

Funnel plots and reporting your results

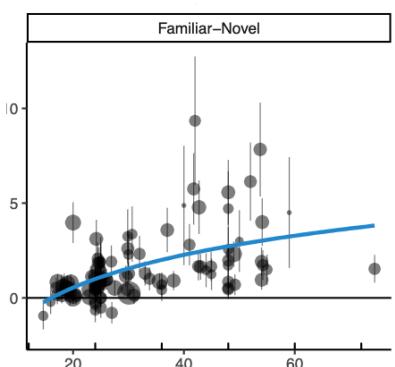
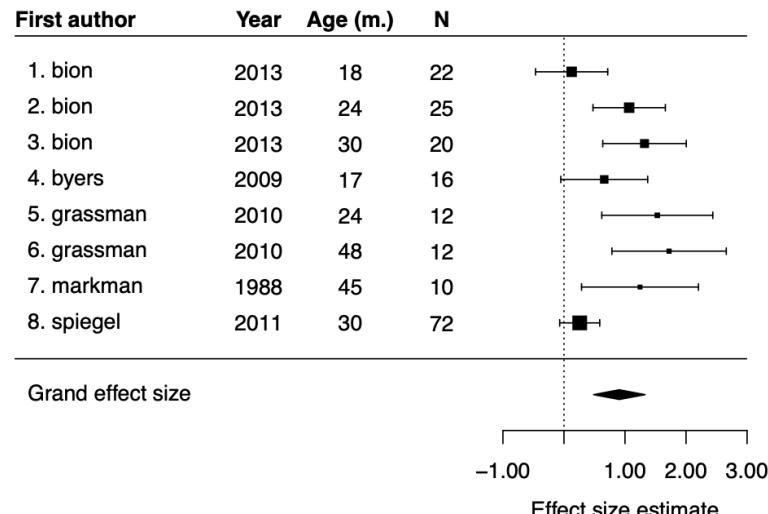
20 April 2020

Modern Research Methods

Some comments on coding data meta-analysis

- It's frustrating when people do lots of different measures – important for cumulative science to use same measures as others and fully report results
- Sent everyone a note on data cleaning to-do items on their meta-analytic datasets
- Between subject design sample sizes – if an experiment uses a between subject design (each participant only in one condition), then the sample size for that condition is N total/ n conditions
- SDs and SEs are similar – SE is the name for standard deviation when the observations are means

