

Meta-Analysis of Gender Differences in Digital Skills

Supplementary Material

02 August 2022

Contents

| | |
|--|-----------|
| Data preparation | 2 |
| Install and load relevant R packages | 2 |
| Data input and adjustments | 2 |
| Meta-Analysis of Effect Sizes | 7 |
| Meta-analytic baseline model | 7 |
| Moderator analyses | 23 |
| Selection and publication bias | 30 |
| Sensitivity analyses | 46 |
| R session info | 74 |

Data preparation

Install and load relevant R packages

```
# Install R packages (if needed)
# install.packages("pacman")
library(pacman)
pacman::p_load(metafor,
               meta,
               robumeta,
               forestplot,
               devtools,
               clubSandwich,
               zcurve,
               PublicationBias)

# devtools::install_github("MathiasHarrer/dmetar")
library(dmetar)
```

Data input and adjustments

We retrieved the original meta-analytic data set from and Siddiq and Scherer (2019) and Scherer et al. (2021) and re-estimated the effect sizes for the individual participant data (IPD) from ICILS using a different analytic model than in the original publication. This model estimated the means and variances of girls and boys via a multi-group model that incorporated the complex survey design features (i.e., total student weights TOTWGTS, clustering in jackknife replicates JKREPS, stratification by jackknife zones JKZONE, and the inclusion of multiple plausible values PV1CIL-PV5CIL to indicate student achievement in digital skills tests). The effect sizes g represent standardized mean differences quantified as Hedges' g and the respective sampling variance v_g (see Borenstein et al., 2009).

```
## Read the data set
data <- read.csv2("Gender-CIL-Full-Country-2.csv",
                 header = TRUE,
                 dec = ',')

head(data, 20)
```

| ## | Reference | IDSTUDY | Sample | IDSAMPLE |
|-------|----------------------------|---------|------------------------------|----------|
| ## 1 | ACARA (2012a,b) | 1 | ACARA (2012a,b)-Grade 6 | 1 |
| ## 2 | ACARA (2012a,b) | 1 | ACARA (2012a,b)-Grade 10 | 2 |
| ## 3 | ACER (2008) | 2 | ACER (2008)-Grade 6 | 3 |
| ## 4 | ACER (2008) | 2 | ACER (2008)-Grade 10 | 4 |
| ## 5 | Aesaert & van Braak (2015) | 3 | Aesaert and van Braak (2015) | 5 |
| ## 6 | Baek et al. (2010) | 4 | Baek et al. (2010) | 6 |
| ## 7 | Calvani et al. (2012) | 5 | Calvani et al. (2012) | 7 |
| ## 8 | Castillo (2010) | 6 | Castillo (2010) | 8 |
| ## 9 | Chu (2012) | 7 | Chu (2012) | 9 |
| ## 10 | Frailon et al. (2014) | 8 | ICILS 2013-Australia | 10 |
| ## 11 | Frailon et al. (2014) | 8 | ICILS 2013-Chile | 11 |
| ## 12 | Frailon et al. (2014) | 8 | ICILS 2013-Croatia | 12 |
| ## 13 | Frailon et al. (2014) | 8 | ICILS 2013-Czech Republic | 13 |

| | | | | | | | | |
|-------|-----------------------|---------------|----------|---------------|----------|----------------------------|-------------|-------------|
| ## 14 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Denmark | 24 | |
| ## 15 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Germany | 14 | |
| ## 16 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Hong Kong SAR | 25 | |
| ## 17 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Korea | 15 | |
| ## 18 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Lithuania | 16 | |
| ## 19 | Frailon et al. (2014) | 8 | | | | ICILS 2013-The Netherlands | 26 | |
| ## 20 | Frailon et al. (2014) | 8 | | | | ICILS 2013-Norway | 17 | |
| ## | Country | IDCOUNTRY | PubYear | N | nM | nF | g | vg |
| ## 1 | Australia | 36 | 2012 | 5710 | 2969 | 2741 | 0.11038549 | 0.000699816 |
| ## 2 | Australia | 36 | 2012 | 5313 | 2869 | 2444 | 0.06669058 | 0.000757786 |
| ## 3 | Australia | 36 | 2008 | 5604 | 2852 | 2752 | 0.08618846 | 0.000714809 |
| ## 4 | Australia | 36 | 2008 | 5322 | 2672 | 2650 | 0.07438951 | 0.000751788 |
| ## 5 | Belgium (Flanders) | 56 | 2015 | 378 | 189 | 189 | 0.37664671 | 0.010723065 |
| ## 6 | Korea, Republic of | 410 | 2010 | 128 | 104 | 24 | -0.52683897 | 0.051776814 |
| ## 7 | Italy | 380 | 2012 | 1056 | 599 | 457 | -0.11981466 | 0.003894450 |
| ## 8 | USA | 840 | 2010 | 272 | 137 | 135 | -0.21649639 | 0.014717816 |
| ## 9 | Hong Kong SAR | 344 | 2012 | 199 | 102 | 97 | 0.48604015 | 0.020542486 |
| ## 10 | Australia | 36 | 2014 | 5326 | 2641 | 2685 | 0.31442780 | 0.000760154 |
| ## 11 | Chile | 152 | 2014 | 3180 | 1628 | 1552 | 0.29591447 | 0.001271755 |
| ## 12 | Croatia | 191 | 2014 | 2850 | 1450 | 1400 | 0.18484378 | 0.001409196 |
| ## 13 | Czech Republic | 203 | 2014 | 3066 | 1510 | 1556 | 0.18675391 | 0.001309974 |
| ## 14 | Denmark | 208 | 2014 | 1767 | 905 | 862 | 0.21238428 | 0.002275904 |
| ## 15 | Germany | 276 | 2014 | 2225 | 1127 | 1098 | 0.21293111 | 0.001807034 |
| ## 16 | Hong Kong SAR | 344 | 2014 | 2088 | 1105 | 983 | 0.26532489 | 0.001937747 |
| ## 17 | Korea, Republic of | 410 | 2014 | 2888 | 1480 | 1408 | 0.44153607 | 0.001418935 |
| ## 18 | Lithuania | 440 | 2014 | 2756 | 1412 | 1344 | 0.19883506 | 0.001458645 |
| ## 19 | The Netherlands | 528 | 2014 | 2196 | 1149 | 1047 | 0.25071517 | 0.001838496 |
| ## 20 | Norway | 576 | 2014 | 2436 | 1214 | 1222 | 0.32815467 | 0.001663145 |
| ## | Seg | Interactivity | SecLevel | AppliedSkills | GreyLit | RandomSample | | |
| ## 1 | 0.02645404 | 0 | 0 | 0 | 1 | 1 | | |
| ## 2 | 0.02752791 | 0 | 1 | 0 | 1 | 1 | | |
| ## 3 | 0.02673590 | 0 | 0 | 0 | 1 | 1 | | |
| ## 4 | 0.02741875 | 0 | 1 | 0 | 1 | 1 | | |
| ## 5 | 0.10355223 | 1 | 0 | 1 | 0 | 1 | | |
| ## 6 | 0.22754519 | 0 | 1 | 0 | 1 | 1 | | |
| ## 7 | 0.06240553 | 0 | 1 | 1 | 0 | 1 | | |
| ## 8 | 0.12131701 | 0 | 1 | 1 | 1 | 1 | | |
| ## 9 | 0.14332650 | 0 | 0 | 0 | 0 | 0 | | |
| ## 10 | 0.02757088 | 1 | 1 | 1 | 1 | 1 | | |
| ## 11 | 0.03566167 | 1 | 1 | 1 | 1 | 1 | | |
| ## 12 | 0.03753926 | 1 | 1 | 1 | 1 | 1 | | |
| ## 13 | 0.03619356 | 1 | 1 | 1 | 1 | 1 | | |
| ## 14 | 0.04770644 | 1 | 1 | 1 | 1 | 1 | | |
| ## 15 | 0.04250922 | 1 | 1 | 1 | 1 | 1 | | |
| ## 16 | 0.04401985 | 1 | 1 | 1 | 1 | 1 | | |
| ## 17 | 0.03766875 | 1 | 1 | 1 | 1 | 1 | | |
| ## 18 | 0.03819221 | 1 | 1 | 1 | 1 | 1 | | |
| ## 19 | 0.04287768 | 1 | 1 | 1 | 1 | 1 | | |
| ## 20 | 0.04078167 | 1 | 1 | 1 | 1 | 1 | | |
| ## | TestFair | IPD | TypeILSA | PDI | cGDP | cGII | logcGDP | |
| ## 1 | 1 | 0 | NonILSA | 38 | 57397.52 | 53.37143 | 10.957756 | |
| ## 2 | 1 | 0 | NonILSA | 38 | 57397.52 | 53.37143 | 10.957756 | |
| ## 3 | 1 | 0 | NonILSA | 38 | 57397.52 | 53.37143 | 10.957756 | |
| ## 4 | 1 | 0 | NonILSA | 38 | 57397.52 | 53.37143 | 10.957756 | |

```

## 5      0  0  NonILSA  65 40991.81 50.90000 10.621128
## 6      0  0  NonILSA  60 28337.09 55.12500 10.251927
## 7      0  0  NonILSA  50 34121.55 47.05000 10.437684
## 8      0  0  NonILSA  40 53792.76 60.65000 10.892894
## 9      0  0  NonILSA  68 38523.08 58.10000 10.559013
## 10     1  1  ICILS2013 38 57397.52 53.37143 10.957756
## 11     1  1  ICILS2013 63 14783.73 38.60000  9.601282
## 12     1  1  ICILS2013 73 13600.19 40.70000  9.517839
## 13     1  1  ICILS2013 57 19744.56 50.20000  9.890633
## 14     1  1  ICILS2013 18 61185.54 57.95000 11.021666
## 15     1  1  ICILS2013 35 46090.75 56.45000 10.738368
## 16     1  1  ICILS2013 68 38523.08 58.10000 10.559013
## 17     1  1  ICILS2013 60 28337.09 55.12500 10.251927
## 18     1  1  ICILS2013 42 16548.41 41.00000  9.714045
## 19     1  1  ICILS2013 38 52249.23 60.93333 10.863780
## 20     1  1  ICILS2013 31 88032.52 54.46667 11.385462

