



ISN Methods Meeting

How to: Systematic Review/Meta-Analysis

Jan Ostrowski | 08.02.22

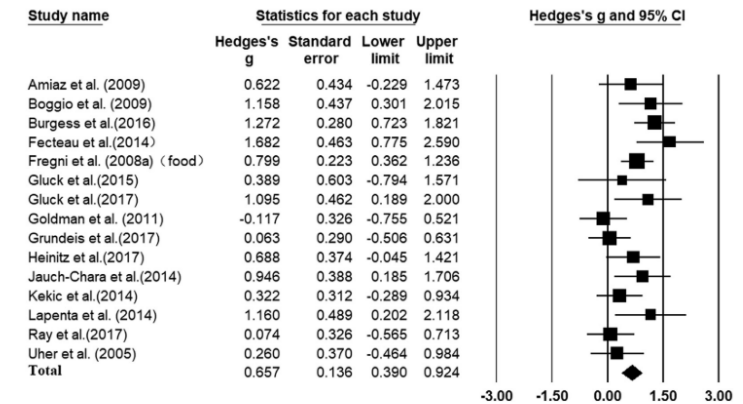
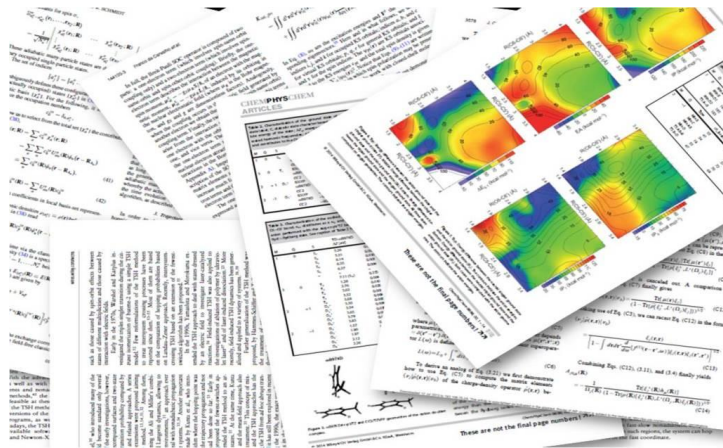


Fig. 6. The overall effect of neuromodulation on consumption.



1. Planning a Systematic Review/Meta-Analysis

- Inclusion/Exclusion Criteria
- Search Terms
- Analysis
- PreRegisterIt! + PRISMA Guidelines

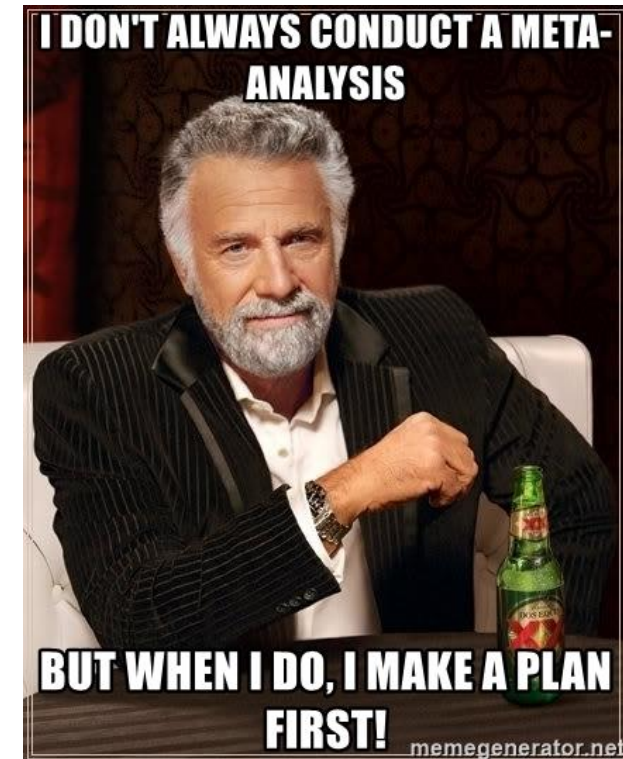
2. Hands on!