Conducting a Meta-analysis



1. Identify Topic

2. Conduct literature search

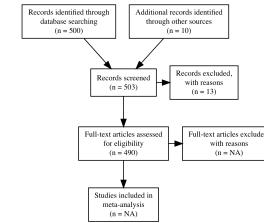
3. Code studies and calculate ES

4. Plot and analyze data

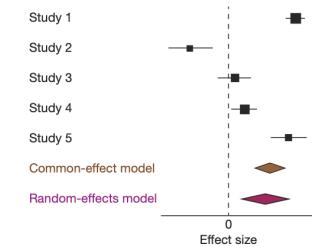
5. Report and discuss results

Four meta-analytic visualizations

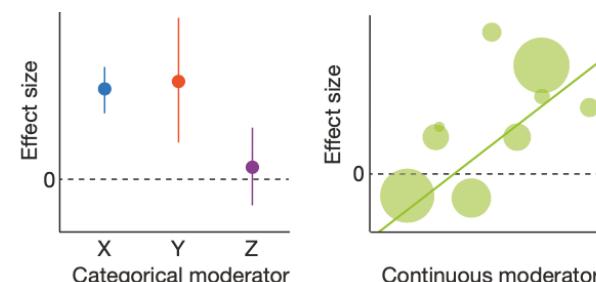
1. PRISMA flow diagram



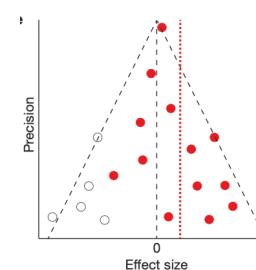
2. Forest plot



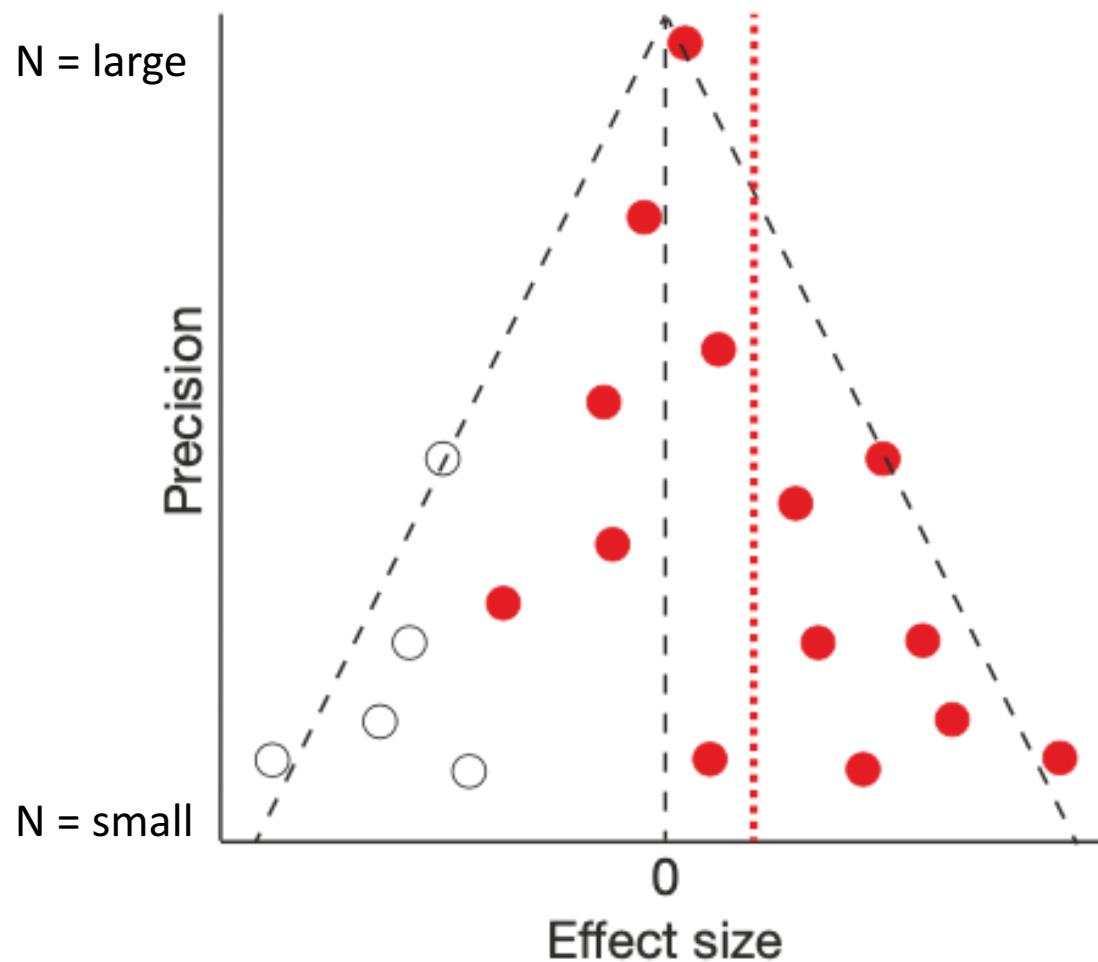
3. Moderator plots



4. Funnel plot



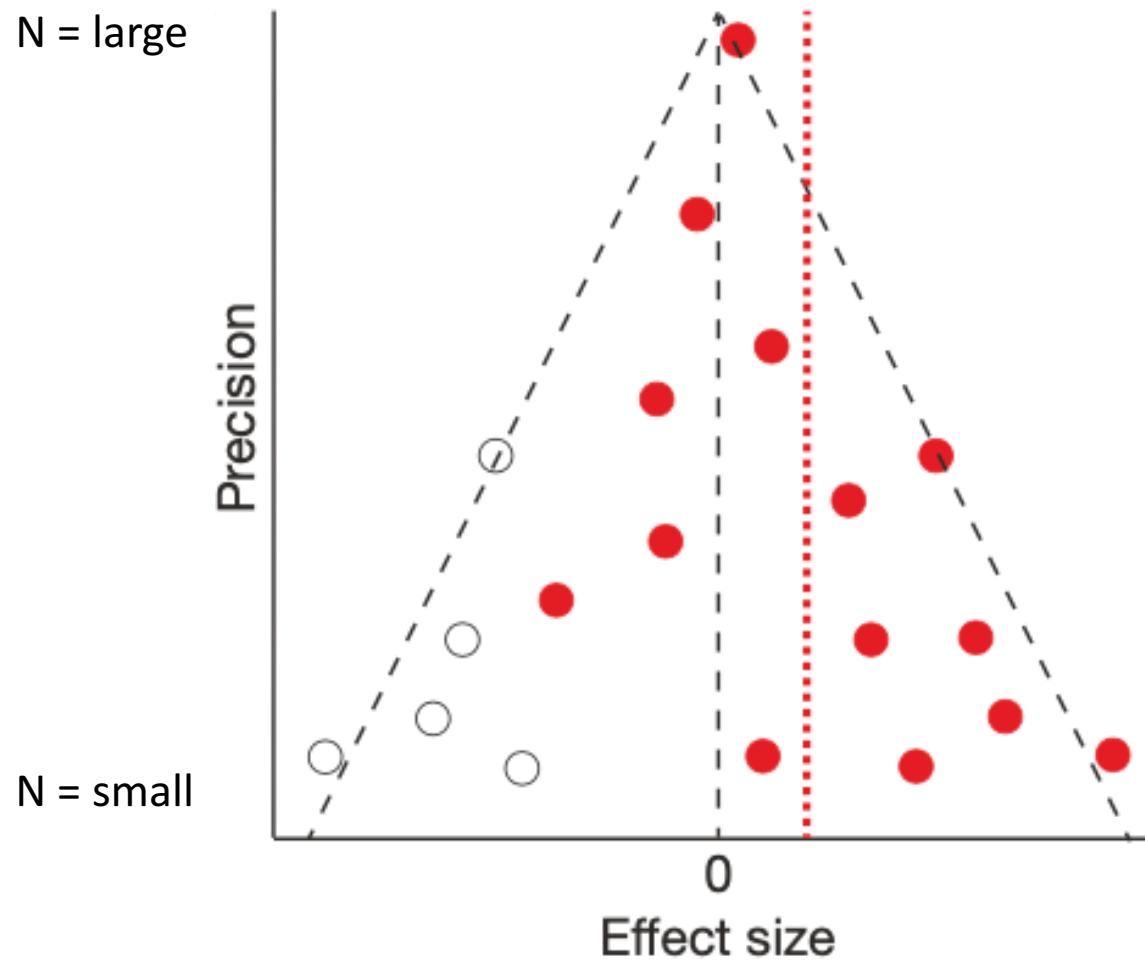
Funnel Plots



- Scatter plot
- Red points are each an effect size
- X –axis = magnitude of effect size
- Y–axis = measure of how precise the study is (number of participants, SE)
- Black vertical dashed line is an effect size of zero
- Red dashed line is meta-analytic effect size

(ignore black circle points for now)

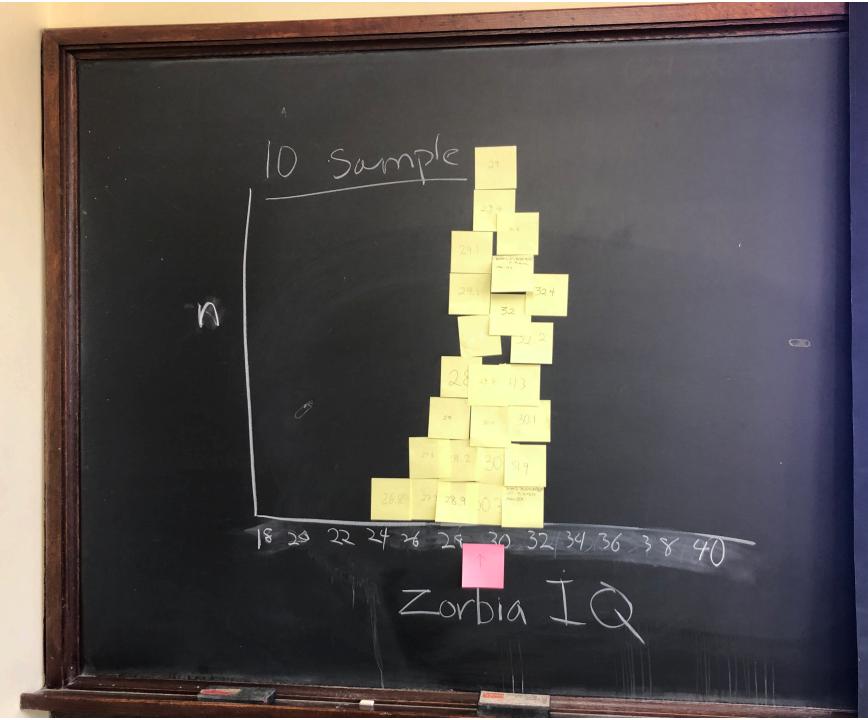
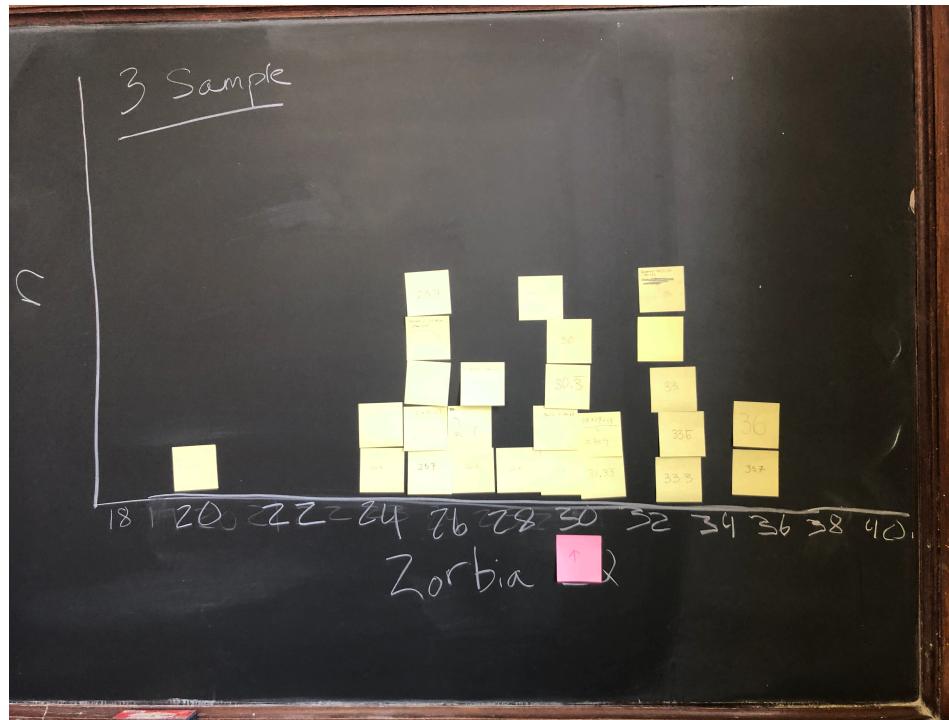
Funnel Plots



Studies that are more precise (i.e. larger sample sizes) should have less variance around the true population effect size.

