r	Z[r]	SE(Z[r])
S 1	100	0,40	0,42	0,10
S 2	86	0,33	0,34	0,11
S 3	60	0,36	0,38	0,13
S 4	120	0,28	0,29	0,09
S 5	200	0,10	0,10	0,07



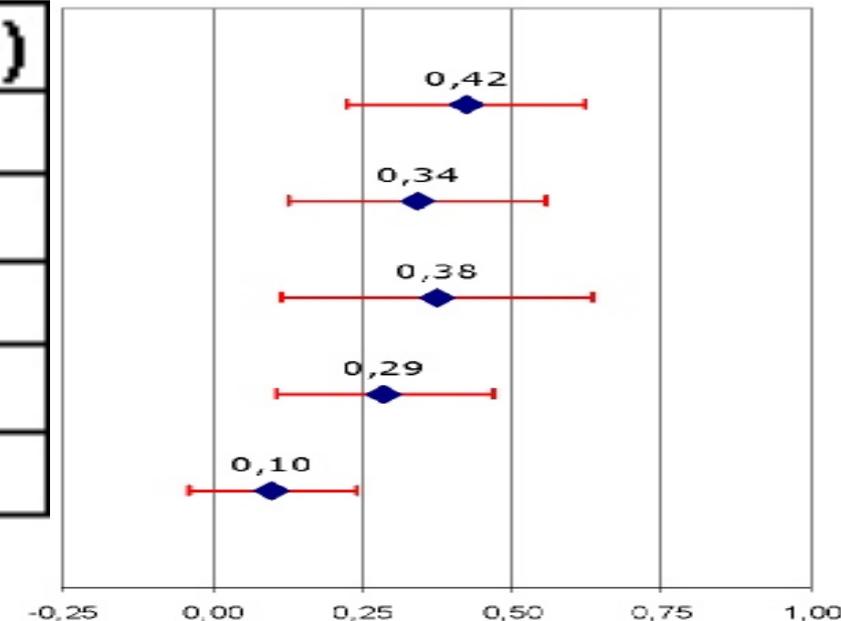
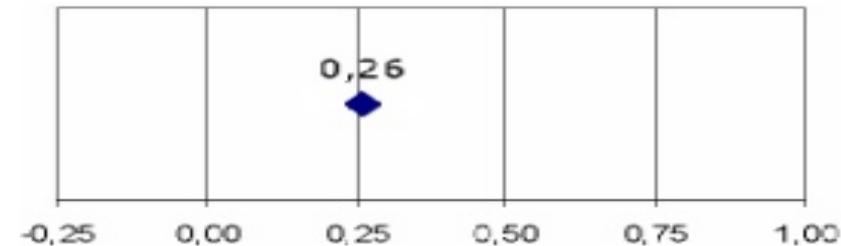
HO-Meta-Analysis: Synthesis & Analysis

$$\overline{ES} = \frac{\sum_{i=1}^k (w_i \times ES_i)}{\sum_{i=1}^k w_i} \quad w_i = \frac{1}{SE_i^2}$$

$$SE_i = \sqrt{\frac{1}{n-3}}$$

	N	r	Z[r]	SE(Z[r])
S 1	100	0,40	0,42	0,10
S 2	86	0,33	0,34	0,11
S 3	60	0,36	0,38	0,13
S 4	120	0,28	0,29	0,09
S 5	200	0,10	0,10	0,07

Step 2:
Weighted Synthesis



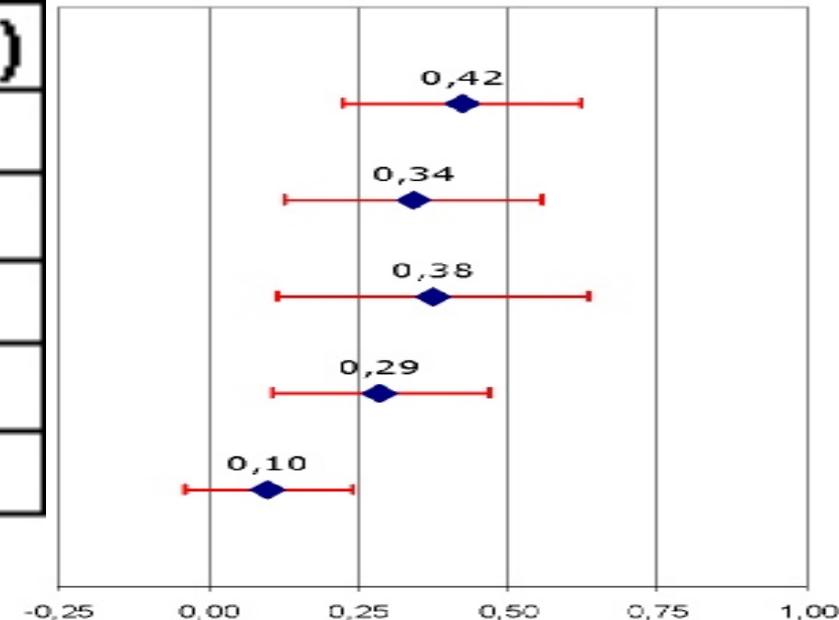
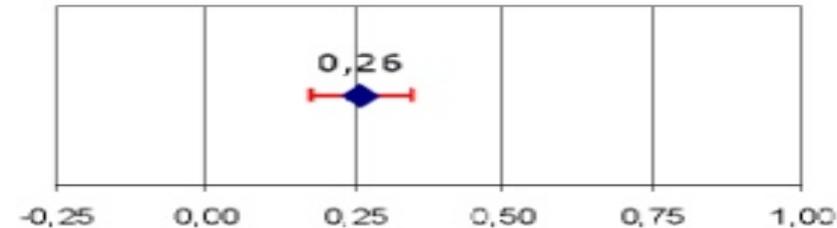
HO-Meta-Analysis: Synthesis & Analysis