- Main Table layout
- Rayyan helps tremendously!
- WebPlotDigitizer!

3. Considerations on Models

- Why not use Multi-Level Models more often?

4. Ressources



Example: Multi-level Meta-Analysis of Cathodal HD-tDCS Effects on Language and Cognition

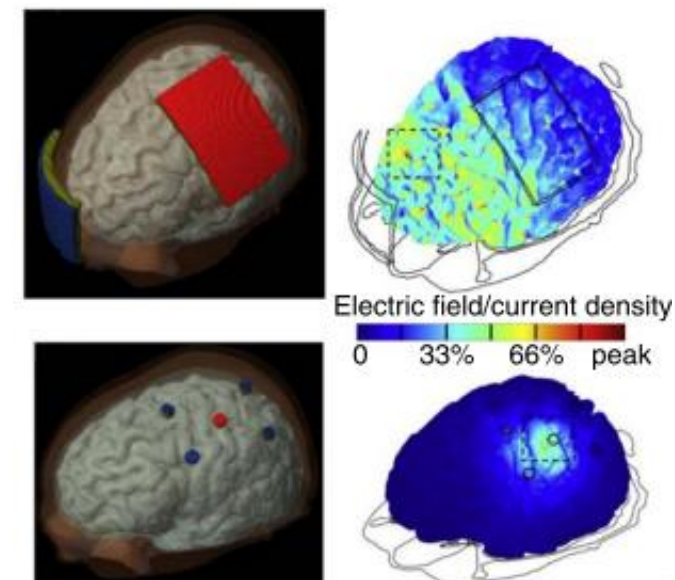
Evaluation of the effects of single-session cathodal HD-tDCS on behavioral measures of cognition.

Experimental and technical parameters as pre-defined moderator variables.

Overall effects?

Heterogeneity in the study sample?

Conventional



HD

Planning a SysReview/Meta-Analysis

	A Narrative review	B Systematic review	C Meta-analysis of published data	D Pooled reanalysis	E Prospectively planned meta-analysis
Preparation of a detailed study protocol and analysis plan	–	+	+	+	+
Literature search for suitable studies in accordance with prospectively defined inclusion and exclusion criteria	–	+	+	+	+
Quantitative summary of the results (calculation of pooled estimates, examination of heterogeneity, sensitivity analyses)	–	–	+	+	+
Analysis of individual data	–	–	–	+	+
Common study protocol for the individual studies and prospectively planned analysis	–	–	–	–	+

Planning a SysReview/Meta-Analysis

Research idea, question, hypotheses...obviously.

Build your „experimental paradigm“:

1. Inclusion/Exclusion Criteria

- Based in research question/hypotheses
- Concepts, questions, methods, measures, sample, design, etc.
- Meta-info about the paper (language, publication, etc.)

2. Literature Search

- Data bases (PubMed, Scopus,)
- Search Terms

Inclusion criteria

- Peer-reviewed, english language
- Use of cathodal HD-tDCS (4x1)
- Control condition/group
- Single session design (or first session of multi-session design)
- Behavioral outcome measures
- Cognitive task

Data bases: PubMed, Scopus, Web of Science

Search Term:

(tDCS OR transcranial direct current stimulation OR HD-tDCS)
AND cathodal stimulation
AND (cognition OR cognitive function OR performance OR behavior)

Planning a SysReview/Meta-Analysis

If it's a quantitative review, also think about analyses...obviously.

Depending on analysis methods, inclusion criteria and search strategy might need adjustment

1. Dependent measures

- Effect of treatments
- Behavioral? Physiological?

2. Model

- Classic or MultiLevel? Fixed-effects of random-effects?
- Statistics (dependent variables, moderator variables, ...)