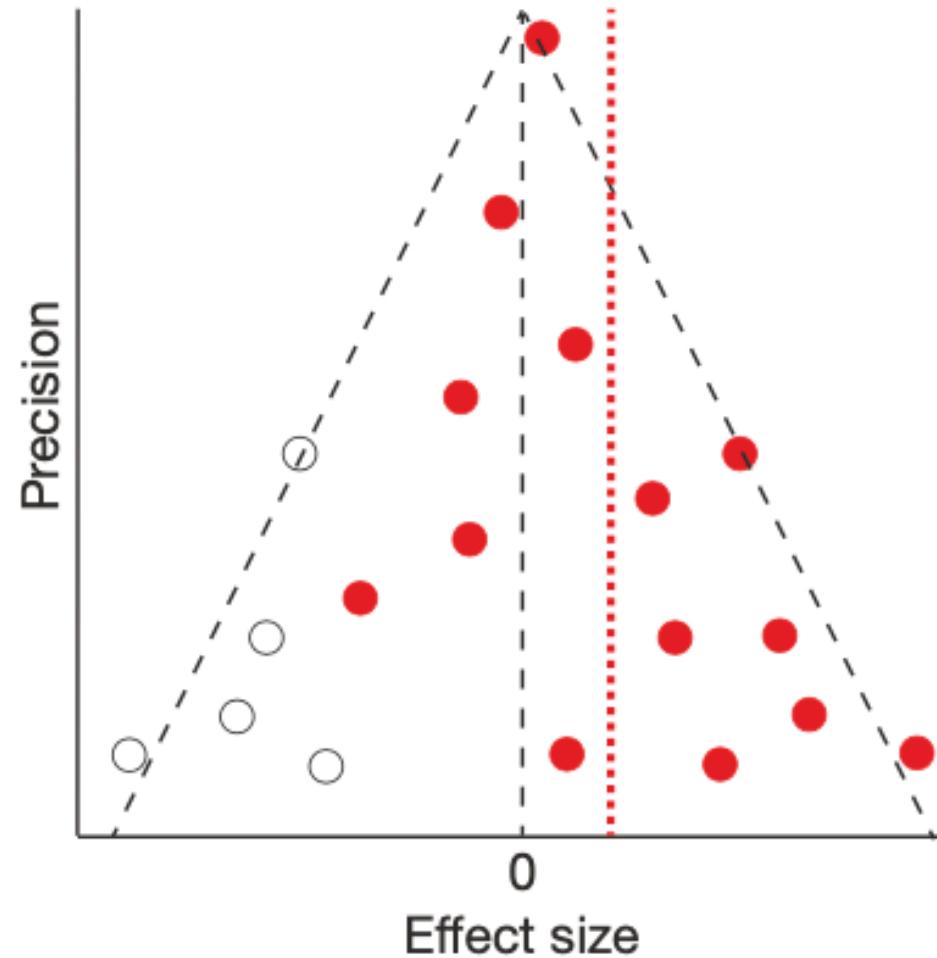
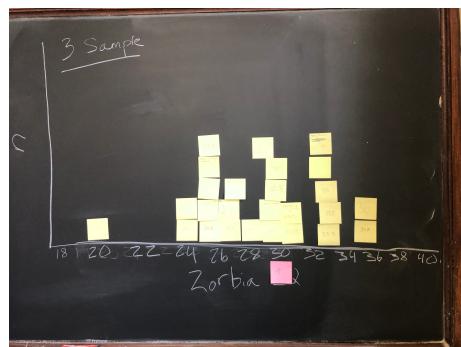
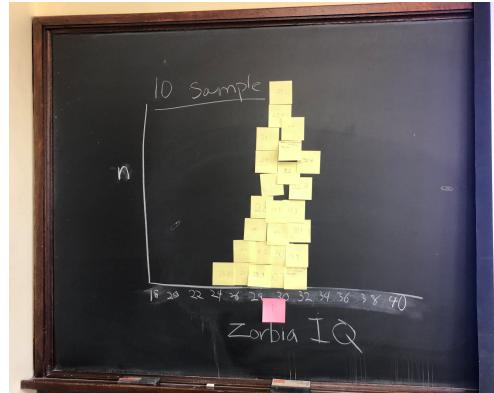
In class simulation results (from week 6)

Sampling Distributions:

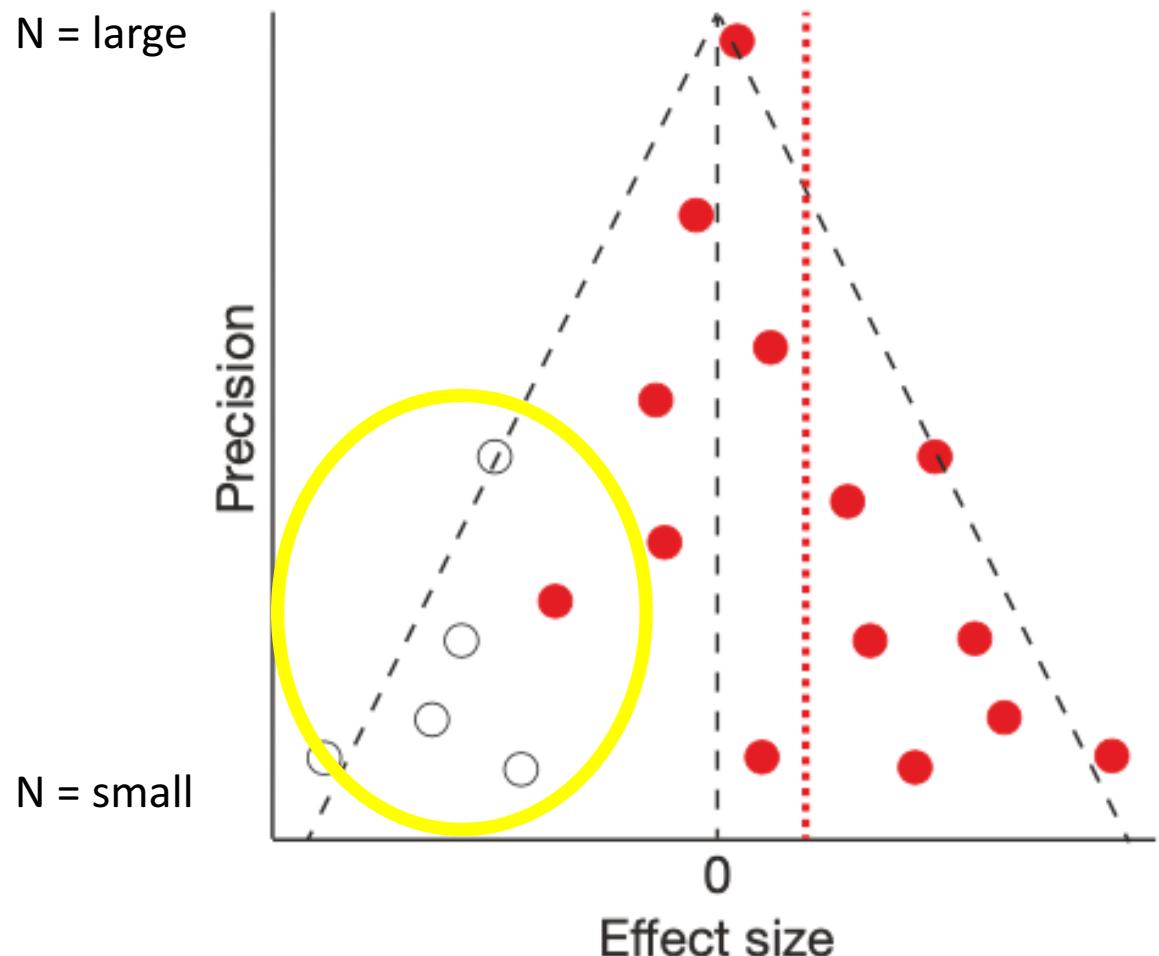


Two samples from the same population will tend to have somewhat different means. The bigger the sample size the narrower the sampling distribution gets

In class simulation results (from week 6)



Funnel Plots and Publication Bias



What is publication bias?

If all results are published, then studies will deviate from mean in either direction (i.e. be **symmetrical**)

If a field of research systematically ignores a certain direction, then this plot can be **asymmetrical**.