$$\overline{ES} \pm 1.96(SE_{\overline{ES}})$$

$$SE_{\overline{ES}} = \sqrt{\frac{1}{\sum_{i=1}^k w_i}}$$

	N	r	Z[r]	SE(Z[r])
S 1	100	0,40	0,42	0,10
S 2	86	0,33	0,34	0,11
S 3	60	0,36	0,38	0,13
S 4	120	0,28	0,29	0,09
S 5	200	0,10	0,10	0,07

Step 3: Significance Testing



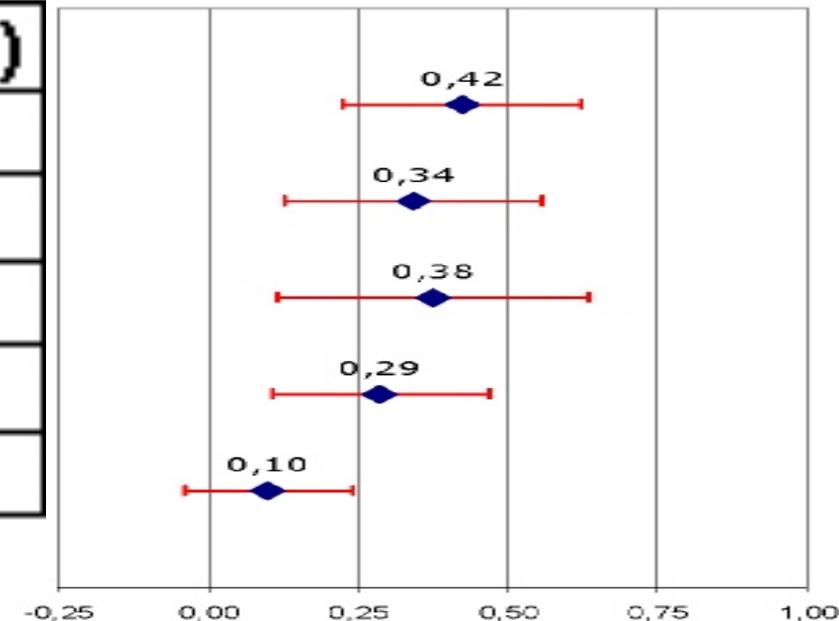
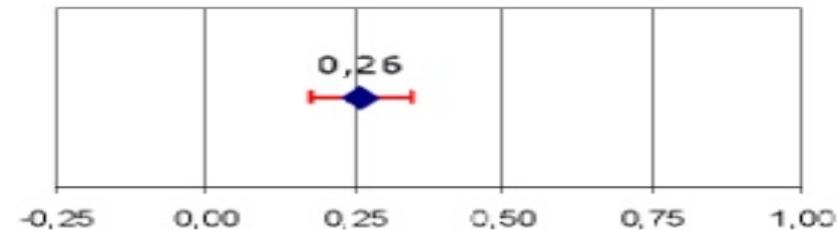
HO-Meta-Analysis: Synthesis & Analysis

$$Q_T = \sum_{i=1}^k \frac{(ES_i - \overline{ES})^2}{SE_i^2} = \sum_{i=1}^k w_i (ES_i - \overline{ES})^2$$

Q_T is approx. χ^2 distributed with $df = k-1$

	N	r	Z[r]	SE(Z[r])
S 1	100	0,40	0,42	0,10
S 2	86	0,33	0,34	0,11
S 3	60	0,36	0,38	0,13
S 4	120	0,28	0,29	0,09
S 5	200	0,10	0,10	0,07

Step 4: Homogeneity Analysis



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Psychometric MA: Data Generation Model

Attenuation model

$$\rho_o = A * \rho$$

$\rho_o = r_o + e$
 $E(e) = 0$

$$A = \prod_{j=1}^m a_j$$

„True“
non-attenuated
correlation

Examples for a(j):

a(1,2): Measurement errors (att. reliability),
a(3,4): Artificial dichotomization.