```

```
colnames(data)
```

```

## [1] "Reference"      "IDSTUDY"      "Sample"      "IDSAMPLE"
## [5] "Country"       "IDCOUNTRY"    "PubYear"     "N"
## [9] "nM"           "nF"           "g"           "vg"
## [13] "Seg"          "Interactivity" "SecLevel"    "AppliedSkills"
## [17] "GreyLit"      "RandomSample" "TestFair"    "IPD"
## [21] "TypeILSA"     "PDI"          "cGDP"        "cGII"
## [25] "logcGDP"

```

This data set contains several identifiers to indicate the complex meta-analytic data structure:

- **IDSTUDY**: Identifier is the primary study
- **IDSAMPLE**: Identifier of the study sample (and thus, in this data set, the effect size)
- **IDCOUNTRY**: Identifier of the country

The effect sizes represent standardized mean differences, quantified by Hedges' g . The corresponding sampling variances are stored in the variable v_g . These effect sizes have been extracted from the primary study publications via the aggregated data (AD) and the primary study raw data via the individual participant data (IPD). The latter were available from the two ILSA studies ICILS 2013 and 2018. For generating the respective effect sizes, all complex sampling characteristics were considered (see Scherer et al., 2021 and Siddiq and Scherer, 2019). The variable IPD indicates if the data were derived from IPD (IPD==1) or AD (IPD==0).

The data set further contains characteristics describing the primary studies, countries, and measures.

- **PubYear**: Publication year
- **N, nF, nM**: Sample sizes overall, girls (female), and boys (male)
- **Interactivity**: Interactive tasks to assess digital skills (coded as 1=interactive, 0=static)
- **AppliedSkills**: Assessment of applied digital skills (coded as 1) or digital knowledge (coded as 0)
- **GreyLit**: Grey (coded as 1) or published literature (coded as 0)
- **RandomSample**: Randomization of the sampling (coded as 1) or convenience sample (coded as 0)
- **TestFair**: Assessment of test fairness conducted and reported (coded as 1) or not (coded as 0)
- **PDI**: Hofstede's power distance index
- **cGII**: Mean-centered global innovation index in the publication year
- **cGDP**: Mean-centered gross domestic product of the country in the publication year

- logcGDP: Log-transformed variable cGDP

In this illustrative example, we will focus on the data from students in secondary education.

```
## Subset the data
## Secondary-education students
dat <- data[data$SecLevel==1,]

## Number of effect sizes
nrow(dat)

## [1] 53

## Countries with numeric ISO codes
table(dat$IDCOUNTRY)

##
## 32 36 124 152 156 191 203 208 246 250 276 344 348 380 398 410 440 442 528 576
## 1 4 2 2 1 1 1 2 1 1 4 1 1 2 1 3 1 1 3 6
## 616 620 643 703 705 756 764 792 840 858
## 1 1 2 1 1 1 1 1 4 1

length(table(dat$IDCOUNTRY))

## [1] 30

## Primary studies
table(dat$IDSTUDY)

##
## 1 2 4 5 6 8 9 10 11 12 13 14 15 16 18 19 20 21 22 23 24
## 1 1 1 1 1 21 13 1 1 1 1 1 1 1 1 1 1 1 1 1 1

length(table(dat$IDSTUDY))

## [1] 21

## Unique study samples
table(dat$IDSAMPLE)

##
## 2 4 6 7 8 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
## 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 52 53 55 56 57 58
## 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## 59
## 1
```

```
length(table(dat$IDSAMPLE))
```

```
## [1] 53
```

```
## Overall sample sizes
```

```
sum(dat$N)
```

```
## [1] 137895
```

```
sum(dat$nF)
```

```
## [1] 67639
```

```
sum(dat$nM)
```

```
## [1] 70256
```

Meta-Analysis of Effect Sizes

Meta-analytic baseline model

To describe the complexity of the meta-analytic data, we test several meta-analytic model with random effects and compare them.

Standard random-effects model with between-sample heterogeneity

```
## Model estimation
REM2 <- rma.mv(g,
              vg,
              random = list(~ 1 | IDSAMPLE),
              method = "REML",
              data = dat,
              slab = paste(Sample),
              tdist = TRUE,
              test = "t")

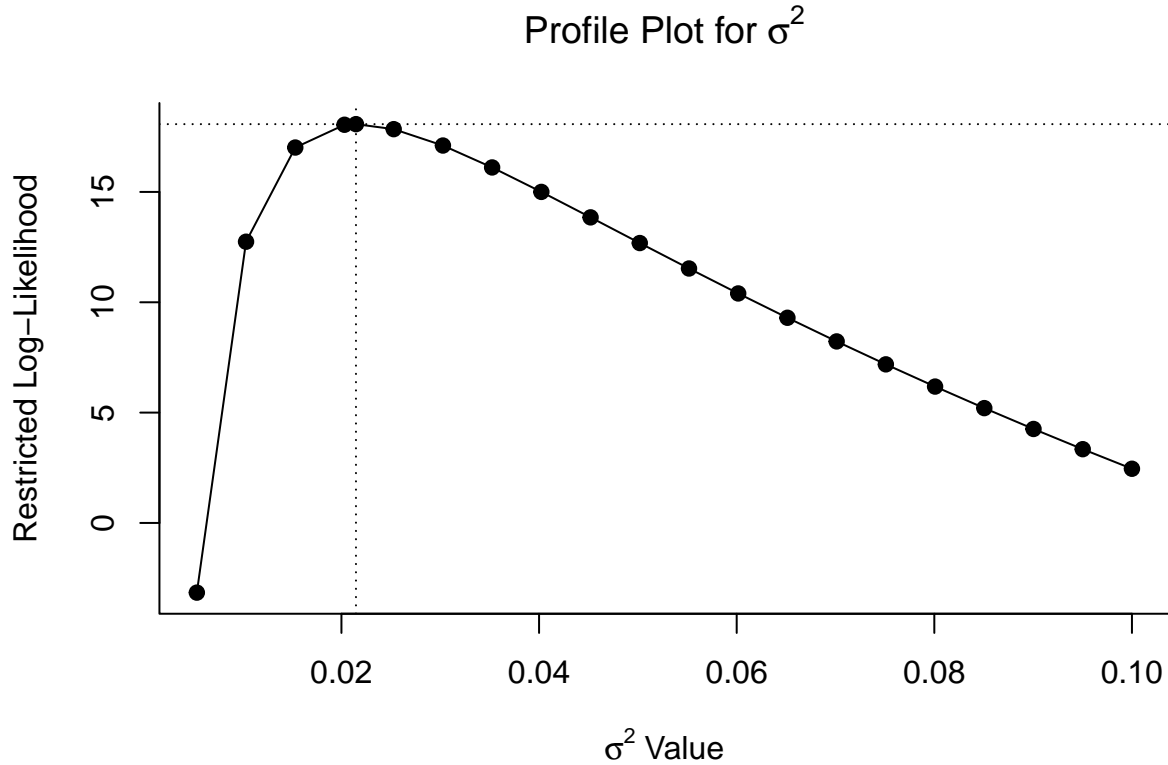
## Model summary
summary(REM2, digits = 4)

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC     AICc
## 18.0723 -36.1445 -32.1445 -28.2420 -31.8996
##
## Variance Components:
##
##           estim      sqrt  nlvls  fixed  factor
## sigma^2    0.0215  0.1465     53     no  IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 52) = 640.3794, p-val < .0001
##
## Model Results:
##
## estimate      se      tval  df      pval  ci.lb  ci.ub
## 0.1809  0.0216  8.3642  52  <.0001  0.1375  0.2243 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Variances: 95 % confidence intervals
confint(REM2, digits = 4)

##
##           estimate  ci.lb  ci.ub
## sigma^2    0.0215  0.0137  0.0351
## sigma      0.1465  0.1171  0.1873
```

```
## Profile plots of the variance component(s)
profile.rma.mv(REM2, sigma2 = 1)
```



```
## Robust standard errors
coef_test(REM2, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.181 0.0216   8.37  50    <0.001 ***
```

Three-level random-effects model with hierarchical effects (HE model)

In this model, we account for the nesting of samples in primary studies. We assume a strict hierarchical structure, because each sample within a study provides only one effect size derived from one measure.

```
## Model estimation
REM3 <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")
```

```
## Model summary
```

```
summary(REM3, digits = 4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 21.8958 -43.7917 -37.7917 -31.9379 -37.2917
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0206 0.1437   21    no      IDSTUDY
## sigma^2.2 0.0129 0.1137   53    no  IDSTUDY/IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 52) = 640.3794, p-val < .0001
##
## Model Results:
##
## estimate      se    tval  df    pval  ci.lb  ci.ub  *
## 0.1057 0.0429 2.4661 52 0.0170 0.0197 0.1917 *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Variances: 95 % confidence intervals
```