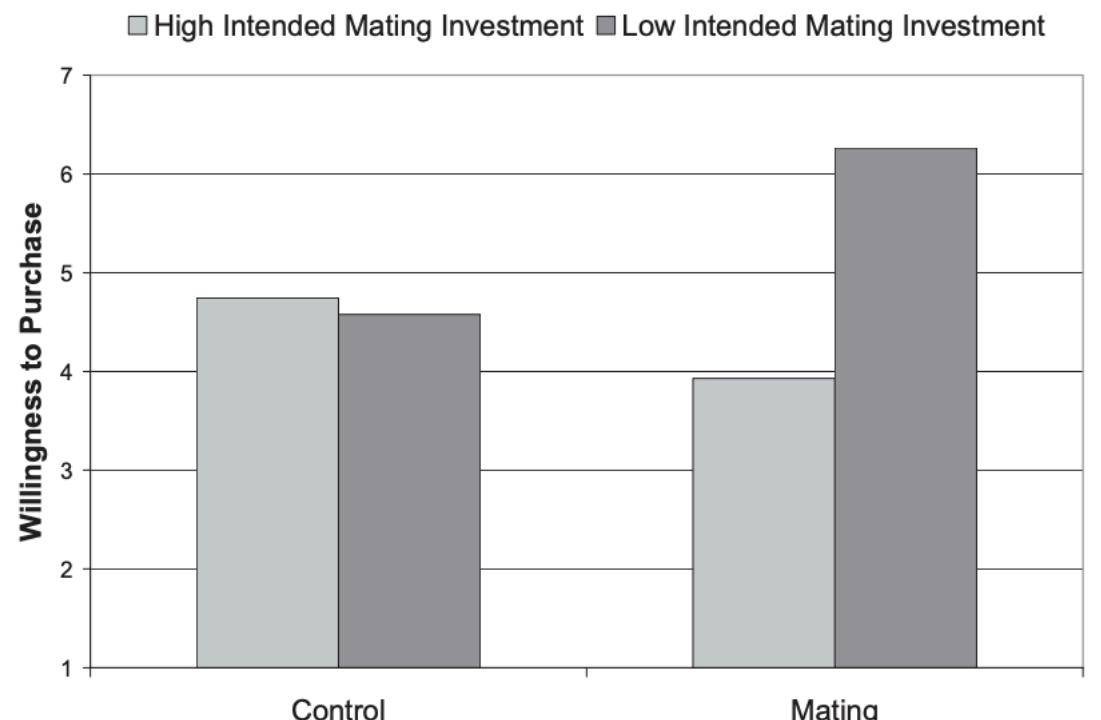
If researchers are not publishing studies that have non-significant ES, we should expect a gap in the lower right hand corner

Romantic Priming

Evolutionary psychologists have argued that male risk-taking and conspicuous consumption are costly sexual signals intended to attract potential mates (Shanks et al. 2015)



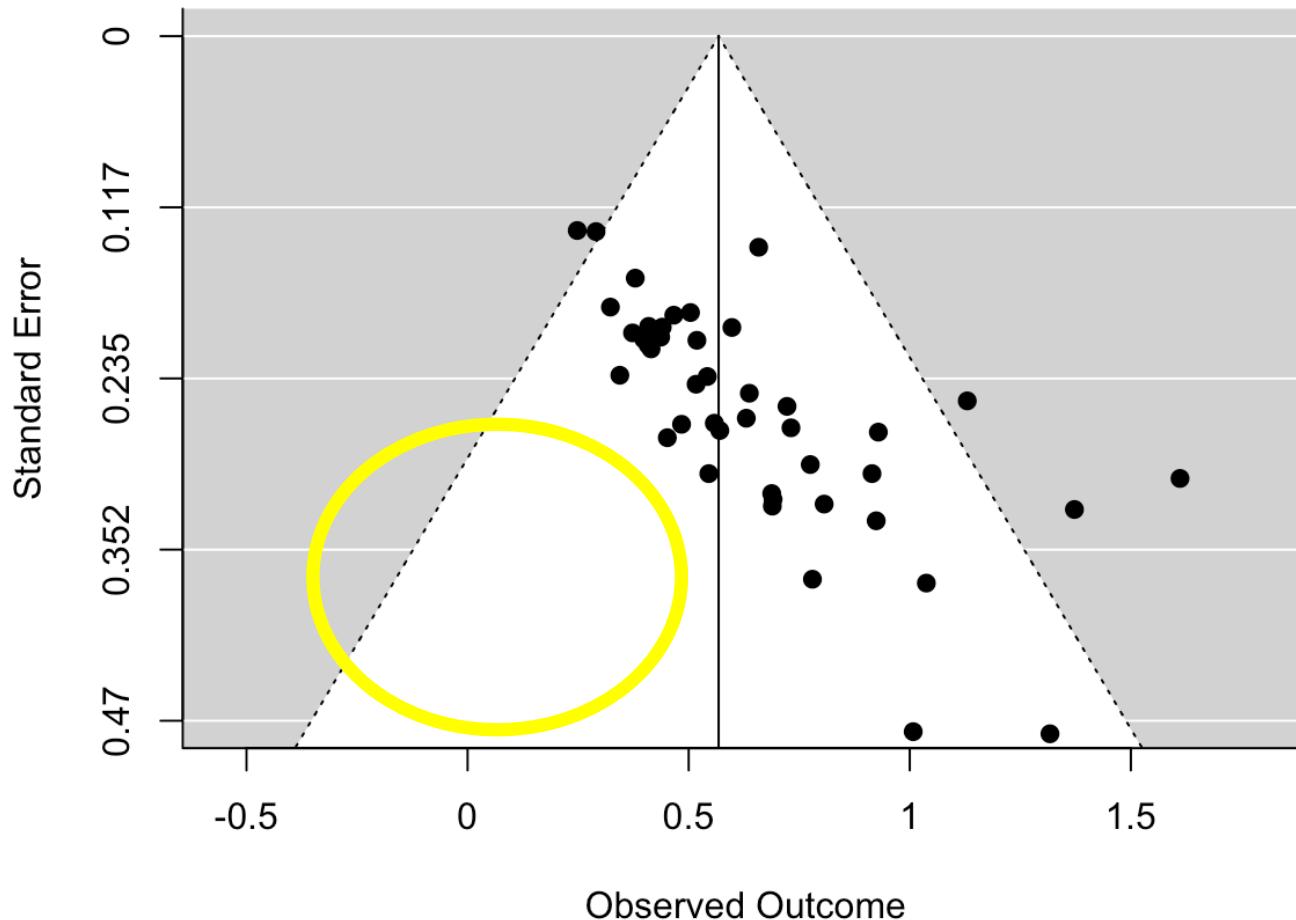
How much do you want to purchase an expensive-looking wallet?



(Sundie et al., 2011; Study 2)

Meta-analysis of the “Romantic Priming Effect”

N = 48 effect sizes



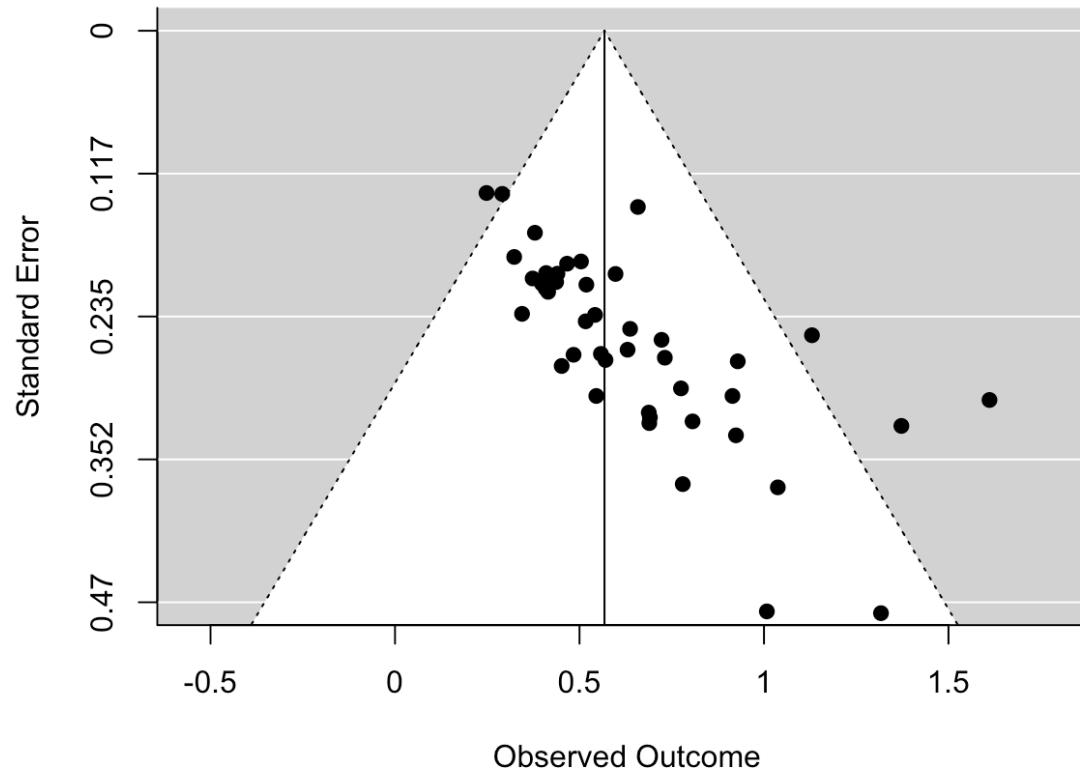
Where are all those
studies? Very
asymmetrical

Suggests publication
bias!