Psychometric MA : Procedure

- Disattenuation model:

$$\rho = \frac{\rho_o}{A} = \frac{r_o}{A} + \frac{e}{A} = r_c + e_c$$

- Integration model:

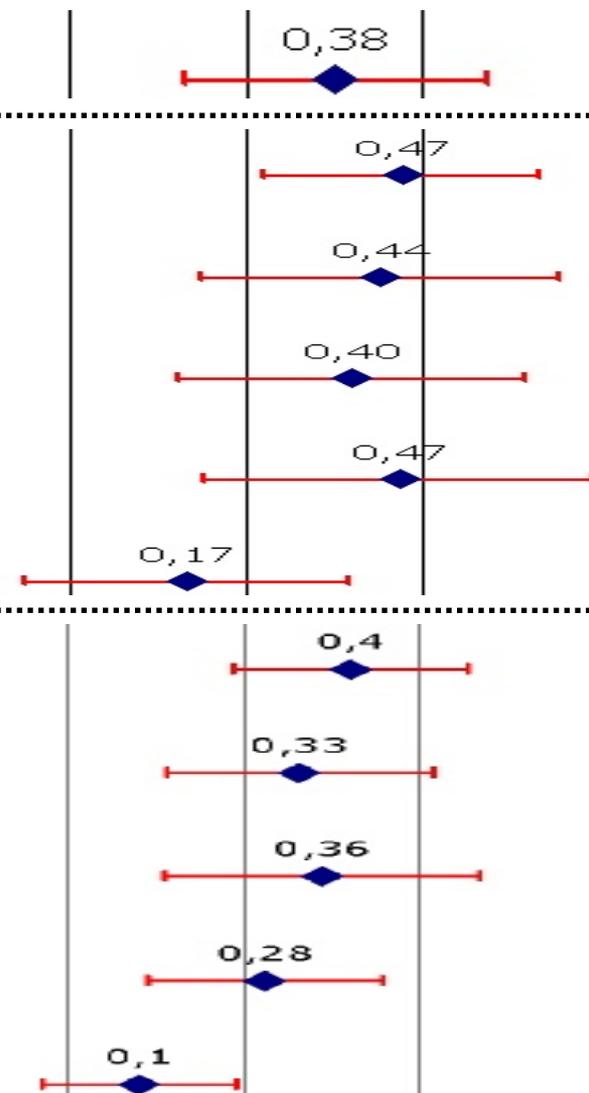
$$\overline{r_c} = \frac{\sum_{i=1}^k (w_i * r_{c(i)})}{\sum_{i=1}^k w_i} \quad \overline{SE_c^2} = \frac{\sum_{i=1}^k (w_i * SE_{c(i)}^2)}{\sum_{i=1}^k w_i} \quad w_i = N_i * A_i^2$$

- 75% rule for homogeneity 'testing' (rule of thumb)

Psychometric MA : Synthesis

	A	r[c]	SE(r[c])
S 1	0,85	0,47	0,10
S 2	0,75	0,44	0,13
S 3	0,90	0,40	0,13
S 4	0,60	0,47	0,14
S 5	0,60	0,17	0,12

	N	r[o]	SE(r[o])
S 1	100	0,40	0,08
S 2	86	0,33	0,10
S 3	60	0,36	0,11
S 4	120	0,28	0,08
S 5	200	0,10	0,07



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Discussion : „Evergreens“

- HO- versus psychometric approach?
- Incommensurability:
 - Multiple (general) vs single (narrow) criteria
 - Incommensurability of aggregated constructs (apple-and-oranges problem).
 - Incommensurability of corrected versus uncorrected estimates ('statistical fruit salad problem')
- Selective publication?
File-drawer problem and publication bias
- Quality of primary studies?
- Dependent effect sizes?

Some Recent Trends

- Cumulative and meta-meta-analyses
- Multivariate meta-analyses (MA-SEM):
 - How to synthesize correlation matrices?
 - How to test homogeneity of correlation matrices?
 - Uneven No of available effect sizes?
 - Which N to use when doing SEM on synthesized matrices?
 - Correlation versus covariance as input for SEM?
- Merging SEM and Meta-Analysis

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Associations: Cochrane Collaboration

Das Deutsche Cochrane Zentrum – Willkommen auf unseren Webseiten

http://www.cochrane.de/de/index.htm

Cochrane entities > DCZ >

Das Deutsche Cochrane Zentrum

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Willkommen auf unseren Webseiten

Das Deutsche Cochrane Zentrum (DCZ) repräsentiert die [Cochrane Collaboration](#), ein internationales Netzwerk von Wissenschaftlern und Ärzten, das sich an den Grundsätzen der [evidenzbasierten Medizin](#) orientiert. Das zentrale Ziel ist die Verbesserung der wissenschaftlichen Grundlagen für Entscheidungen im Gesundheitssystem. Dieses Ziel wird vor allem durch die [Erstellung, Aktualisierung und Verbreitung systematischer Übersichtsarbeiten \(systematic reviews\)](#) zur Bewertung von Therapien erreicht. Diese werden in der Datenbank Cochrane Library online veröffentlicht.