3. Publication Bias

Parameters to be extracted:

- Study
- Sample
- Stimulation
 - Target region, return distance
 - Timing
 - Technical

Parameters to be extracted:

- Effect size measure: Hedge's g (SMD)
- Multi-level random-effects model
 - Q-test for heterogeneity
 - I^2 statistic for heterogeneity magnitude
- Publication bias
 - Egger's regression
 - Outlier detection

Planning a SysReview/Meta-Analysis

Like 2 P's in a pot:

Preregistration and PRISMA.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses

- Improvement of reporting in articles
- Improvement of critical appraisal in peer review

RESEARCH METHODS AND REPORTING

OPEN ACCESS

Check for updates

The PRISMA 2020 statement: an updated guideline for reporting systematic reviews

Matthew J Page,¹ Joanne E McKenzie,¹ Patrick M Bossuyt,² Isabelle Boutron,³ Tammy C Hoffmann,⁴ Cynthia D Mulrow,⁵ Larissa Shamseer,⁶ Jennifer M Tetzlaff,⁷ Elie A Akl,⁸ Sue E Brennan,¹ Roger Chou,⁹ Julie Glanville,¹⁰ Jeremy M Grimshaw,¹¹ Asbjørn Hróbjartsson,¹² Manoj M Lalu,¹³ Tianjing Li,¹⁴ Elizabeth W Loder,¹⁵ Evan Mayo-Wilson,¹⁶ Steve McDonald,¹ Luke A McGuinness,¹⁷ Lesley A Stewart,¹⁸ James Thomas,¹⁹ Andrea C Tricco,²⁰ Vivian A Welch,²¹ Penny Whiting,¹⁷ David Moher²²

For numbered affiliations see end of the article.

Correspondence to: M J Page
matthew.page@monash.edu
(ORCID 0000-0002-4242-7526)

Additional material is published online only. To view please visit the journal online.

Cite this as: *BMJ* 2021;372:n71
<http://dx.doi.org/10.1136/bmj.n71>

Accepted: 4 January 2021

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, published in 2009, was designed to help systematic reviewers transparently report why the review was done, what the authors did, and what they found. Over the past decade, advances in systematic review

the revised flow diagrams for original and updated reviews.

Systematic reviews serve many critical roles. They can provide syntheses of the state of knowledge in a field, from which future research priorities can be identified; they can address questions that otherwise could not be answered by individual studies; they can identify problems in primary research that should be rectified in future studies; and they can generate or