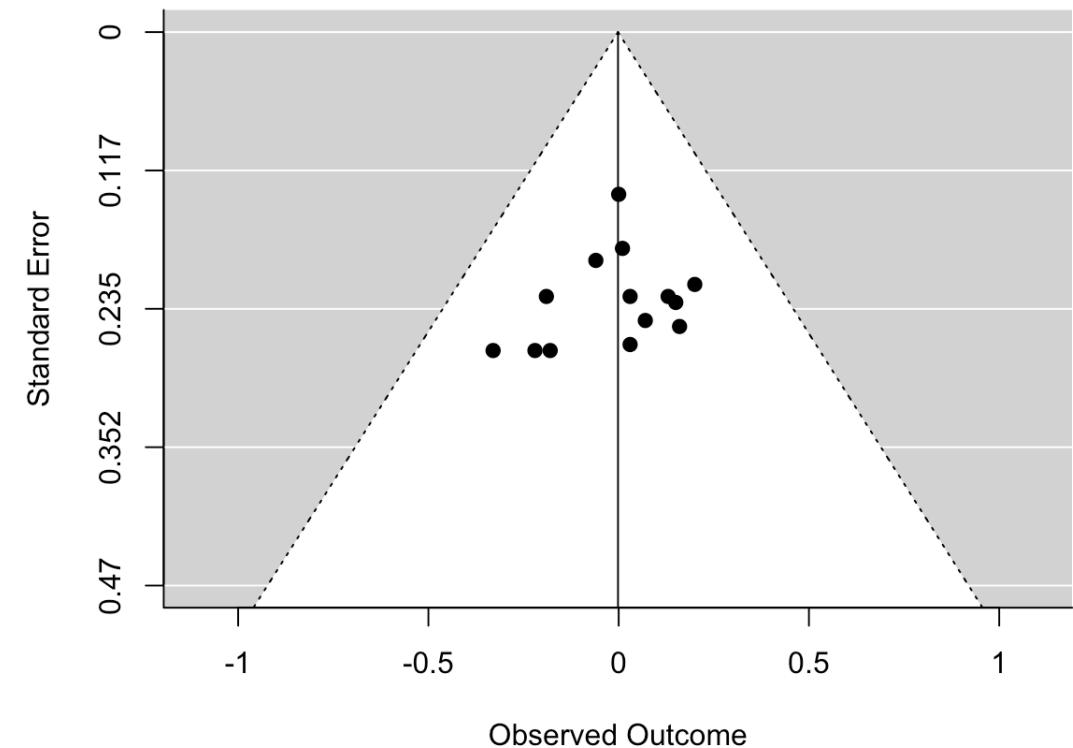
What should be done
next?

Large-scale, pre-registered replications

MA funnel plot (for comparison)

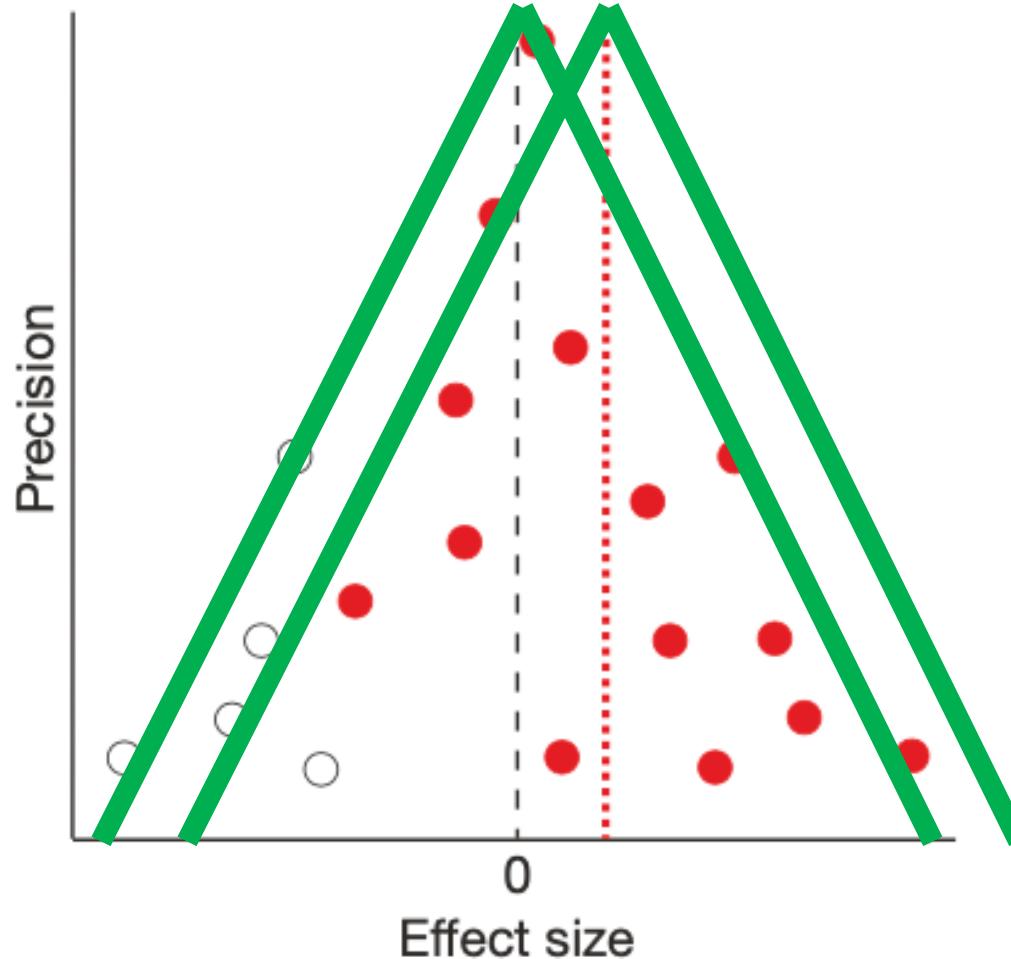


Shanks, et al. 2015: 14 replications



Suggests there is no effect!

Funnel plots – what's with the weird triangle?



This triangle is called a “funnel” (in green)

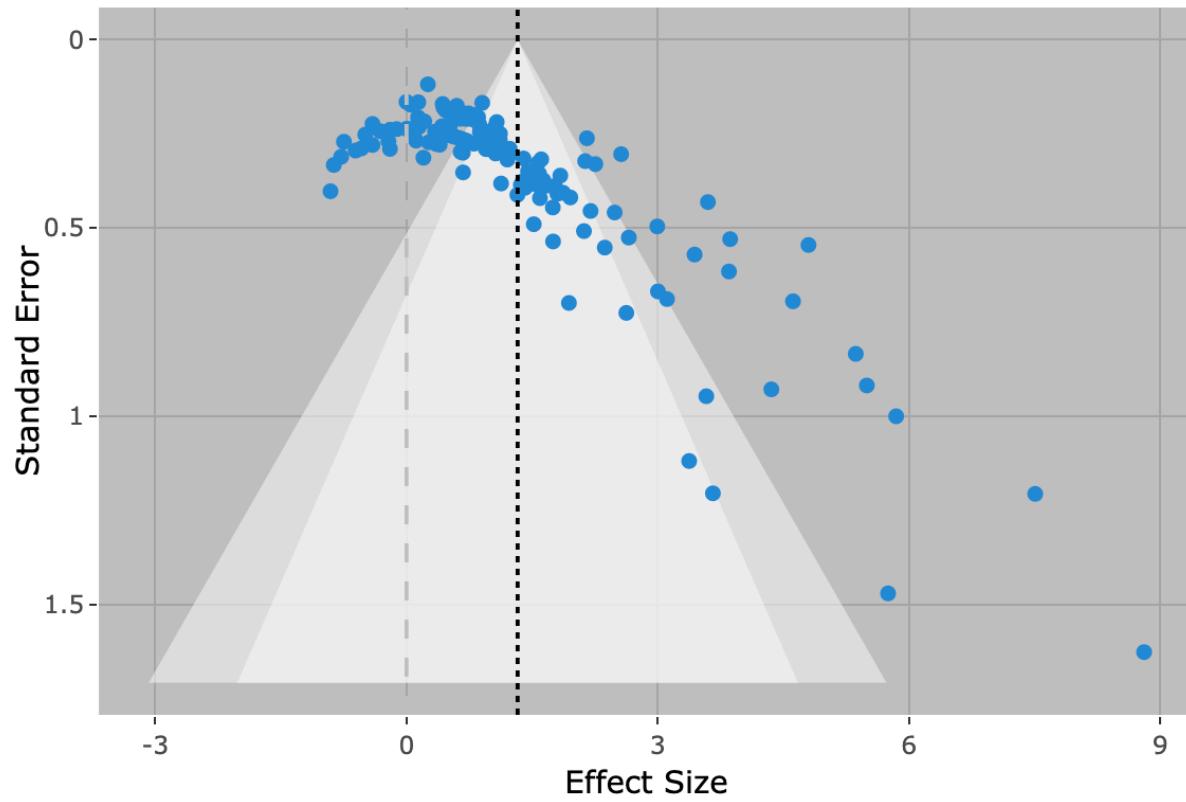
This triangle is for your reference, and corresponds to a 95% confidence interval around the mean