Auf diesen Webseiten möchten wir alle Interessierten über unsere Arbeit informieren und Akteure im Gesundheitswesen Hilfestellungen bieten. **Top Ressourcen:**

- Systematische Übersichtsarbeiten: [The Cochrane Library](#)
- Was ist [EBM?](#) [Literatursuche](#) und [Literaturbewertung](#)
- [Ressourcen](#) für Reviewer
- Unsere [Workshops](#)
- [Patienteninformation](#)
- [FAQs](#) - Häufig gestellte Fragen
- [Audio-Zusammenfassungen](#) (podcasts) von Reviews aus der Cochrane Library

Aktuell:

 **Joint Colloquium of the Cochrane & Campbell Collaborations**
18-22 Oct 2010
Bringing Evidence-Based Decision-Making to New Heights

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Join the discussion

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Latest: Annual Continental European Cochrane Entities Meeting - Perugia, Italy

Welcome Practitioners, providers & policymakers Patients Authors & researchers Journalists & bloggers I am here to...

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We are world leaders in evidence-based health care

Our contributors work together to produce systematic assessments of healthcare interventions, known as [Cochrane Reviews](#), which are published online in [The Cochrane Library](#). Cochrane Reviews are intended to help providers, practitioners and patients make informed decisions about health care, and are the most comprehensive, reliable and relevant source of evidence on which to base these decisions.

"The Cochrane Collaboration is an enterprise that rivals the Human Genome Project in its potential implications for modern medicine."
- The Lancet

Browse free summaries

Browse by topic:

deutsch español

Featured Reviews (What's this?):

- [Combined chiropractic interventions for low-back pain](#)
- [Self-monitoring and self-management of oral anticoagulation](#)

Cochrane in the News

[Health: best treatments](#)

[Smoking bans improve health and reduce heart attacks](#)

New article in the Guardian and BMJ's joint column 'Health: best treatments' discusses recent [Cochrane evidence on public smoking bans](#).

1 of 93 >> All news

Cochrane Multimedia

 **Podcasts from The Cochrane Library**

- News!** Listen to summaries of selected Reviews from Issue 4, 2010
- Watch slidecasts from the Singapore Colloquium
- More audio and video

Annual Colloquium

Associations: Campbell Collaboration

The Campbell Collaboration

http://www.campbellcollaboration.org/

THE CAMPBELL COLLABORATION

What helps? What harms? Based on what evidence?

News

Push for evidence-based teen pregnancy research

The Campbell review [Interventions Intended to Reduce Pregnancy-Related Outcomes Among Adolescents](#) highlighted the "relative dearth of evidence to judge the overall effectiveness of particular intervention strategies". So a recent US funding initiative is a very positive development.

[Read more...](#)

New Editor for the Education Group

The Campbell Collaboration announces the confirmation of Sandra Wilson as Editor of the Education Coordinating Group, Associate Director and a Senior Research Associate at the [Peabody Research Institute](#) at Vanderbilt University

[Read more...](#)

Commentary on "important" Campbell review

The US-based [National Center for Juvenile Justice](#) (NCJJ) has commented extensively on the recently published Campbell review [Formal System Processing of Juveniles: Effects on Delinquency](#).

[Read more...](#)

Spotlight Event

Joint Cochrane/Campbell Co-Colloquium: *"Bringing evidence-based decision making to new heights"*
18-22 October 2010
Keystone, Colorado, USA

Improving decision-making through systematic reviews on the effects of interventions within the areas of education, crime and justice, and social welfare.

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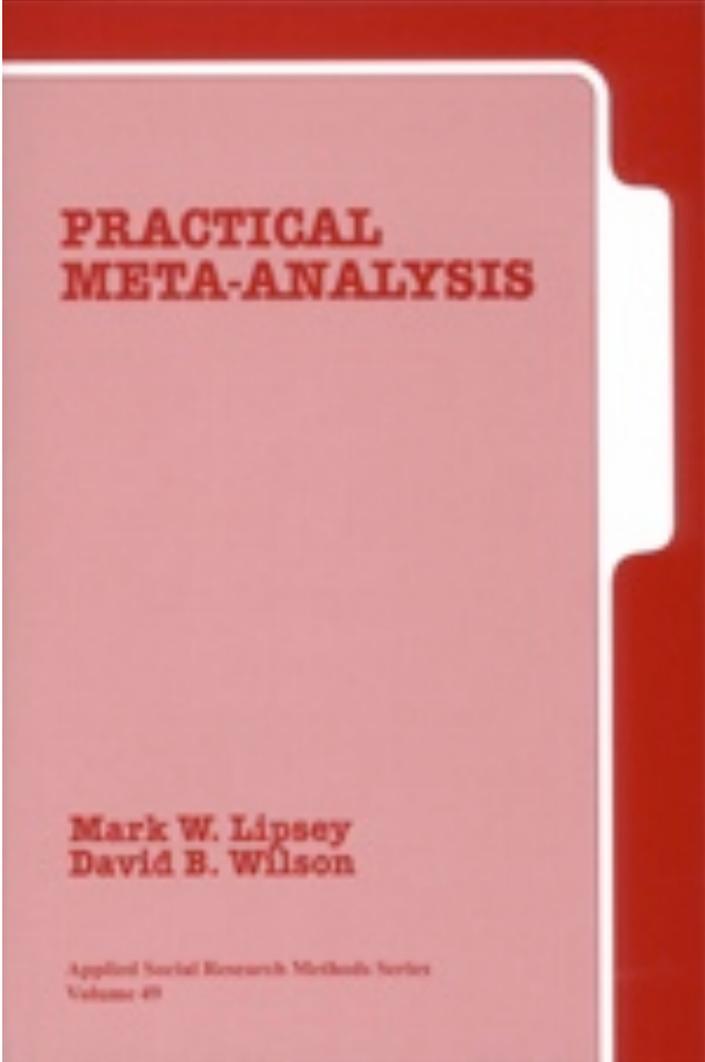
www.campbellcollaboration.org