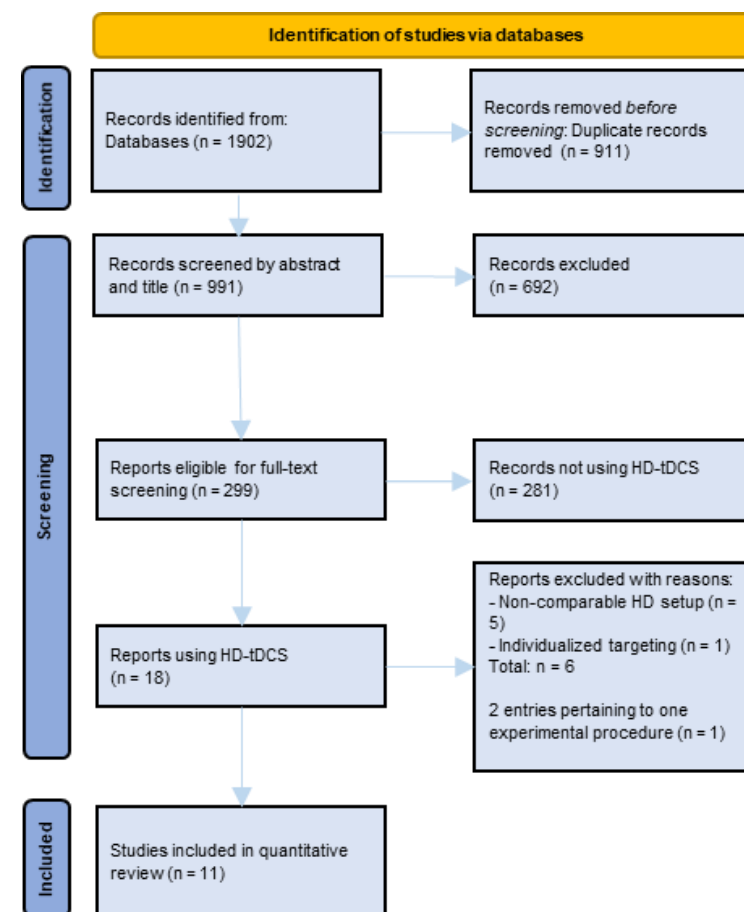
Planning a SysReview/Meta-Analysis

Like 2 P's in a pot:

Preregistration and PRISMA.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses

- Improvement of reporting in articles
- Improvement of critical appraisal in peer review



Hands On!

Prepare your „data set“ in a table with all necessary variables

Properties of tables will vary depending on all previous decisions.

ID	long_cite	long_cite_2	short_cite	exp_no	exp_design	between_var	within_var	blinding	no_target	no_return	target_1	target_2	return_1	return_2	return_3	return_4	el_dist
1	Guo, H., Zhang, Z., Da, S.,	Guo et al. (2		1	between		none	single	1	4	F3		AF3	F1	F5	FC3	one
1	Guo, H., Zhang, Z., Da, S.,	Guo et al. (2		1	between		none	single	1	4	F3		AF3	F1	F5	FC3	one
1	Guo, H., Zhang, Z., Da, S.,	Guo et al. (2		1	between		none	single	1	4	F3		AF3	F1	F5	FC3	one

cognitive_domain	task	measure	measure_type	group	diff_calc	mean_active	sd_active	se_active	mean_control	sd_control	se_control	outcome_polarity	timing	control	el_size_target	el_size_return	intensity	density	duration	ramp_up
Decision-making	BART	earnings	other			154.250	34.400	8.600	187.640	49.670	10.590	positive	online	sham	4	4	1.5	3.75	20	30
Decision-making	BART	n_explosions	other			11.440	4.530	1.133	11.050	4.630	0.987	negative	online	sham	4	4	1.5	3.75	20	30
Decision-making	BART	n_pumps	other			8.930	3.330	0.833	10.790	4.510	0.962	negative	online	sham	4	4	1.5	3.75	20	30

Good idea: Index files with explanations of variables and abbreviations!

Document changes in the table!

Hands On!

Easy screening with **RAYYAN** – a handy tool for conducting initial screenings!

- Import search results
- De-duplication algorithm
- Inclusion/Exclusion
- Collaboration
- Tags, Labels, etc.

Example Search Term: (cognition OR cognitive OR cognitive function) AND (music OR instrument OR musician) AND (eeg OR fMRI) AND memory

Hands On!

What if you're not able to get the data you need?

- Supplementary material?
- Contacting authors?

Easy extraction of outcome measures from figures as a last resort:

WEBPLOTDIGITIZER

Statistics

Main goal: Overall effect of a treatment/condition/intervention/...