You should expect all points to fall within the 95% confidence interval

This plot shows the 95% confidence interval centered on zero

You could also center the confidence interval on the grand mean effect size

What if the points fall far outside the funnel?



Funnel plot for mutual exclusivity meta-analysis (Lewis, et al., 2020)

Suggests there may be an important **moderator** for your effect.

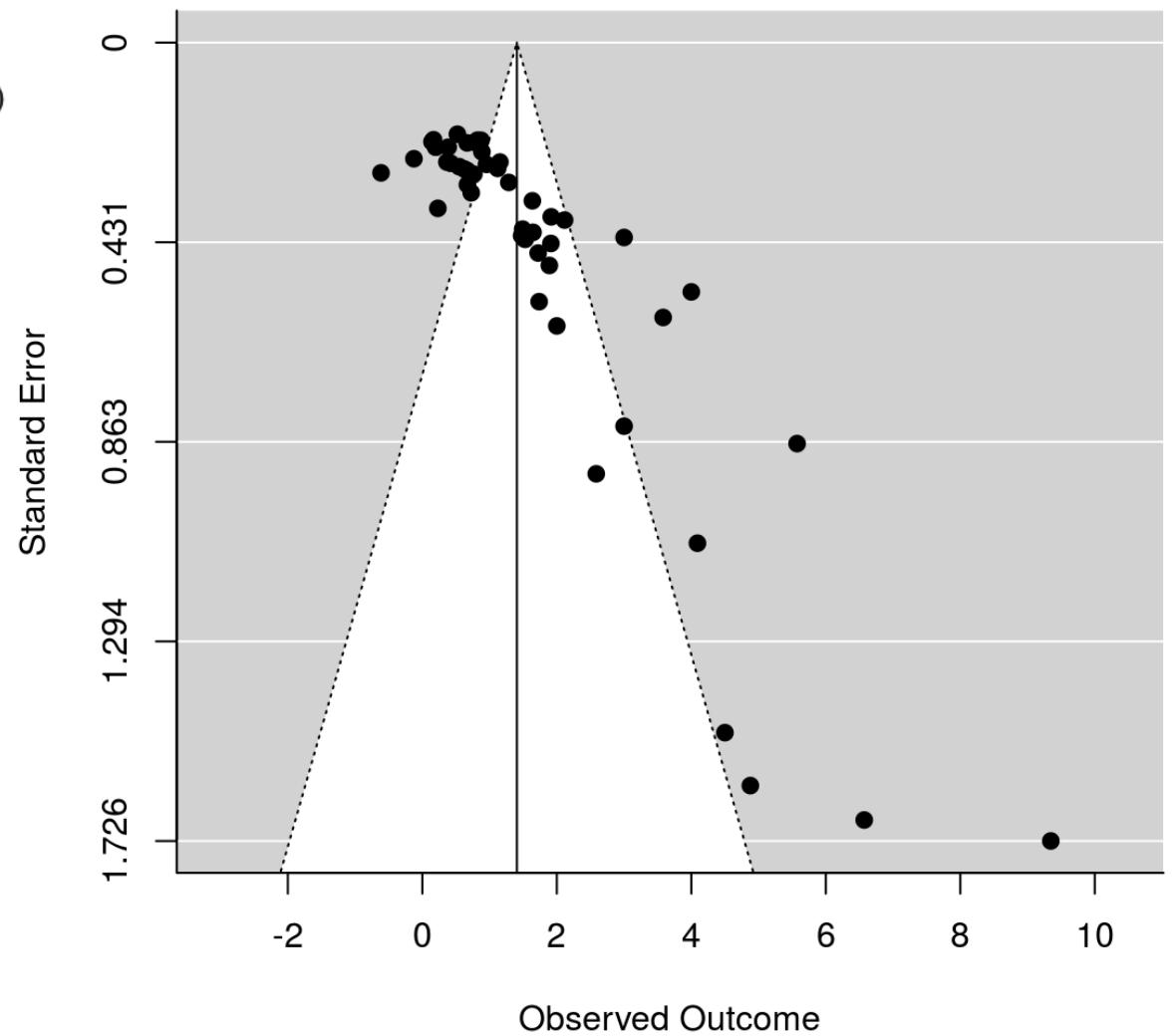
What is the most likely moderator in this case?

Funnel Plots: Questions addressed

1. Is there evidence for publication bias/p-hacking?
 - In the absence of bias/p-hacking should expect points to be symmetrical
2. Are there moderators?
 - In the absence of moderators, should expect all points to fall inside funnel

Making your own funnel plot

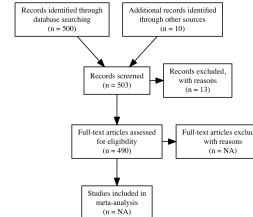
```
ma_model <- rma(ma_data$d_calc, ma_data$d_var_calc)  
  
funnel(ma_model)
```



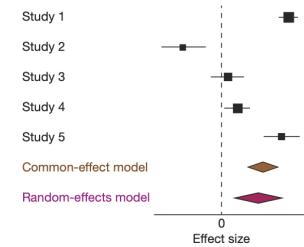
<https://www.youtube.com/watch?v=dZcqEKFLH6I&list=PLu8FqtGdUsEJUqHmhEo2Kqe7qJ07ocUi&index=12>

Four meta-analytic visualizations

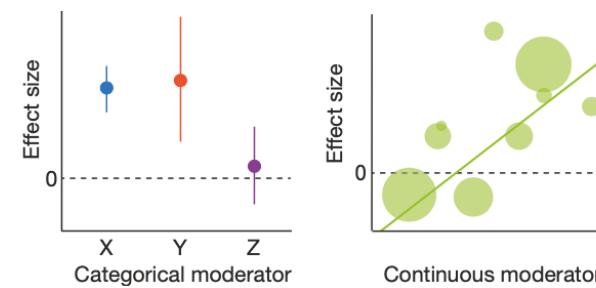
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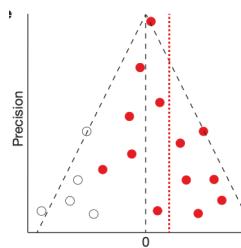
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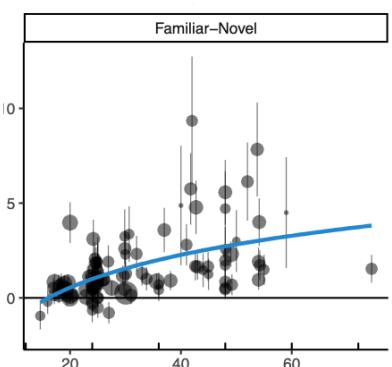
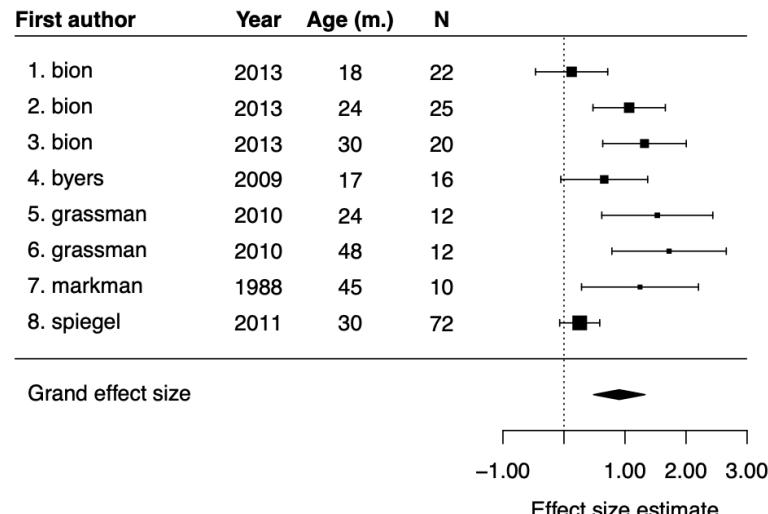
3. Moderator plots