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Lipsey & Wilson (2001)

Lipsey, M.W., & Wilson, D.B.(2001). *Practical Meta-analysis*. Thousand Oaks: Sage.

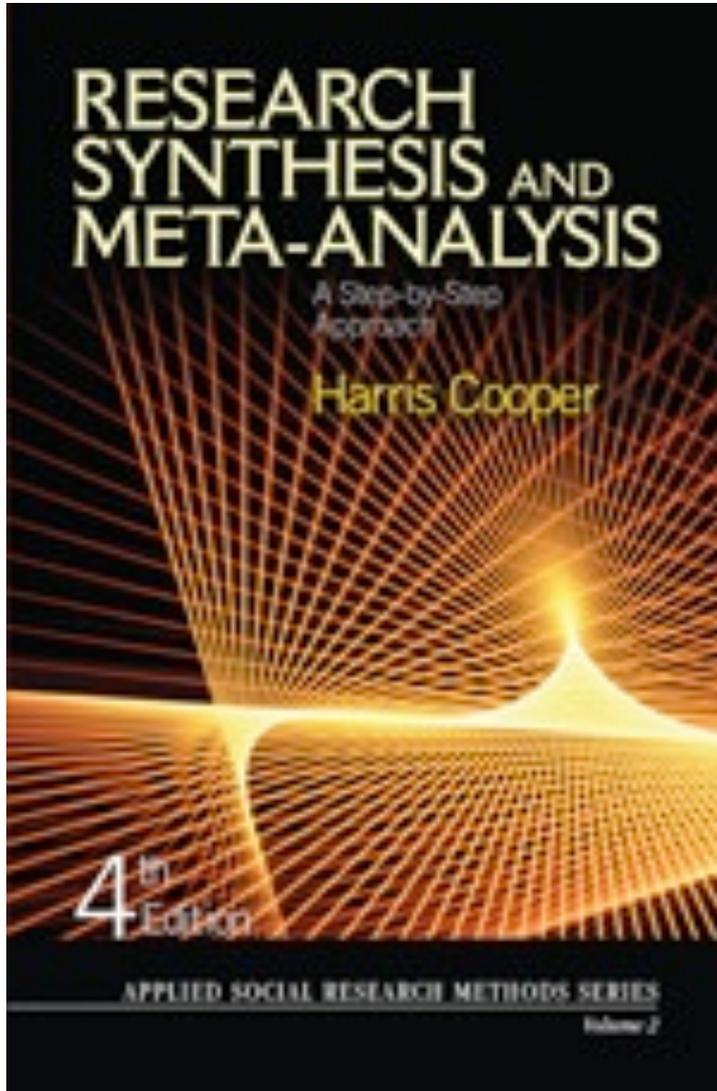


**PRACTICAL
META-ANALYSIS**

**Mark W. Lipsey
David B. Wilson**

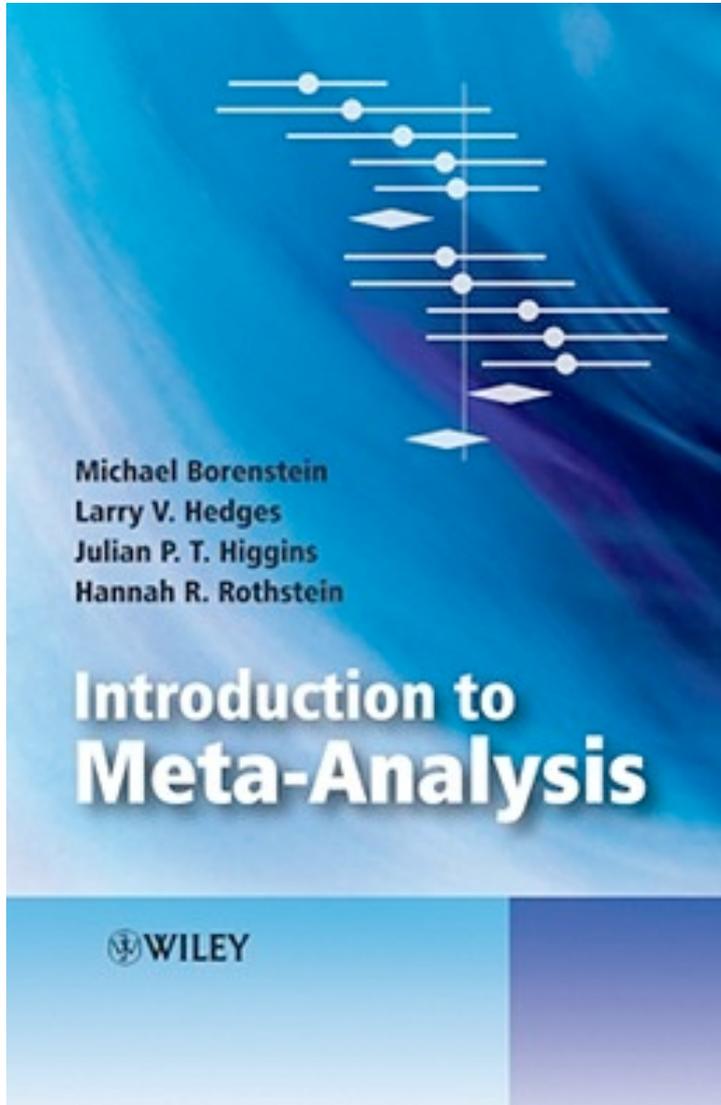
Applied Social Research Methods Series
Volume 49