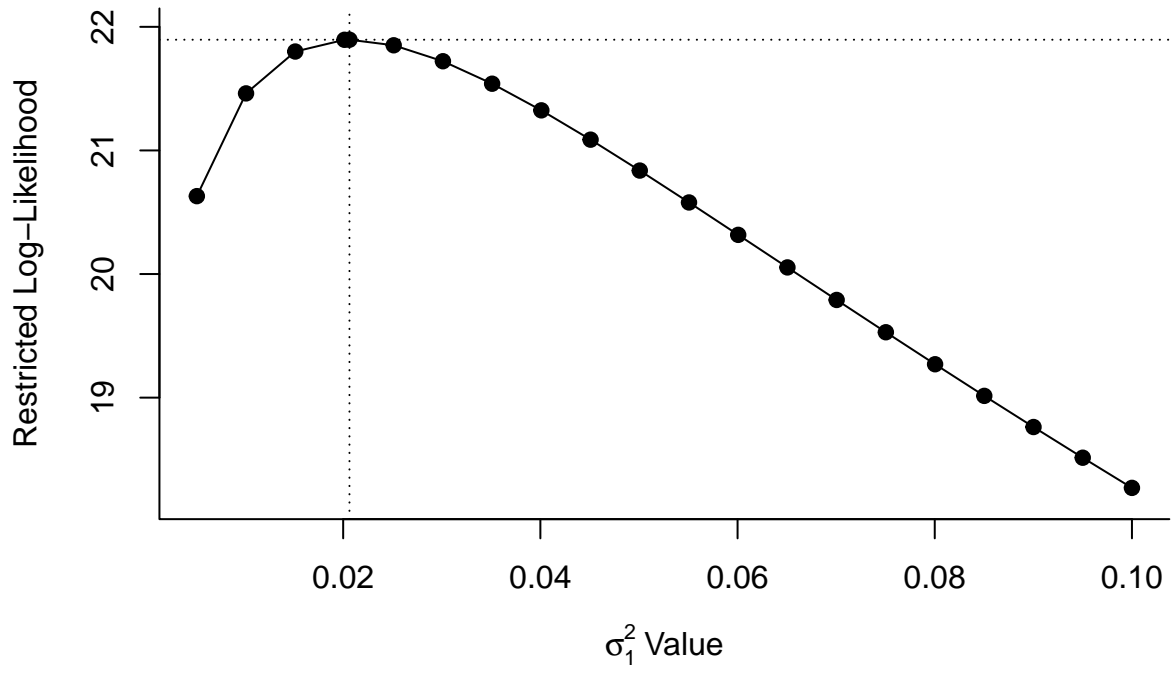
```
confint(REM3, digits = 4)
```

```
##
##      estimate  ci.lb  ci.ub
## sigma^2.1 0.0206 0.0031 0.0666
## sigma.1 0.1437 0.0555 0.2580
##
##      estimate  ci.lb  ci.ub
## sigma^2.2 0.0129 0.0076 0.0232
## sigma.2 0.1137 0.0873 0.1524
```

```
## Profile plots of the variance component(s)
```

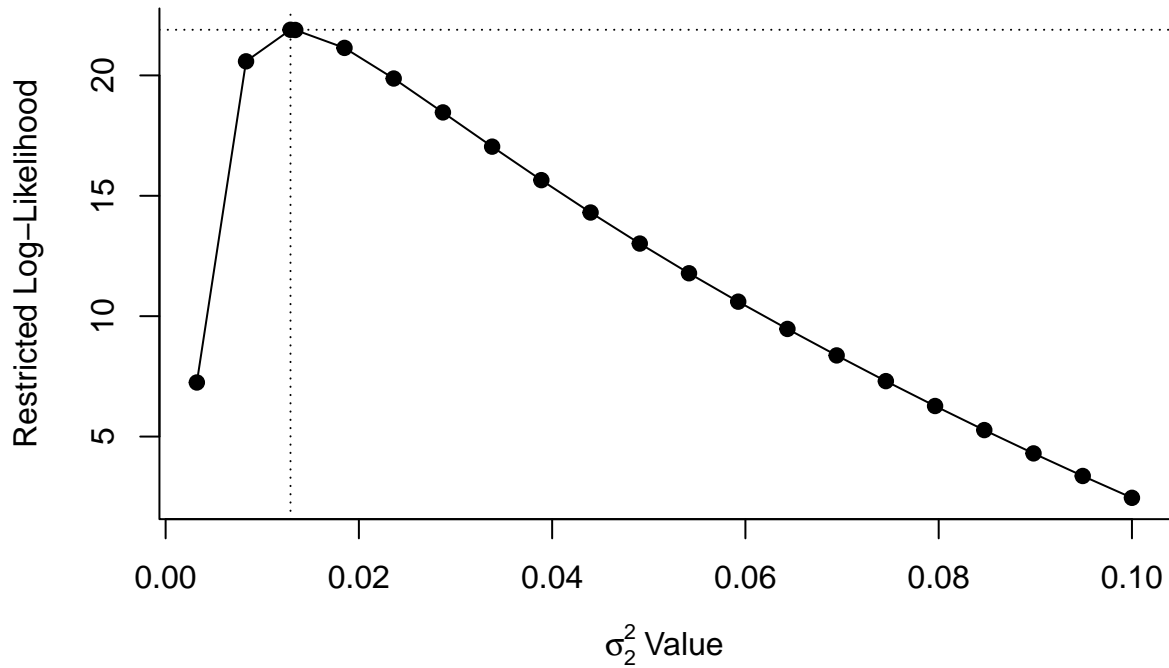
```
profile.rma.mv(REM3, sigma2 = 1)
```

Profile Plot for σ_1^2



```
profile.rma.mv(REM3, sigma2 = 2)
```

Profile Plot for σ_2^2



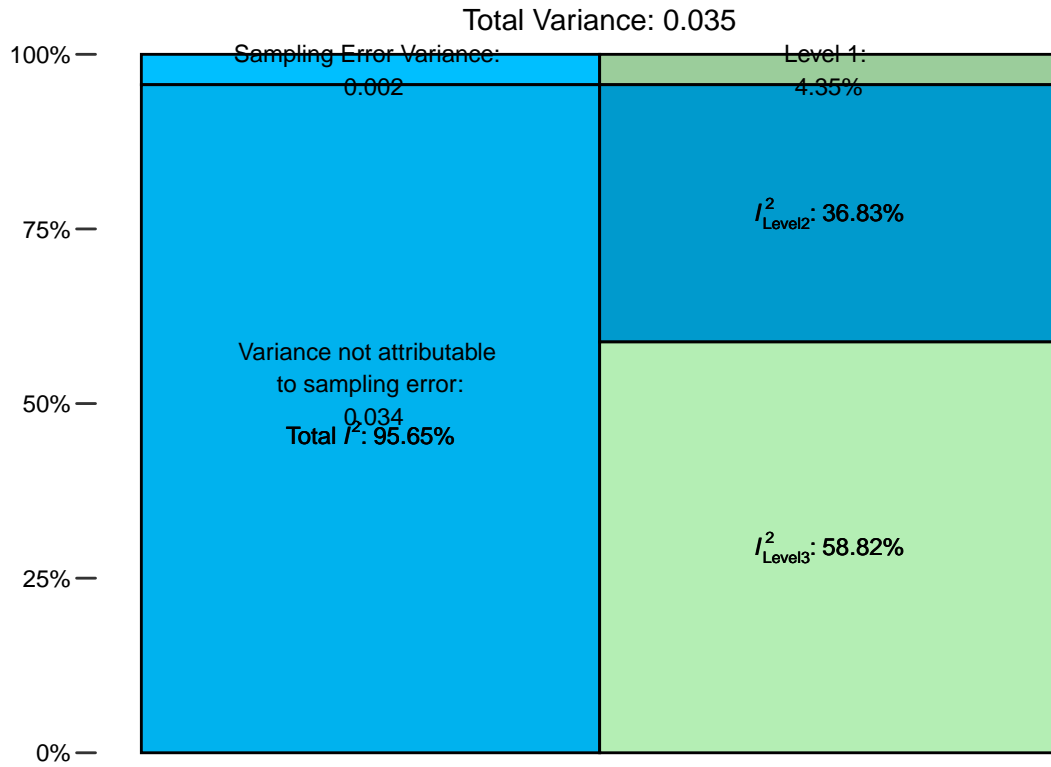
```
## Robust standard errors
coef_test(REM3, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.106 0.0427   2.47 17.8   0.0236  *
```