4. Funnel plot



Conducting a Meta-analysis



1. Identify Topic
2. Conduct literature search
3. Code studies and calculate ES
4. Plot and analyze data
5. Report and discuss results

Report and discuss results

- Two “reports” for this class
 - Poster and presentation
 - Final write-up
- Poster Presentation details
 - Each group will make 1 poster and a 4 min recorded presentation
 - Judges from the psychology community will watch your presentations
 - On 4/30 (week from Thursday), we’ll have an online poster session from 4:30 – 6pm where the judges will ask you questions about your project after watching your pre-recorded presentations

Poster template

A meta-analysis of the mutual exclusivity effect in word learning [TEMPLATE]

Molly Lewis and other group members
Carnegie Mellon University
Modern Research Methods

Background

- Mapping a word to its referent is an under-constrained learning problem.
- One of the mechanisms hypothesized to constrain the problem is a bias to map novel words to novel objects – termed the "Mutual exclusivity (ME) effect"

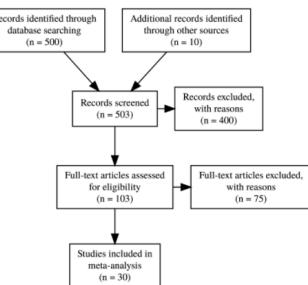


- Seminal Paper: Markman & Wachtel, 1988
- Conducted the ME paradigm with 3 and 4 year olds, and found that older but not younger children have shown the effect (+ additional methodological details)
- Since 1988, paper cited over 1000 times, and replicated with many methodological changes
- E.g., if there's space briefly describe 1 other methodological version that have been conducted since the original

Research Goal: Evaluate the degree of publication bias in the ME literature, estimate the size of the effect, and examine potential moderators.

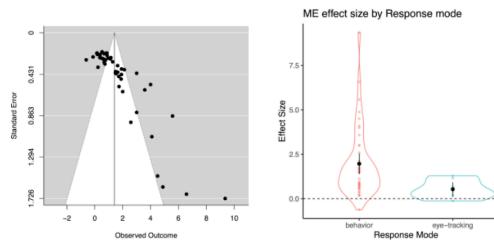
Method

- Meta-analytic approach
- Conducted database search on google scholar using term "mutual exclusivity"
- Inclusion criteria: child participants, no prior experience with objects, etc.
- Calculated effect size (Cohen's d) as the proportion of children selecting the novel object, relative to familiar object
- Coded moderators: object type, demographic type
- Estimated effect size using *metafor* package in R (Viechtbauer, 2019)



Results

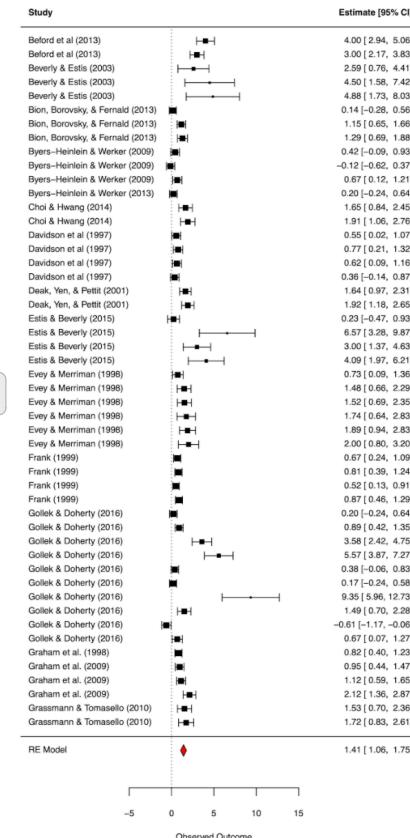
- 50 effect sizes
- Some evidence for publication bias
- Overall effect size is 1.41 [1.06, 1.75]
- Effect is bigger in X than Y, and is larger when X is larger (moderator analyses)



Conclusion and Next Steps

- Mutual exclusivity is a robust effect with a large effect size.
- There is little evidence for publication bias
- Next steps: Explore additional moderators (which ones?), and code remaining papers (how many?).

References:
1. Markman, E. M., & Wachtel, G. F. (1988). Children's knowledge of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, 20(2), 121-157.
2. Viechtbauer, W. (2010). Conducting meta-analyses in R with the *metafor* package. *Journal of Statistical Software*, 36(3), 1-48. URL: <http://www.jstatsoft.org/v36/03/>



Poster presentation logistics

- Once data is clean, I'll calculate effect sizes for your MAs so you'll have a dataset for doing your analyses
- Use the "Final Project Analyses" project on R studio Cloud to conduct your analyses, and make four meta-analytic plots by **Thursday at noon**
 - Flow diagram
 - Forest plot
 - Funnel plot
 - Your coolest moderator plot

Final Project Analyses

ASSIGNMENT Final Project Analyses



Created Apr 14, 2020 6:19 PM [View 1 derived project ...](#)

- Code to make the four plots we've talked about is in this project
- Right now, shows data for mutual exclusivity case, but you can read in your own data once it's clean
- Save plots from this markdown for your poster

The screenshot shows the RStudio interface with the following components:

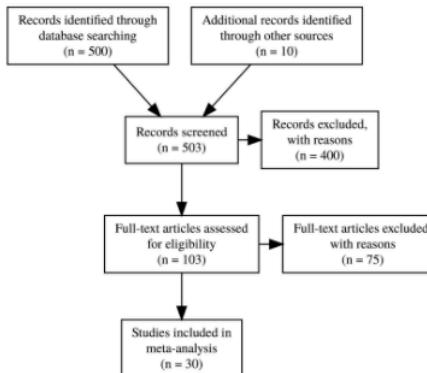
- Title Bar:** Cumulative_science_2020 / Final Project Analyses
- File Menu:** File Edit Code View Plots Session Build Debug Profile Tools Help
- Toolbar:** Go to file/function, Addins
- Code Editor:** The file `final_project_analyses.Rmd` contains R Markdown code. The code includes a YAML header with title, subtitle, date, output type (html_document), and theme (cosmo). It also includes global options for knitr and imports for tidyverse, metafor, and prisma_diagram packages. A PRISMA diagram is mentioned.
- Environment Tab:** Shows the Global Environment, which is currently empty.
- Files Tab:** Shows the project structure:
 - Cloud > project
 - final_project_analyses.html (3.8 MB)
 - final_project_analyses.Rmd (4.6 KB)
 - helpers
 - mutual_exclusivity_sample_MA_data.csv (4.3 KB)
 - plots
 - prisma_diagram.R (4 KB)
 - project.Rproj (205 B)
- Console Tab:** Shows the command `/cloud/project/`.