1. Choose a model
2. Maybe include moderators (ideally defined a-priori)
3. Meta-regression

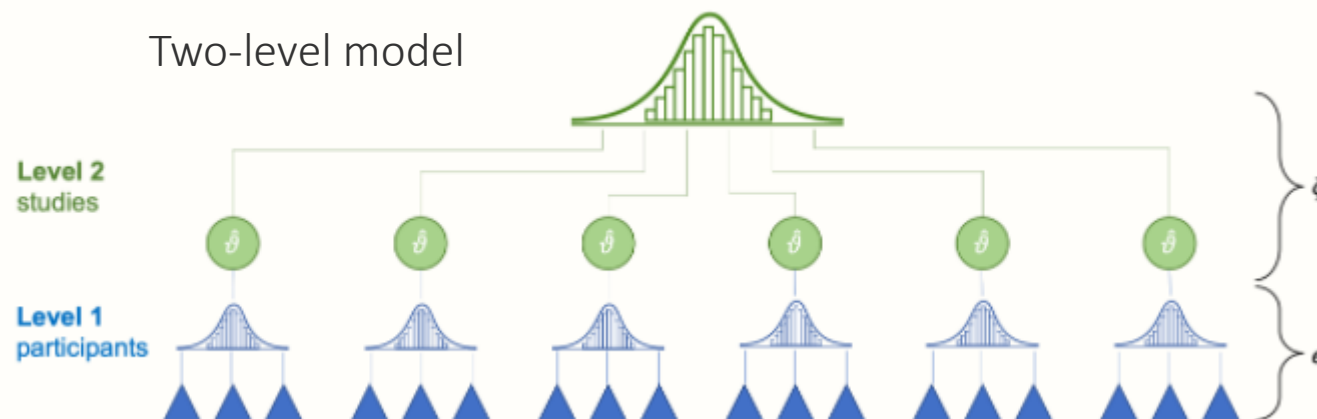
But what model to choose?

Parameters to be extracted:

- Effect size measure: Hedge's g (SMD)
 - One for every measure/condition/group combination
- Pre-defined moderator variables
 - Design, blinding, cognitive domain
 - Target region, timing
 - Intensity, density, ...
 - Age, gender
- Multi-level random-effects model
 - Q-test for heterogeneity
 - I^2 statistic for heterogeneity magnitude
- Publication bias
 - Egger's regression
 - Outlier detection

Conventional vs Multi-level model

Two-level model



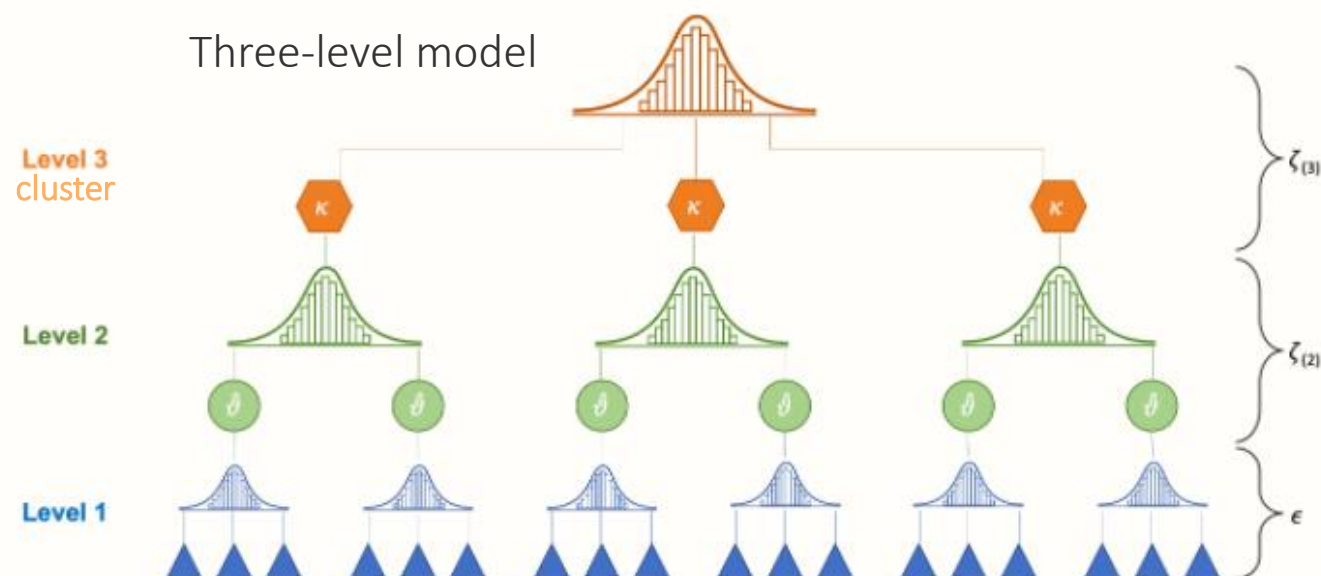
Dependency among effect sizes can artificially reduce heterogeneity
→ false-positives!