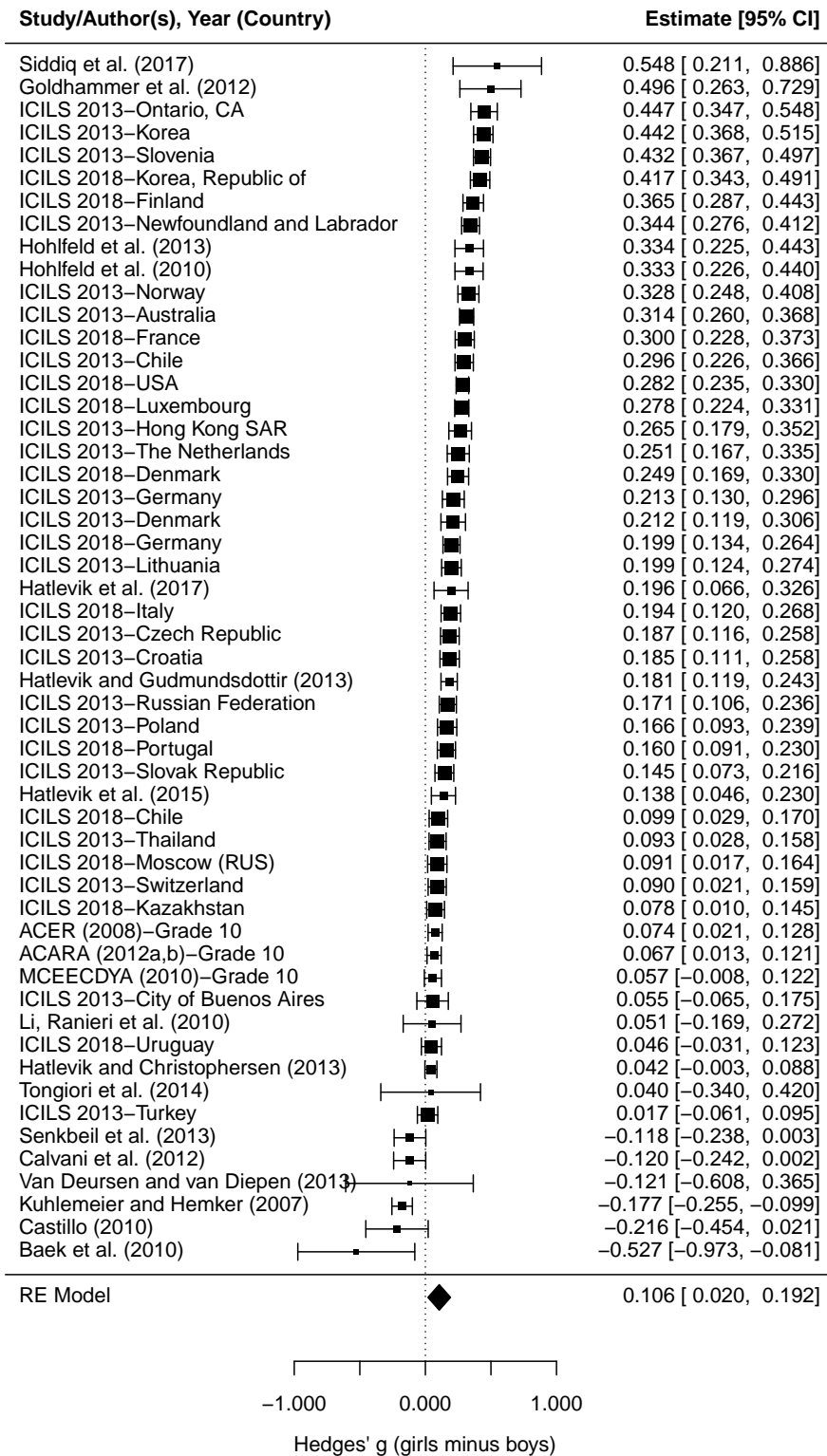
```
## Variance components: Overview
dmetar::var.comp(REM3)
```

```
##          % of total variance      I2
## Level 1          4.34887      ---
## Level 2          36.83168 36.83
## Level 3          58.81945 58.82
## Total I2: 95.65%
```

```
plot(dmetar::var.comp(REM3))
```



```
## Forest plot
forest.rma(REM3,
  addfit = TRUE,
  order = "obs",
  header = "Study/Author(s), Year (Country)",
  refline = 0,
  rows = 1:REM3$k,
  digits = 3,
  level = 95,
  cex = .9,
  xlab = "Hedges' g (girls minus boys)")
```



Both the confidence intervals and the likelihood plots indicate that heterogeneity within and between studies exists.

Alternatively, we may ignore the clustering of samples in studies and model the clustering in countries.

```
## Model estimation
REM3c <- rma.mv(g,
  vg,
  random = list(~ 1 | IDCOUNTRY/IDSAMPLE),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")

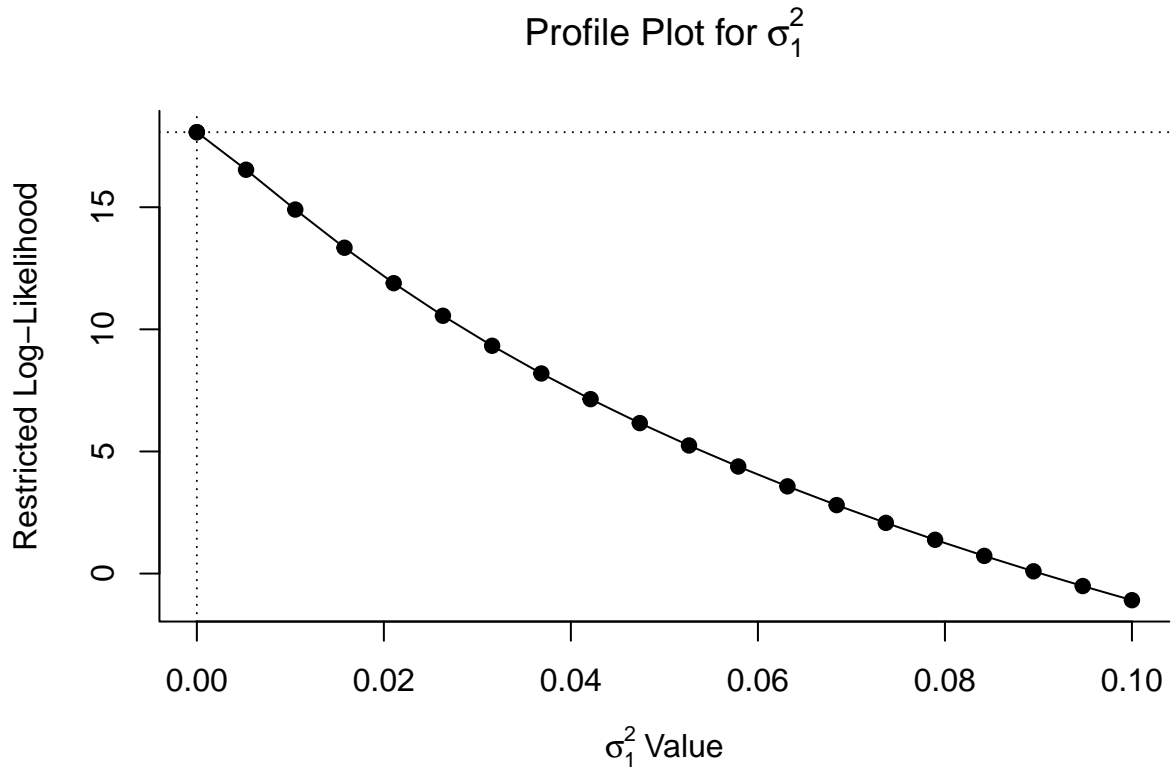
## Model summary
summary(REM3c, digits = 4)

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik Deviance      AIC      BIC      AICc
## 18.0723 -36.1445 -30.1445 -24.2908 -29.6445
##
## Variance Components:
##
##      estim      sqrt  nlvls  fixed      factor
## sigma^2.1 0.0000 0.0000   30    no      IDCOUNTRY
## sigma^2.2 0.0215 0.1465   53    no IDCOUNTRY/IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 52) = 640.3794, p-val < .0001
##
## Model Results:
##
## estimate      se      tval  df      pval  ci.lb  ci.ub  ***
## 0.1809 0.0216 8.3642 52 <.0001 0.1375 0.2243 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Variances: 95 % confidence intervals
confint(REM3c, digits = 4)

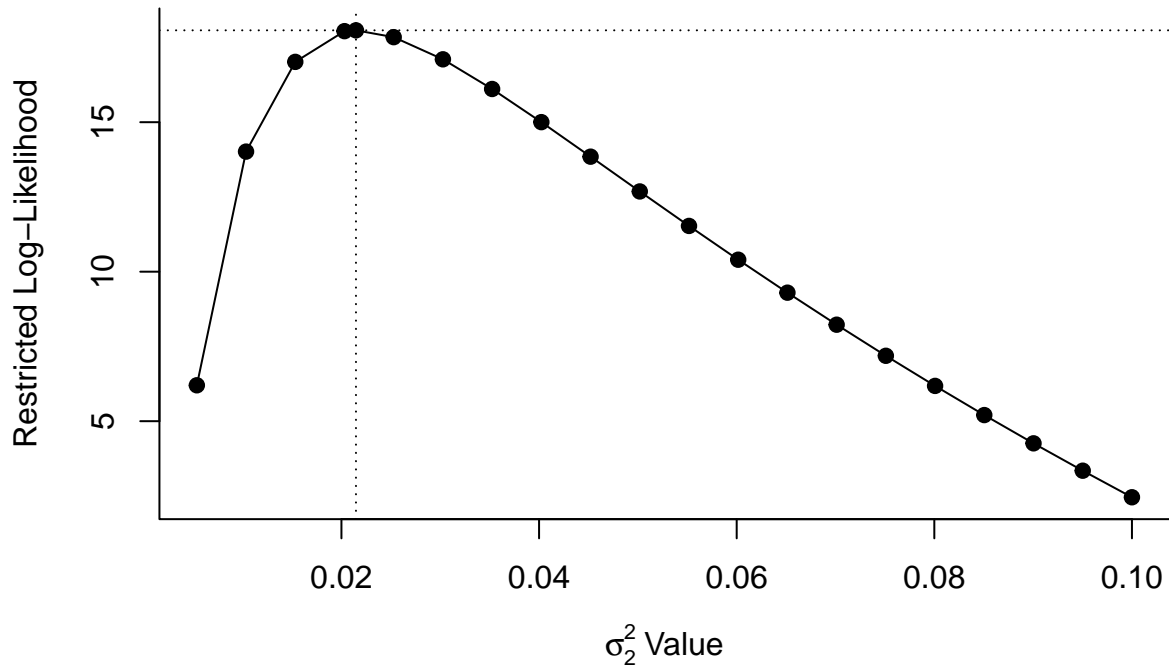
##
##      estimate  ci.lb  ci.ub
## sigma^2.1 0.0000 0.0000 0.0065
## sigma.1 0.0000 0.0000 0.0806
##
##      estimate  ci.lb  ci.ub
## sigma^2.2 0.0215 0.0134 0.0351
## sigma.2 0.1465 0.1159 0.1873
```

```
## Profile plots of the variance component(s)
profile.rma.mv(REM3c, sigma2 = 1)
```



```
profile.rma.mv(REM3c, sigma2 = 2)
```