A meta-analysis of the mutual exclusivity effect in word learning [TEMPLATE]

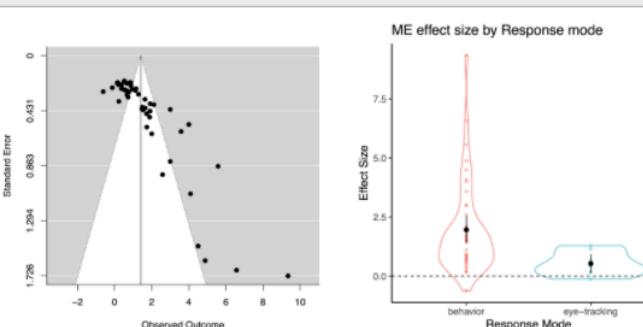
Molly Lewis and other group members
Carnegie Mellon University
Modern Research Methods

Background

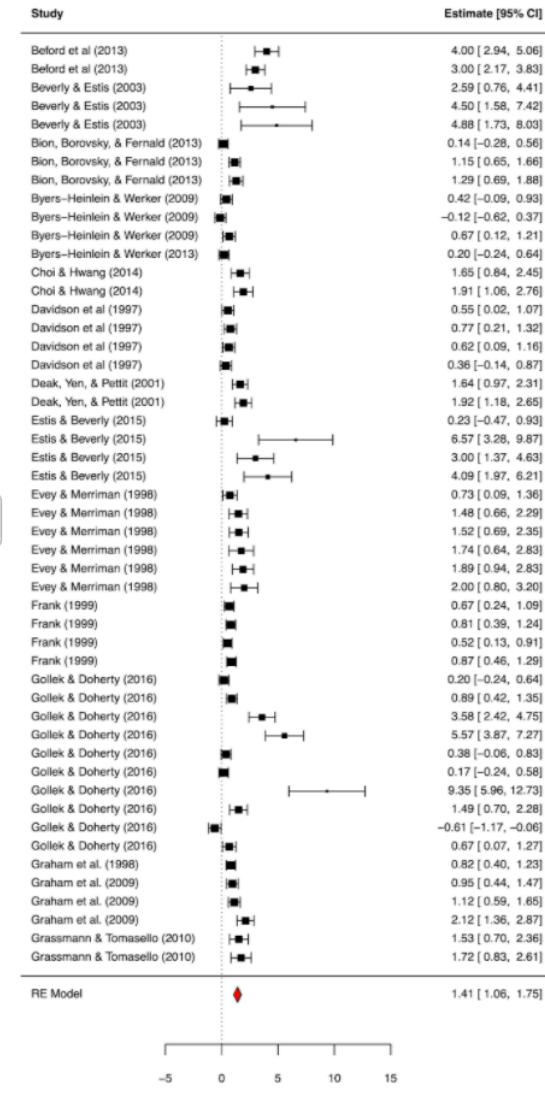
Method



Results



Conclusion and Next Steps



*Editable
template in your
final project
folders

Summary of remaining deadlines

T, 4/21 (noon) – data cleaning due

Th, 4/24 (noon) – markdown of analyses and poster with four plots due

S, 4/26 (5pm) – full poster draft due (Jaeah will have office hours on Sunday)

W, 4/29 (noon) – 4 min recording due

Th, 4/40 (4:30-6pm) – live poster session

F, 5/8 (noon) – final writeup due

Next Time: Creating your own poster presentation

What goes in the each part?

A meta-analysis of the mutual exclusivity effect in word learning [TEMPLATE]

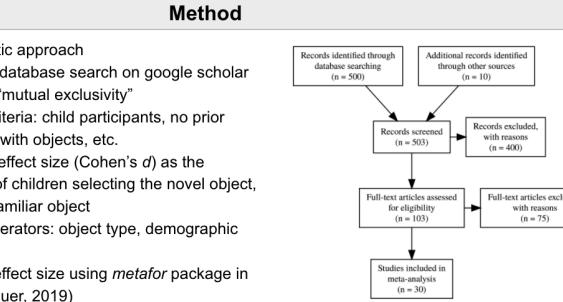
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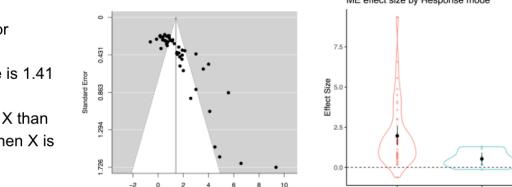


Method



Results

- 50 effect sizes
- Some evidence for publication bias
- Overall effect size is 1.41 [1.06, 1.75]
- Effect is bigger in X than Y, and is larger when X is larger (moderator analyses)



Conclusion and Next Steps

- Mutual exclusivity is a robust effect with a large effect size.
- There is little evidence for publication bias
- Next steps: Explore additional moderators (which ones?), and code remaining papers (how many?).

Research Goal: Evaluate the degree of publication bias in the ME literature, estimate the size of the effect, and examine potential moderators.

Study **Estimate [95% CI]**

Beford et al (2019)	4.00 [2.94, 5.06]
Bialystok & Fernald (2013)	3.00 [2.00, 4.00]
Beverly & Estis (2003)	2.59 [0.76, 4.41]
Beverly & Estis (2003)	4.50 [1.18, 7.42]
Beverly & Estis (2003)	4.88 [1.73, 8.03]
Bion, Borovsky, & Fernald (2013)	0.14 [-0.28, 0.56]
Bion, Borovsky, & Fernald (2013)	1.15 [0.65, 1.66]
Bion, Borovsky, & Fernald (2013)	1.29 [0.69, 1.88]
Byers-Heinlein & Werker (2009)	0.42 [-0.09, 0.93]
Byers-Heinlein & Werker (2009)	-0.12 [-0.62, 0.37]
Byers-Heinlein & Werker (2009)	0.07 [-0.17, 0.31]
Byers-Heinlein & Werker (2013)	0.20 [-0.24, 0.64]
Choi & Hwang (2014)	1.65 [0.84, 2.45]
Choi & Hwang (2014)	1.91 [1.06, 2.76]
Davidson et al (1997)	0.55 [0.02, 1.07]
Davidson et al (1997)	0.77 [0.21, 1.32]
Davidson et al (1997)	0.62 [0.09, 1.16]
Davidson et al (1997)	0.36 [-0.14, 0.87]
Deak, Yen, & Pettit (2001)	1.64 [0.97, 2.31]
Deak, Yen, & Pettit (2001)	1.93 [1.26, 2.60]
Edits & Beverly (2015)	0.23 [-0.47, 0.93]
Edits & Beverly (2015)	6.57 [3.28, 9.87]
Edits & Beverly (2015)	3.00 [1.37, 4.63]
Edits & Beverly (2015)	4.09 [1.97, 6.21]
Evry & Merriman (1998)	0.73 [0.09, 1.36]
Evry & Merriman (1998)	1.48 [0.68, 2.29]
Evry & Merriman (1998)	1.52 [0.69, 2.35]
Evry & Merriman (1998)	1.74 [0.64, 2.83]
Evry & Merriman (1998)	1.80 [0.73, 2.87]
Evry & Merriman (1998)	2.00 [0.46, 3.20]
Frank (1999)	0.67 [0.24, 1.09]
Frank (1999)	0.81 [0.38, 1.24]
Frank (1999)	0.52 [0.13, 0.91]
Frank (1999)	0.95 [0.51, 1.39]
Gollek & Doherty (2016)	0.87 [0.48, 1.29]
Gollek & Doherty (2016)	0.20 [-0.24, 0.64]
Gollek & Doherty (2016)	0.89 [0.42, 1.35]
Gollek & Doherty (2016)	3.58 [2.42, 4.75]
Gollek & Doherty (2016)	0.57 [0.13, 1.01]
Gollek & Doherty (2016)	0.88 [-0.06, 0.93]
Gollek & Doherty (2016)	0.17 [-0.24, 0.58]
Gollek & Doherty (2016)	0.93 [0.98, 1.73]
Gollek & Doherty (2016)	1.49 [0.70, 2.28]
Gollek & Doherty (2016)	0.67 [0.07, 1.27]
Gollek & Doherty (2016)	0.82 [0.40, 1.23]
Graham et al. (1998)	0.95 [0.44, 1.47]
Graham et al. (2009)	1.12 [0.59, 1.65]
Graham et al. (2009)	2.12 [1.36, 2.97]
Grassmann & Tomasello (2010)	1.53 [0.70, 2.36]
Grassmann & Tomasello (2010)	1.72 [0.63, 2.81]

RE Model **Estimate [95% CI]**

	1.41 [1.06, 1.75]
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References:

1. Markman, E. M., & Mitchell, G. F. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, 20(2), 121-157.
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