Accounting for dependency among effect sizes!

- Introduced by the individual authors
- Introduced by meta-analyst

[Doing Meta-Analysis in R \(Ch. 10.1\)](#)

Three-level model



Conventional vs Multi-level model

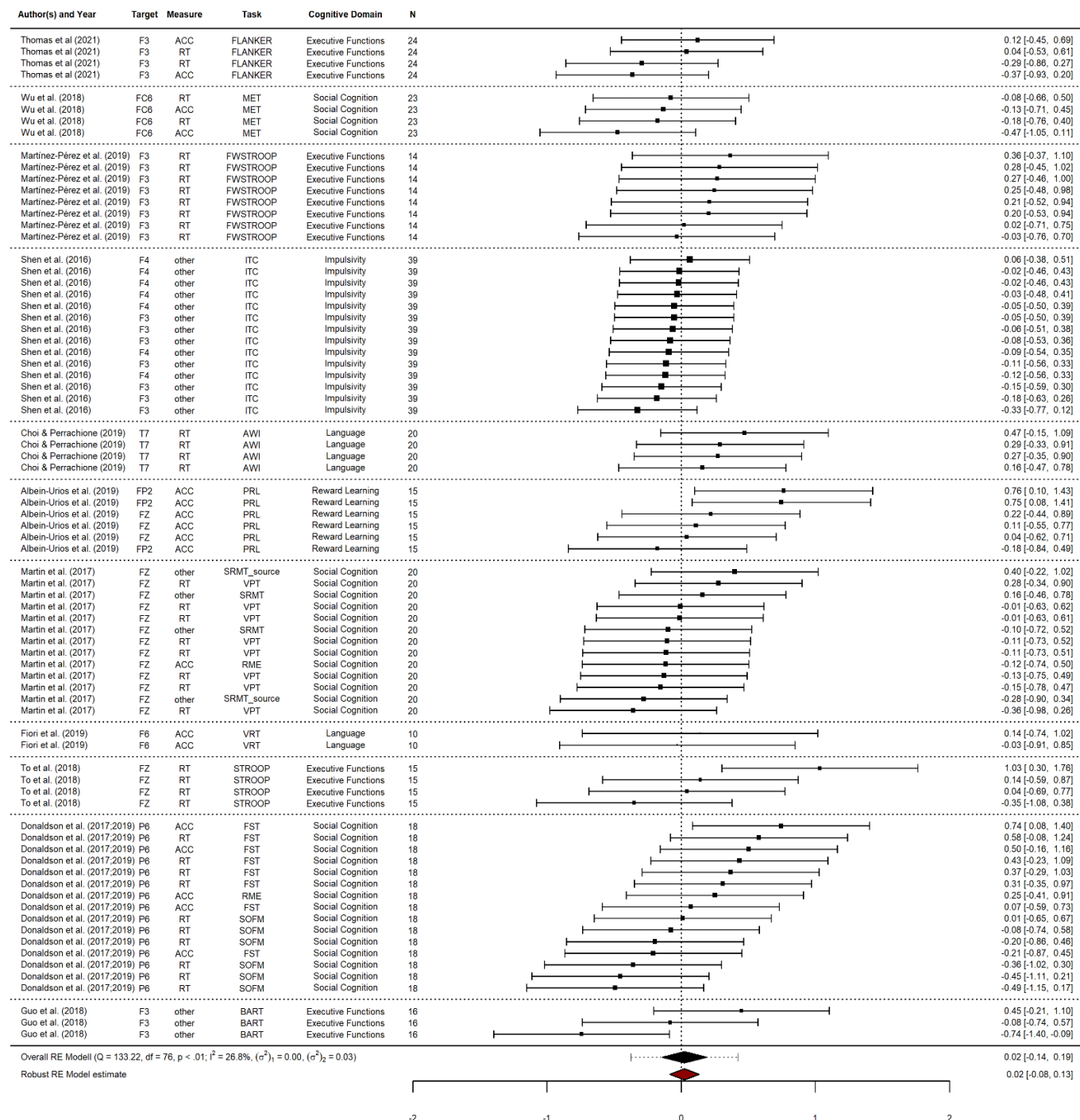
Extraction of multiple individual effect sizes within each study