Cooper (2010)



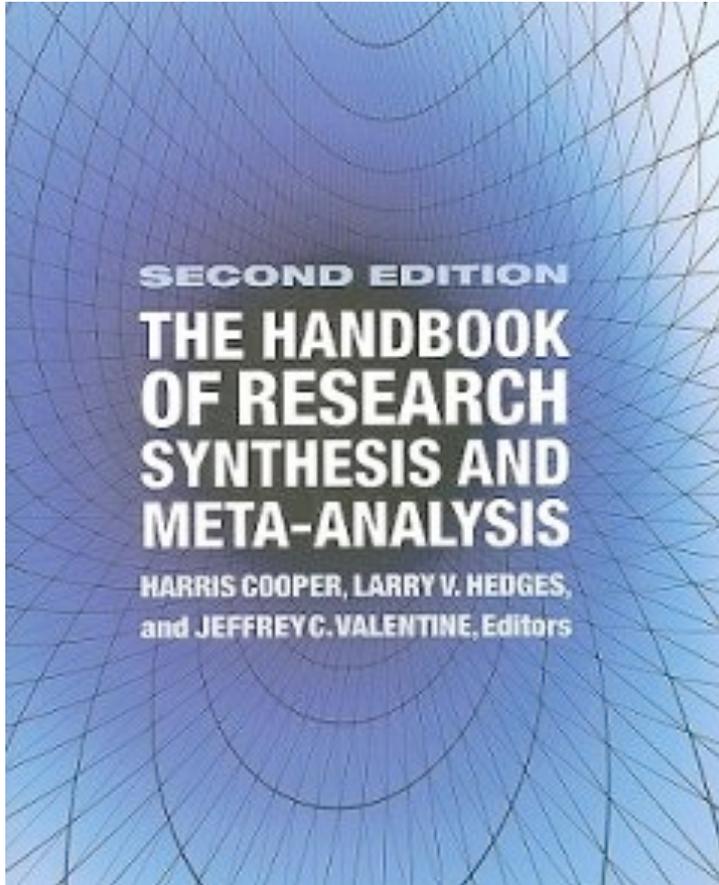
Cooper, H. (2010). *Research Synthesis and Meta-Analysis: A Step-by-Step Approach*. Thousand Oaks, CA: Sage.

Borenstein et al. (2009)



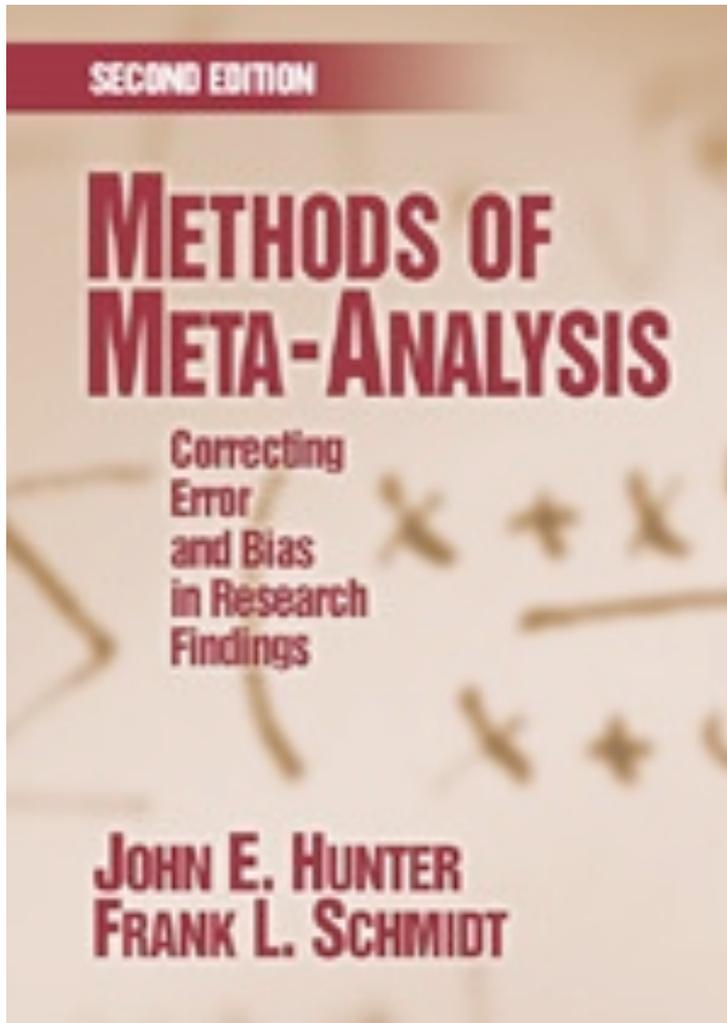
Borenstein, M., Hedges, L.V., Higgins, J.P.T, & Rothstein, H.R. (2009). *Introduction to Meta-Analysis*. Chichester, UK: Wiley.