Profile Plot for σ_2^2



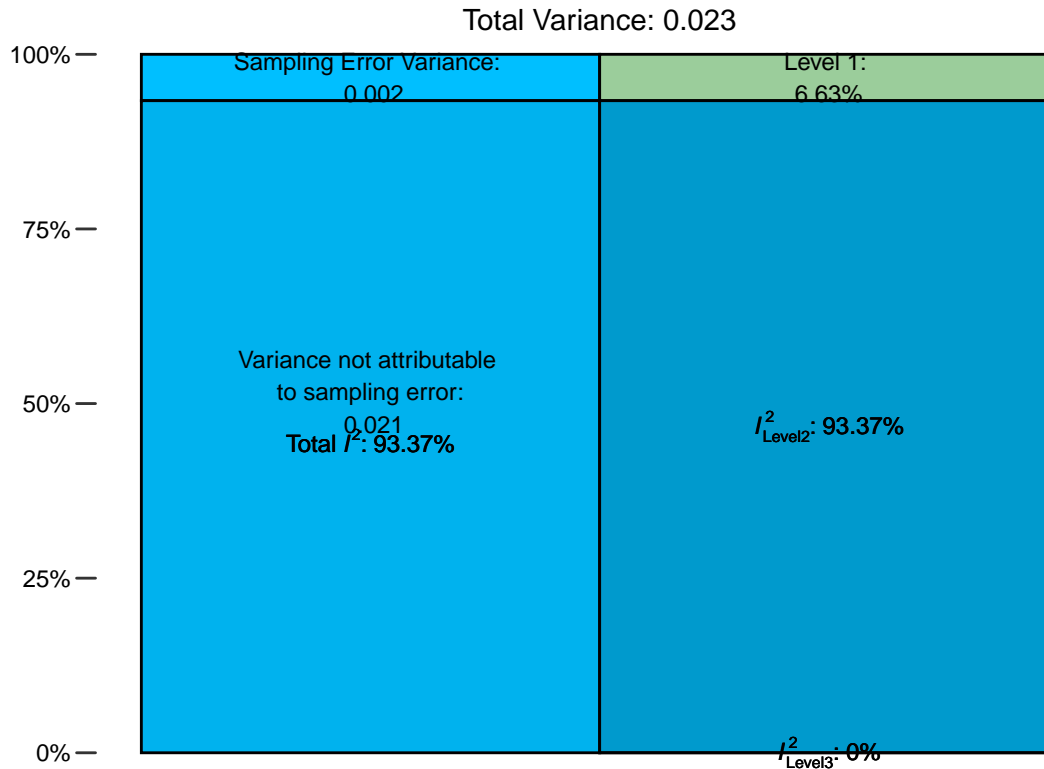
```
## Robust standard errors
coef_test(REM3c, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.181 0.0185   9.78 19.4   <0.001 ***
```

```
## Variance components: Overview
dmetar::var.comp(REM3c)
```

```
##          % of total variance      I2
## Level 1          6.634828e+00    ---
## Level 2          9.336517e+01  93.37
## Level 3          2.355424e-08     0
## Total I2: 93.37%
```

```
plot(dmetar::var.comp(REM3c))
```



Cross-classified random-effects model (CCREM model)

This model assumes four levels of variance: sampling variance (level 1), variance within studies (level 2), variance between studies (level 3), and variance between countries (level 4). Given that some countries are represented in multiple primary studies and IPD data sets, levels 3 and 4 are not hierarchically nested. Hence, the meta-analytic data structure is represented by cross-classification.

```
## Model estimation
CCREM4 <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE,
               ~ 1 | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")

## Model summary
summary(CCREM4, digits = 4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
## logLik Deviance AIC BIC AICc
```

```

## 23.0232 -46.0464 -38.0464 -30.2414 -37.1953
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0312 0.1767   21    no      IDSTUDY
## sigma^2.2 0.0028 0.0532   53    no  IDSTUDY/IDSAMPLE
## sigma^2.3 0.0093 0.0962   30    no      IDCOUNTRY
##
## Test for Heterogeneity:
## Q(df = 52) = 640.3794, p-val < .0001
##
## Model Results:
##
## estimate      se      tval  df      pval      ci.lb      ci.ub
## 0.0549 0.0504 1.0899 52 0.2808 -0.0462 0.1561
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Variances: 95 % confidence intervals
confint(CCREM4, digits = 4)

```

```

##
##      estimate  ci.lb  ci.ub
## sigma^2.1 0.0312 0.0074 0.0828
## sigma.1 0.1767 0.0862 0.2878
##
##      estimate  ci.lb  ci.ub
## sigma^2.2 0.0028 0.0000 0.0187
## sigma.2 0.0532 0.0000 0.1367
##
##      estimate  ci.lb  ci.ub
## sigma^2.3 0.0093 0.0000 0.0202
## sigma.3 0.0962 0.0000 0.1422

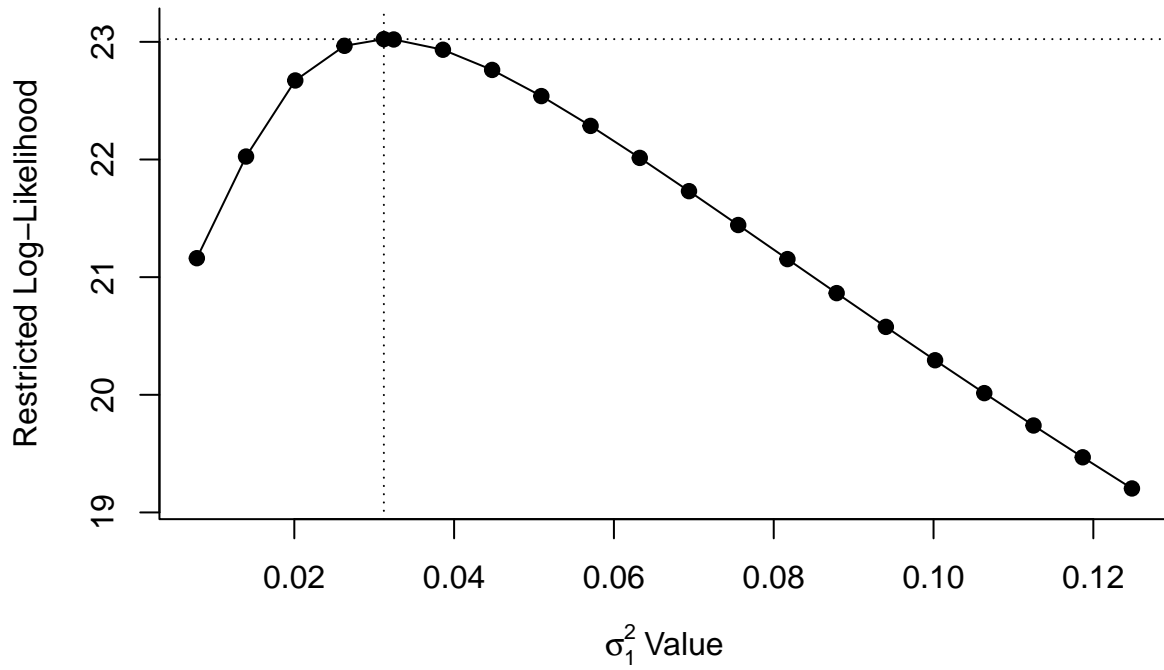
```

```

## Profile plot of the variance component(s)
profile.rma.mv(CCREM4, sigma2 = 1)

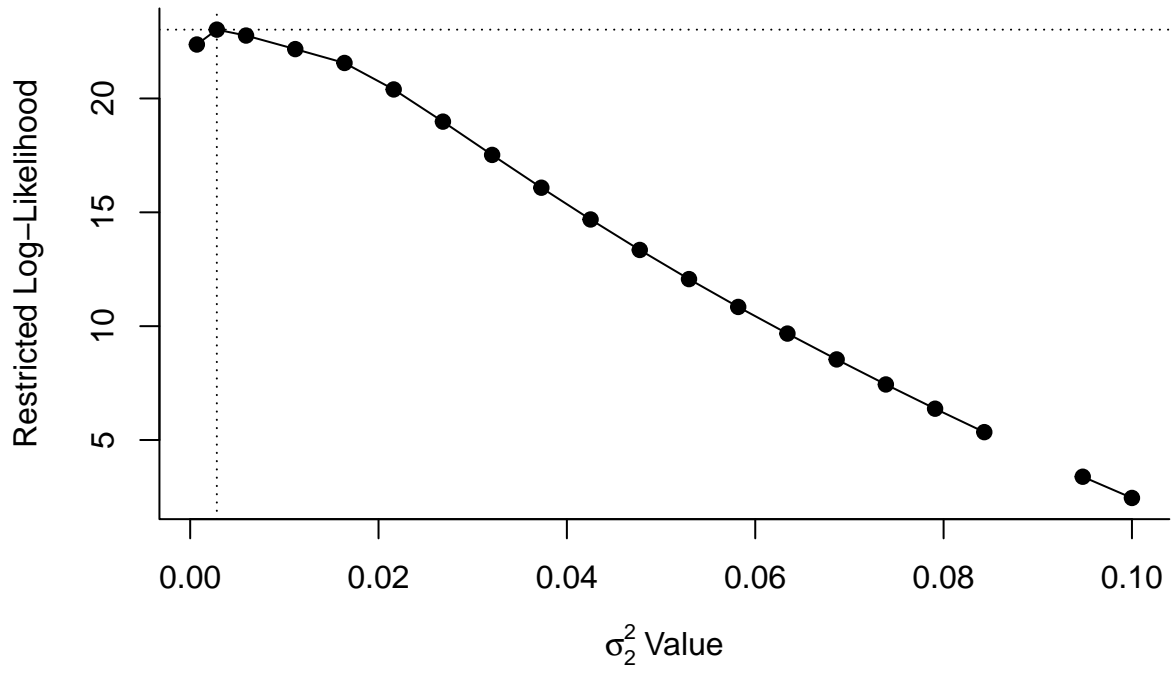
```