ACC and RT measures from the same task

Each study becomes a cluster

Possible to

- Assess within- and between-study heterogeneity!
- Quantify heterogeneity separately



Publication Bias

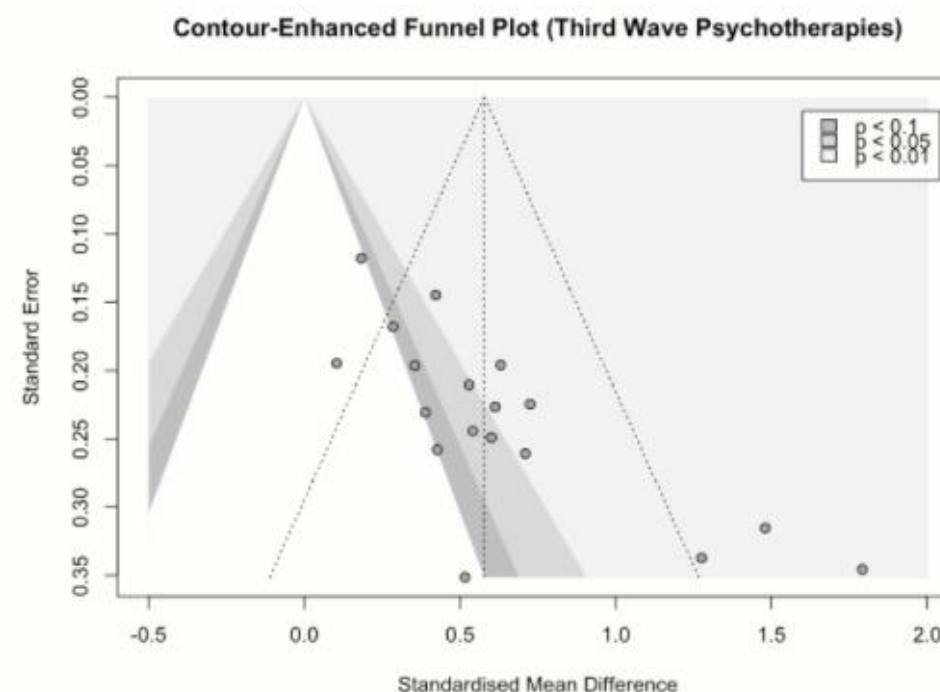
Is the data included in your review comprehensive and/or representative of the field?

Publication bias = probability of publishing is affected by results

Only published studies are included in reviews...what about the unpublished results?

Example first step:

Inspecting publication bias through *funnel plots*



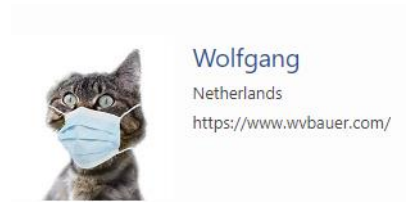
Useful ressources

R packages

- *metafor* [1]
- *meta* [2]
- *clubSandwich* ([3]; cluster-robust variance estimation)

Guide(line)s

- [PRISMA Statement](#)
- [Doing Meta-Analysis in R: A Hands-on Guide](#)
- [Wolfgang Viechtbauer's webpage](#) (he's also quite active on stackoverflow and streams on twitch)



[1] [Viechtbauer \(2010\)](#)

[2] [Balduzzi et al. \(2019\)](#)

[3] [Pustejovsky & Tipton \(2018\)](#)

Useful ressources

Tools

- [Rayyan Screening Tool](#)
- [WebPlotDigitizer](#)

Not mentioned here

- [Covidence SysReview Tool](#) (subscription service)