Cooper, Hedges & Valentine (2009)



Cooper, H., Hedges, L.V., & Valentine, J.C. (Eds.) (2009). *Handbook of Research Synthesis (2nd ed.)*. New York: Russell Sage Foundation.

Hunter & Schmidt (2004)



Hunter, J. E., & Schmidt, F. L. (2004). *Methods of meta-analysis: Correcting error and bias in research findings (2nd ed.)*. Thousand Oaks, CA: Sage.

<http://www.um.es/metaanalysis/search.php>

The screenshot shows a web browser window with the address bar containing <http://www.um.es/metaanalysis/search.php>. The page header features the University of Murcia logo and name. A navigation menu includes links for INICIO, INFORMACIÓN, UTILIDADES Y SERVICIOS, ACTUALIDAD, AYUDA, and PERFIL. A search bar is located in the top right corner. The main content area is titled "The Meta-Analysis Unit Bibliographic Database" and "Database Search". It includes a sidebar with navigation links, a search form with fields for Author, Year, Title, and Source, and a "Search" button. Below the search form, there is a paragraph of text and a "top" link.

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Database Search

Find results:

with **all** of the words in:

Author:

Year:

Title:

Source:

with the **exact phrase**:

In this Database you can consult papers about the methodology of meta-analysis as well as meta-analytic reviews carried out in psychology, education, criminology, health sciences, etc.

You can combine keywords in title and/or source with an author and a year. Then, you can save the search result in a file or print it.

At present, our Database contains a total of **3921** records.

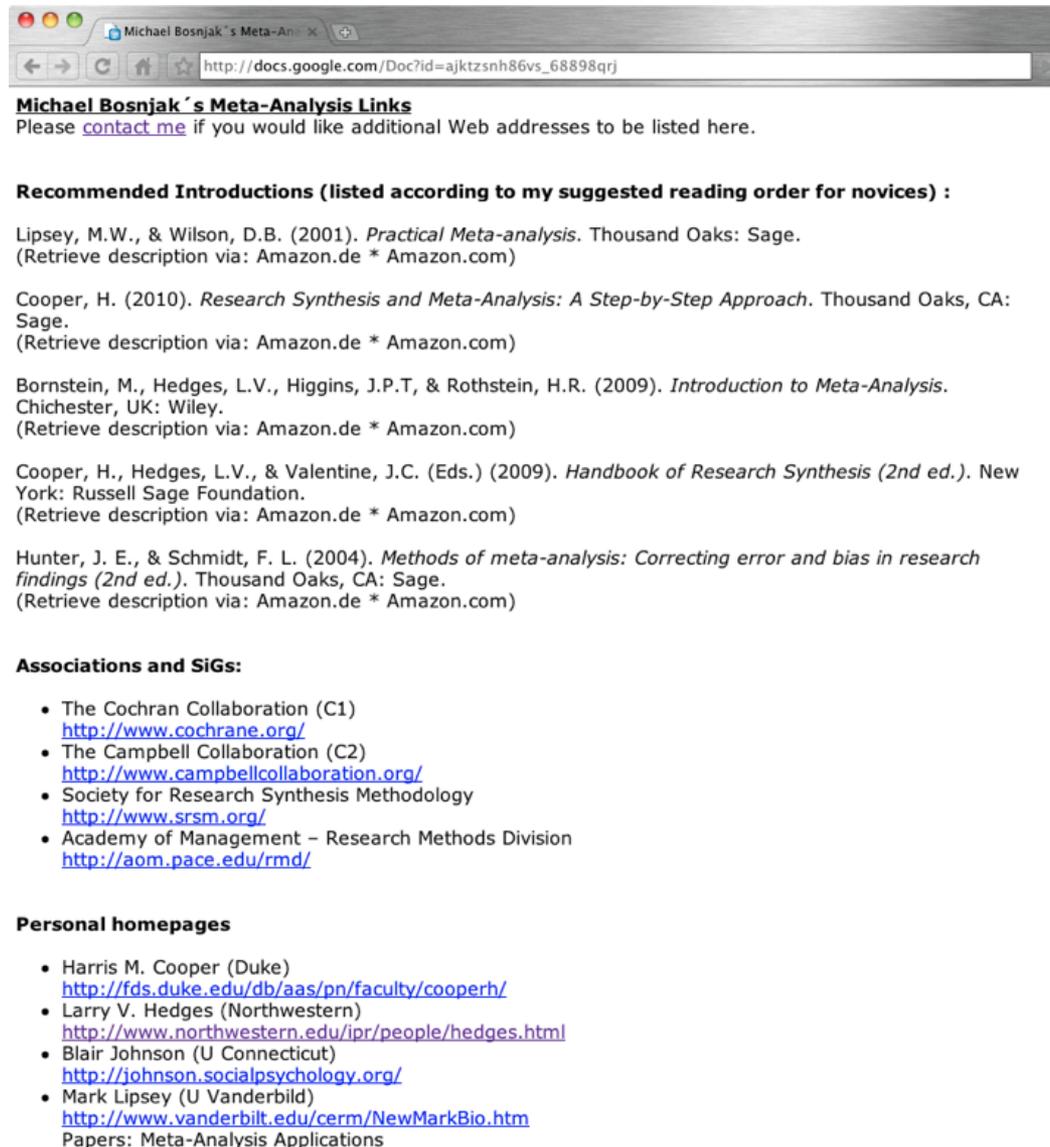
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Tlf: +34 868884114, Fax: +34 868883439, e-mail: jsmeca@um.es