Profile Plot for σ_1^2



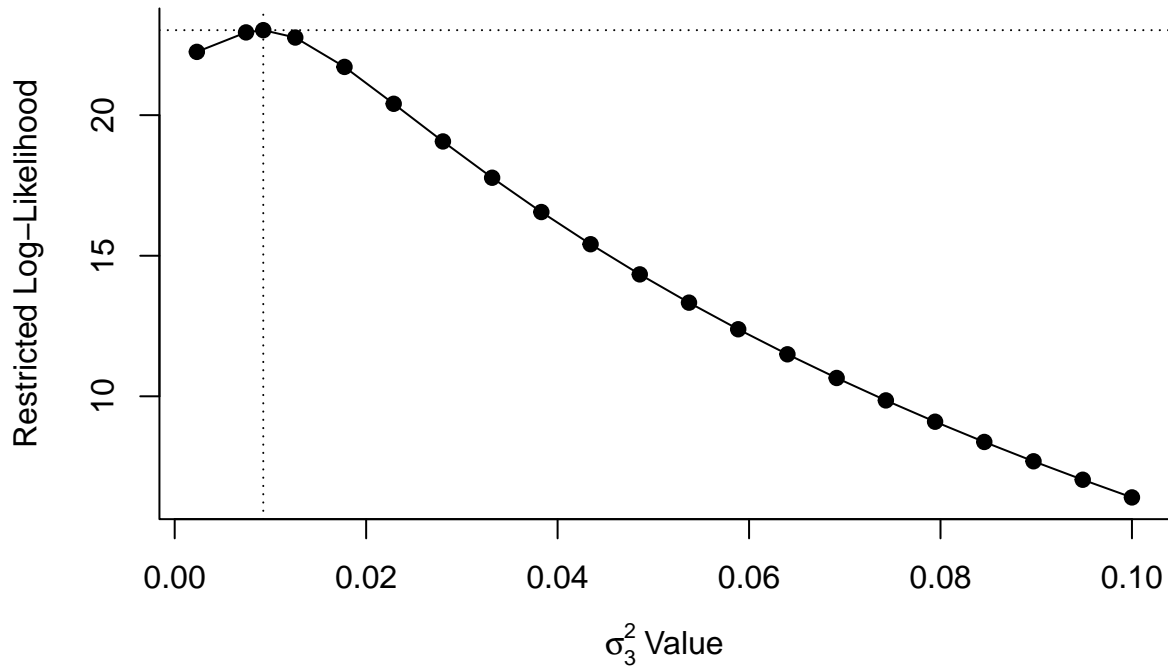
```
profile.rma.mv(CCREM4, sigma2 = 2)
```

Profile Plot for σ_2^2



```
profile.rma.mv(CCREM4, sigma2 = 3)
```

Profile Plot for σ_3^2



Model comparisons

```
## REM3 vs. REM2
anova.rma(REM2, REM3)
```

```
##
##          df      AIC      BIC      AICc  logLik    LRT    pval      QE
## Full      3 -37.7917 -31.9379 -37.2917  21.8958          640.3794
## Reduced   2 -32.1445 -28.2420 -31.8996  18.0723  7.6471  0.0057  640.3794
```

```
## CCREM4 vs. REM3
anova.rma(REM3, CCREM4)
```

```
##
##          df      AIC      BIC      AICc  logLik    LRT    pval      QE
## Full      4 -38.0464 -30.2414 -37.1953  23.0232          640.3794
## Reduced   3 -37.7917 -31.9379 -37.2917  21.8958  2.2547  0.1332  640.3794
```

The three-level random-effects model with hierarchical effects (REM3) represents the data better than the standard model (REM2). The between-study and within-study variance components are different from zero. However, adding the country level to the data (CCREM4) only improved the model fit marginally, yet not significantly. Between-country variation is small.

To conclude, the model **REM3** represents the variation in the meta-analytic data set best; however, the model **CCREM4** provides evidence for some but small variation across countries. Both models exhibit similar model fit.

Moderator analyses

We extend the meta-analytic baseline models by possible moderators to mixed-effects meta-regression models.

Moderation by multiple test and country characteristics

In these analyses, we test multiple moderator effects.

```
## Model estimation
MEM3a <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ Interactivity +
  RandomSample +
  TestFair +
  PDI +
  logGDP)

## Model summary
summary(MEM3a, digits = 4)
```

Three-level mixed-effects meta-regression model

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik Deviance      AIC      BIC      AICc
## 26.5489 -53.0978 -37.0978 -22.2966 -33.3083
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0172 0.1312   21    no      IDSTUDY
## sigma^2.2 0.0095 0.0975   53    no  IDSTUDY/IDSAMPLE
##
## Test for Residual Heterogeneity:
## QE(df = 47) = 363.8892, p-val < .0001
##
## Test of Moderators (coefficients 2:6):
## F(df1 = 5, df2 = 47) = 3.9130, p-val = 0.0048
##
## Model Results:
##
##      estimate      se      tval  df      pval      ci.lb      ci.ub
## intrcpt      -1.0351 0.4217 -2.4545 47 0.0179 -1.8835 -0.1867 *
```

```
## Interactivity    0.1299  0.0980   1.3264  47  0.1911  -0.0671  0.3270
## RandomSample    -0.0594  0.0718  -0.8277  47  0.4120  -0.2039  0.0850
## TestFair        0.1427  0.0859   1.6603  47  0.1035  -0.0302  0.3156
## PDI              0.0008  0.0013   0.6320  47  0.5305  -0.0017  0.0033
## logcGDP         0.0969  0.0348   2.7822  47  0.0077   0.0268  0.1669  **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Robust standard errors
coef_test(MEM3a, vcov = "CR2")
```

```
##          Coef. Estimate      SE t-stat  d.f. p-val (Satt) Sig.
## 1      intrcpt -1.035095 0.232215 -4.457  1.42   0.0838  .
## 2  Interactivity  0.129945 0.073180  1.776  5.01   0.1359
## 3  RandomSample -0.059437 0.075761 -0.785  3.59   0.4813
## 4      TestFair  0.142701 0.094360  1.512 14.20   0.1524
## 5          PDI   0.000792 0.000499  1.586  1.08   0.3451
## 6      logcGDP  0.096887 0.016208  5.978  1.39   0.0589  .
```

```
## Variance inflation factors
metafor::vif.rma(MEM3a)
```

```
##
## Interactivity  RandomSample      TestFair      PDI      logcGDP
##          1.1447          1.1195          1.1987          2.2492          2.2732
```

```
## Level-specific variance explanations
## R-squared as the proportional variance reductions
max((REM3$sigma2[1]-MEM3a$sigma2[1])/REM3$sigma2[1],0)
```

```
## [1] 0.1656088
```

```
max((REM3$sigma2[2]-MEM3a$sigma2[2])/REM3$sigma2[2],0)
```

```
## [1] 0.2639033
```

```
## Model estimation
CCMEM4a <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE,
    ~ 1 | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ Interactivity +
```

```

RandomSample +
TestFair +
PDI +
logcGDP)

```

```

## Model summary
summary(CCMEM4a, digits = 4)

```

Cross-classified mixed-effects meta-regression model

```

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 27.1653 -54.3305 -36.3305 -19.6792 -31.4657
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0255 0.1598    21    no      IDSTUDY
## sigma^2.2 0.0031 0.0553    53    no  IDSTUDY/IDSAMPLE
## sigma^2.3 0.0057 0.0752    30    no      IDCOUNTRY
##
## Test for Residual Heterogeneity:
## QE(df = 47) = 363.8892, p-val < .0001
##
## Test of Moderators (coefficients 2:6):
## F(df1 = 5, df2 = 47) = 3.6350, p-val = 0.0073
##
## Model Results:
##
##           estimate      se      tval  df      pval      ci.lb      ci.ub
## intrcpt      -1.0402  0.4162  -2.4992  47  0.0160  -1.8775  -0.2029  *
## Interactivity  0.1334  0.1101  1.2115  47  0.2318  -0.0881  0.3549
## RandomSample  -0.0477  0.0667  -0.7142  47  0.4786  -0.1819  0.0866
## TestFair      0.1444  0.0926  1.5597  47  0.1255  -0.0418  0.3305
## PDI           0.0008  0.0013  0.5974  47  0.5531  -0.0018  0.0034
## logcGDP       0.0959  0.0347  2.7637  47  0.0081  0.0261  0.1658  **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Level-specific variance explanations
## R-squared as the proportional variance reductions
max((CCREM4$sigma2[1]-CCMEM4a$sigma2[1])/CCREM4$sigma2[1],0)

```

```
## [1] 0.1822424
```

```
max((CCREM4$sigma2[2]-CCMEM4a$sigma2[2])/CCREM4$sigma2[2],0)
```

```
## [1] 0
```

```
max((CCREM4$sigma2[3]-CCMEM4a$sigma2[3])/CCREM4$sigma2[3],0)
```

```
## [1] 0.3891347
```

Both mixed-effects meta-regression models suggest a moderation by the log-transformed and mean-centered GDP (logcGDP). Specifically, the higher the logcGDP value, the larger the gender differences in favor of girls.

Moderation by a test and a country characteristic and their interaction

```
## Model estimation
MEM3b <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ AppliedSkills*scale(PDI,
                                center = TRUE,
                                scale = TRUE))

## Model summary
summary(MEM3b, digits = 4)
```

Three-level mixed-effects meta-regression model with hierarchical effects

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 24.1458 -48.2917 -36.2917 -24.9408 -34.2917
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0201 0.1417   21    no      IDSTUDY
## sigma^2.2 0.0119 0.1089   53    no  IDSTUDY/IDSAMPLE
##
## Test for Residual Heterogeneity:
## QE(df = 49) = 515.4162, p-val < .0001
##
## Test of Moderators (coefficients 2:4):
## F(df1 = 3, df2 = 49) = 2.9795, p-val = 0.0403
##
## Model Results:
##
##                                     estimate      se
## intrcpt                             -0.2337  0.1548
```

```

## AppliedSkills                0.3658  0.1635
## scale(PDI, center = TRUE, scale = TRUE)  -0.4039  0.1998
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE)  0.3691  0.2007
##                                tval  df   pval
## intrcpt                       -1.5097  49  0.1375
## AppliedSkills                   2.2368  49  0.0299
## scale(PDI, center = TRUE, scale = TRUE)  -2.0213  49  0.0487
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE)  1.8396  49  0.0719
##                                ci.lb  ci.ub
## intrcpt                       -0.5448  0.0774
## AppliedSkills                   0.0372  0.6944 *
## scale(PDI, center = TRUE, scale = TRUE)  -0.8055 -0.0023 *
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE) -0.0341  0.7724 .
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Robust standard errors
coef_test(MEM3b, vcov = "CR2")

```

```

##                                Coef. Estimate    SE t-stat
## 1                                intrcpt    -0.234 0.0814  -2.87
## 2                                AppliedSkills  0.366 0.1023   3.58
## 3                                scale(PDI, center = TRUE, scale = TRUE) -0.404 0.1062  -3.80
## 4 AppliedSkills:scale(PDI, center = TRUE, scale = TRUE)  0.369 0.1073   3.44
##  d.f. p-val (Satt) Sig.
## 1 1.60    0.1320
## 2 1.99    0.0706 .
## 3 1.71    0.0798 .
## 4 1.74    0.0914 .

```

```

## Level-specific variance explanations
## R-squared as the proportional variance reductions
max((REM3$sigma2[1]-MEM3b$sigma2[1])/REM3$sigma2[1],0)

```

```
## [1] 0.02680325
```

```
max((REM3$sigma2[2]-MEM3b$sigma2[2])/REM3$sigma2[2],0)
```

```
## [1] 0.08208763
```

```

## Model estimation
CCMEM4b <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE,
    ~ 1 | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),

```

```

      tdist = TRUE,
      test = "t",
      mods =~ AppliedSkills*scale(PDI,
                                   center = TRUE,
                                   scale = TRUE))

## Model summary
summary(CCMEM4b, digits = 4)

```

Cross-classified mixed-effects meta-regression model

```

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik Deviance      AIC      BIC      AICc
## 26.3005 -52.6010 -38.6010 -25.3583 -35.8693
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed      factor
## sigma^2.1 0.0270 0.1642   21    no      IDSTUDY
## sigma^2.2 0.0024 0.0487   53    no  IDSTUDY/IDSAMPLE
## sigma^2.3 0.0090 0.0946   30    no      IDCOUNTRY
##
## Test for Residual Heterogeneity:
## QE(df = 49) = 515.4162, p-val < .0001
##
## Test of Moderators (coefficients 2:4):
## F(df1 = 3, df2 = 49) = 3.5831, p-val = 0.0202
##
## Model Results:
##
##                                     estimate      se
## intrcpt                            -0.3407  0.1572
## AppliedSkills                        0.4563  0.1662
## scale(PDI, center = TRUE, scale = TRUE) -0.4839  0.2034
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE) 0.4481  0.2029
##
##                                     tval  df  pval
## intrcpt                            -2.1672  49  0.0351
## AppliedSkills                        2.7457  49  0.0084
## scale(PDI, center = TRUE, scale = TRUE) -2.3795  49  0.0213
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE) 2.2085  49  0.0319
##
##                                     ci.lb  ci.ub
## intrcpt                            -0.6566 -0.0248  *
## AppliedSkills                        0.1223  0.7902  **
## scale(PDI, center = TRUE, scale = TRUE) -0.8926 -0.0752  *
## AppliedSkills:scale(PDI, center = TRUE, scale = TRUE) 0.0404  0.8559  *
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Level-specific variance explanations
## R-squared as the proportional variance reductions
max((CCREM4$sigma2[1]-CCMEM4b$sigma2[1])/CCREM4$sigma2[1],0)

```

```
## [1] 0.1357047
```

```
max((CCREM4$sigma2[2]-CCMEM4b$sigma2[2])/CCREM4$sigma2[2],0)
```

```
## [1] 0.1636761
```

```
max((CCREM4$sigma2[3]-CCMEM4b$sigma2[3])/CCREM4$sigma2[3],0)
```

```
## [1] 0.03258792
```

These models suggest a significant and positive interaction effect (**AppliedSkills*PDI**) and significant main effects (negative for PDI and positive for **AppliedSkills**).

- For applied skills assessed in primary studies (**AppliedSkills==1**) in model **MEM3c** (without cluster-robust estimation), the expected value is $-0.2337+0.3658-0.4039* PDI + 0.3691* PDI = 0.1321-0.0348* PDI$. Hence, the higher the power distance index is, the smaller the gender gap becomes and the more it may favor boys.
- For knowledge assessed in primary studies (**AppliedSkills==0**) in model **MEM3c** (without cluster-robust estimation), the expected value is $-0.2337-0.4039* PDI$. Hence, the higher the power distance index is, the larger the gender gap becomes in favor of boys.

Selection and publication bias

Given that the data set contains both AD and IPD data, selection and publication bias may exist.

Egger's Regression (Precision-Effect) Test (PET)

```
## Details: https://wviechtb.github.io/metafor/reference/regtest.html
## Three-level MEM
MEM3.pet <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSTUDY/IDSAMPLE),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ sqrt(vg))

# Summarize the results
summary(MEM3.pet, digits=4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 22.0102 -44.0204 -36.0204 -28.2931 -35.1508
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1  0.0214  0.1464    21    no      IDSTUDY
## sigma^2.2  0.0130  0.1139    53    no  IDSTUDY/IDSAMPLE
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 638.6053, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 0.9371, p-val = 0.3376
##
## Model Results:
##
##           estimate      se    tval  df    pval    ci.lb  ci.ub
## intrcpt    0.1562  0.0682   2.2909  51  0.0261  0.0193  0.2931 *
## sqrt(vg)  -0.7614  0.7865  -0.9681  51  0.3376 -2.3403  0.8176
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

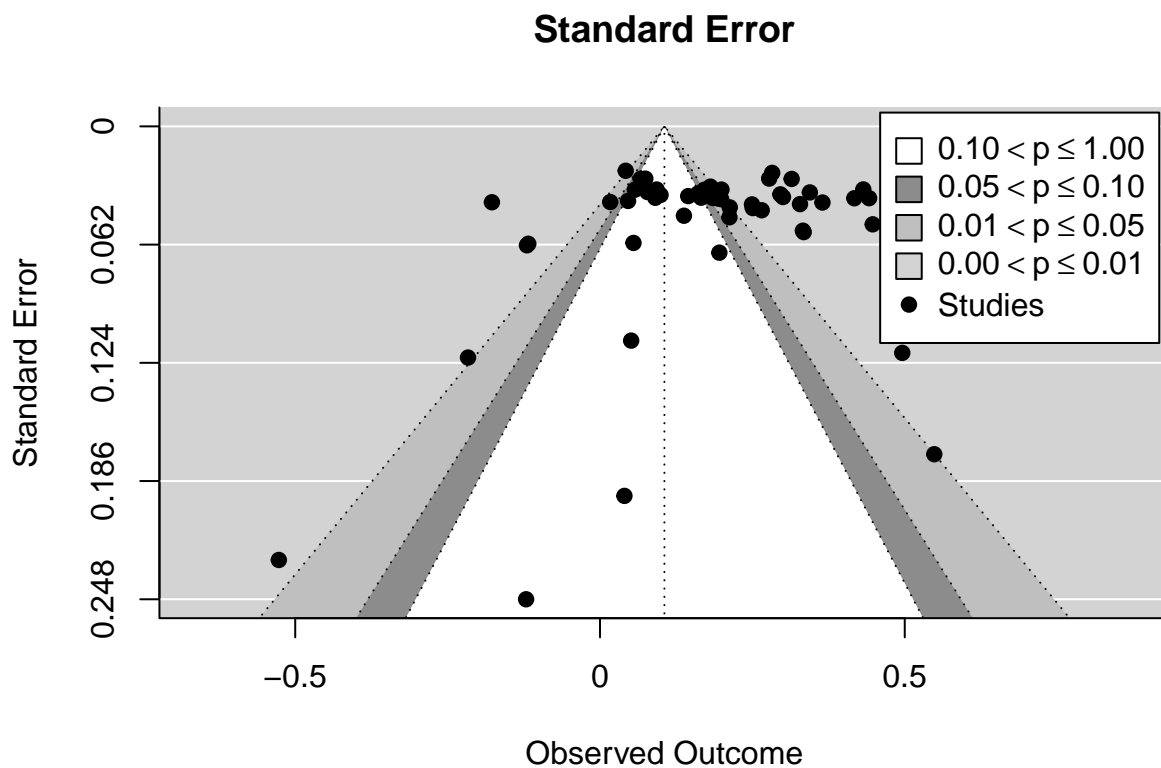
```
## Robust standard errors
coef_test(MEM3.pet, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1  intrcpt      0.156 0.0615  2.542 13.2   0.0244  *
## 2  sqrt(vg)    -0.761 0.9864 -0.772  7.0   0.4654
```

This model does not show a significant moderation effect of the sampling error. Hence, there is no evidence on selection (publication) bias from this analysis.

Funnel Plot Test (FPT)

```
## Contour-enhanced funnel plot
funnel(REM3, main="Standard Error",
       level = c(90, 95, 99),
       shade = c("white", "gray55", "gray75"),
       legend = TRUE)
```



```
## Three-level MEM
MEM3.fpt <- rma.mv(g,
                  vg,
                  random = list(~ 1 | IDSTUDY/IDSAMPLE),
                  method = "REML",
                  data = dat,
                  slab = paste(Sample),
                  tdist = TRUE,
```

```

      test = "t",
      mods = ~ N)

## Summarize the results
summary(MEM3.fpt, digits=4)

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 21.3531 -42.7063 -34.7063 -26.9790 -33.8367
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1  0.0218  0.1475   21    no      IDSTUDY
## sigma^2.2  0.0130  0.1138   53    no  IDSTUDY/IDSAMPLE
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 637.6175, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 0.6075, p-val = 0.4393
##
## Model Results:
##
##           estimate      se   tval  df   pval   ci.lb  ci.ub
## intrcpt    0.0770  0.0565  1.3618  51  0.1792 -0.0365  0.1905
## N          0.0000  0.0000  0.7794  51  0.4393 -0.0000  0.0000
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

No evidence on possible publication (selection) bias.