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www.meta-analysis.eu



Michael Bosnjak's Meta-Analysis Links

Please [contact me](#) if you would like additional Web addresses to be listed here.

Recommended Introductions (listed according to my suggested reading order for novices) :

Lipsey, M.W., & Wilson, D.B. (2001). *Practical Meta-analysis*. Thousand Oaks: Sage.
(Retrieve description via: Amazon.de * Amazon.com)

Cooper, H. (2010). *Research Synthesis and Meta-Analysis: A Step-by-Step Approach*. Thousand Oaks, CA: Sage.
(Retrieve description via: Amazon.de * Amazon.com)

Bornstein, M., Hedges, L.V., Higgins, J.P.T, & Rothstein, H.R. (2009). *Introduction to Meta-Analysis*. Chichester, UK: Wiley.
(Retrieve description via: Amazon.de * Amazon.com)

Cooper, H., Hedges, L.V., & Valentine, J.C. (Eds.) (2009). *Handbook of Research Synthesis (2nd ed.)*. New York: Russell Sage Foundation.
(Retrieve description via: Amazon.de * Amazon.com)

Hunter, J. E., & Schmidt, F. L. (2004). *Methods of meta-analysis: Correcting error and bias in research findings (2nd ed.)*. Thousand Oaks, CA: Sage.
(Retrieve description via: Amazon.de * Amazon.com)

Associations and SiGs:

- The Cochran Collaboration (C1)
<http://www.cochrane.org/>
- The Campbell Collaboration (C2)
<http://www.campbellcollaboration.org/>
- Society for Research Synthesis Methodology
<http://www.srsm.org/>
- Academy of Management – Research Methods Division
<http://aom.pace.edu/rmd/>

Personal homepages

- Harris M. Cooper (Duke)
<http://fds.duke.edu/db/aas/pn/faculty/cooperh/>
- Larry V. Hedges (Northwestern)
<http://www.northwestern.edu/jpr/people/hedges.html>
- Blair Johnson (U Connecticut)
<http://johnson.socialpsychology.org/>
- Mark Lipsey (U Vanderbilt)
<http://www.vanderbilt.edu/cerm/NewMarkBio.htm>
Papers: Meta-Analysis Applications

LMS

<http://campus.bosnjak.eu>

The screenshot shows a web browser window with the address bar displaying <http://www.psyconsult.com/campus/login/index.php>. The page title is "Prof. Dr. Bosnjak's Learning Management System". In the top right corner, it says "You are not logged in. (Login)". Below the title is a blue navigation bar with "BLMS Login to the site" on the left and a language dropdown menu set to "English (en)" on the right.

The main content area is divided into two columns:

- Returning to this web site?**
 - Text: "Login here using your username and password: (Cookies must be enabled in your browser) ?"
 - Form: "Username:" followed by an input field, "Password:" followed by an input field, and a "Login" button.
 - Text: "Some courses may allow guest access:"
 - Form: "Login as a guest" button.
 - Text: "Forgotten your username or password?"
 - Form: "Yes, help me log in" button.
- Is this your first time here?**
 - Text: "Hi! For full access to courses you'll need to take a minute to create a new account for yourself on this web site. Each of the individual courses may also have a one-time 'enrolment key', which you won't need until later. Here are the steps:"
 - List of 7 steps for creating an account.
 - Form: "Create new account" button.

At the bottom of the page, it says "You are not logged in. (Login)" and a "Home" button.