Precision-Effect Estimate with SE (PEESE)

```

## Three-level MEM
MEM3.peese <- rma.mv(g,
                    vg,
                    random = list(~ 1 | IDSTUDY/IDSAMPLE),
                    method = "REML",
                    data = dat,
                    slab = paste(Sample),
                    tdist = TRUE,
                    test = "t",
                    mods = ~ vg)

## Summarize the results
summary(MEM3.peese, digits=4)

```

```

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 22.3171 -44.6342 -36.6342 -28.9069 -35.7646
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1  0.0204  0.1430    21    no      IDSTUDY
## sigma^2.2  0.0130  0.1140    53    no  IDSTUDY/IDSAMPLE
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 635.3130, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 1.4620, p-val = 0.2322
##
## Model Results:
##
##           estimate      se      tval  df      pval      ci.lb  ci.ub
## intrcpt      0.1349  0.0491   2.7490  51  0.0082   0.0364  0.2335  **
## vg           -4.0023  3.3101  -1.2091  51  0.2322  -10.6476  2.6429
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

No evidence on possible publication (selection) bias.

Begg's Correlation Test (BCT)

```

## Source code: Fernandez-Castilla et al. (2021)
## https://doi.org/10.1080/00220973.2019.1582470

## Define the precision
preci = 1/dat$vg
Stand_Var = dat$vg - (1/(sum(preci)))

## Draw from the model REM3Lc
## Define the pooled effect size from a baseline model
pooled_es <- REM3$b[1]
Stand_es <- (dat$g - (pooled_es))/sqrt(Stand_Var)
N <- dat$N
df_cor_N <- data.frame(Stand_es, N)

## Correlation coefficient and test
cor(df_cor_N, method = "kendall" )

```

```

##           Stand_es      N
## Stand_es 1.000000 0.138657
## N        0.138657 1.000000

```

```
bct <- cor.test(Stand_es, N, method = "kendall")
bct
```

```
##
## Kendall's rank correlation tau
##
## data: Stand_es and N
## z = 1.4651, p-value = 0.1429
## alternative hypothesis: true tau is not equal to 0
## sample estimates:
##      tau
## 0.138657
```

No evidence on possible publication (selection) bias.

Trim-and-fill analyses

```
## Source code: Fernandez-Castilla et al. (2021)
## https://doi.org/10.1080/00220973.2019.1582470

## Create an object d with all observed effect sizes
d <- dat$g

## Create a new function
## see the source code
RO_func<-function(d, pooled_d){
  d_difference1=0
  rank_positive=0
  final_rank=0
  d_difference<- d-pooled_d
  for(i in 1:length(d_difference)){
    d_difference1[i]<- if ( d_difference[i]<0) d_difference[i]*-1
    else d_difference[i] }
  rank_positive<-rank(d_difference1)
  for(i in 1:length(d_difference)){
    final_rank[i]<- if (d_difference[i]<0) rank_positive[i]*-1
    else rank_positive[i]}
  O=length(d_difference)-(min(final_rank)*-1)
  RO_ps= O-1
  RO=if (RO_ps<0) 0 else RO_ps
  print(RO)
}

## Obtain the R0+ estimator
RO_func(d, pooled_es)
```

Trim-and-fill analyses with the estimator R_0^+

```
## [1] 0
```

Given that $R_0^+ < 3$, there is no evidence for selection bias.

```

## Source code: Fernandez-Castilla et al. (2021)
## https://doi.org/10.1080/00220973.2019.1582470

## Define a new function
LO_func<-function(d, pooled_d){
  d_difference1=0
  rank_positive=0
  d_difference<- d-pooled_d
  d_difference1=0
  only_positive=0
  final_rank=0
  N_ES<-length(d)
  for(i in 1:length(d_difference)){
    d_difference1[i]<- if ( d_difference[i]<0) d_difference[i]*-1
    else d_difference[i] }
  rank_positive<-rank(d_difference1)
  for(i in 1:length(d_difference)){
    final_rank[i]<- if (d_difference[i]<0) rank_positive[i]*-1
    else rank_positive[i]
    only_positive[i]<- if (final_rank[i]<0) 0
    else final_rank[i]}
  t=sum(only_positive)
  LO_ps=(4*t-N_ES*(N_ES+1))/(2*N_ES-1)
  LO= if (LO_ps<0) 0 else LO_ps
  print(LO)
}

## Obtain the L0+ estimate
LO_func(d, pooled_es)

```

Trim-and-fill analyses with the estimator L_0^+

```
## [1] 12.20952
```

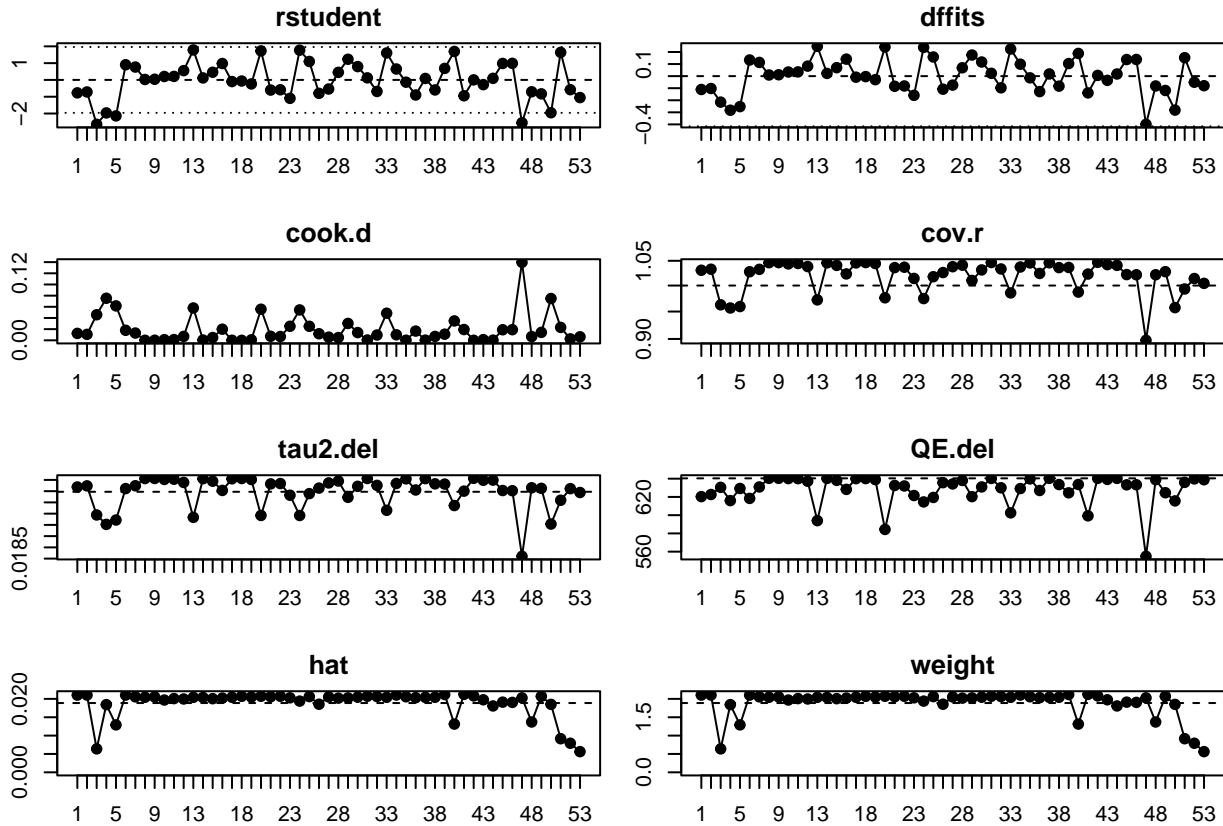
Given that $L_0^+ > 2$, there is some evidence for selection bias. About 12 effect sizes might be missing.

Influential effect sizes

```

# Analyses based on the REM with variation between effect sizes
# Plots indicating potential influential effect sizes
inf1 <- influence.rma.uni(rma(g,
                             vg,
                             data = dat,
                             method = "REML"))
plot.infl.rma.uni(inf1)

```



```
# Increase max print options to show all effect sizes
options(max.print = 1000000)
print(inf1)
```

```
##
##   rstudent dffits cook.d cov.r tau2.del   QE.del   hat weight  dfbs inf
## 1  -0.7699 -0.1108 0.0124 1.0306  0.0217 620.3382 0.0210 2.1033 -0.1108
## 2  -0.7172 -0.1026 0.0107 1.0327  0.0217 622.6639 0.0210 2.1039 -0.1026
## 3  -2.6425 -0.2155 0.0458 0.9627  0.0204 630.5164 0.0064 0.6383 -0.2188
## 4  -1.9643 -0.2826 0.0753 0.9567  0.0200 615.9370 0.0184 1.8433 -0.2832
## 5  -2.1410 -0.2527 0.0617 0.9594  0.0202 629.2640 0.0129 1.2920 -0.2551
## 6   0.9027  0.1336 0.0180 1.0275  0.0216 618.3848 0.0210 2.1031  0.1336
## 7   0.7667  0.1135 0.0130 1.0324  0.0217 630.9386 0.0206 2.0558  0.1136
## 8   0.0271  0.0093 0.0001 1.0460  0.0221 640.3740 0.0204 2.0435  0.0093
## 9   0.0397  0.0112 0.0001 1.0462  0.0221 640.3789 0.0205 2.0524  0.0112
## 10  0.2050  0.0341 0.0012 1.0436  0.0220 640.1056 0.0197 1.9689  0.0341
## 11  0.2106  0.0353 0.0013 1.0444  0.0220 640.0180 0.0201 2.0085  0.0353
## 12  0.5533  0.0828 0.0070 1.0382  0.0219 637.2134 0.0200 1.9973  0.0828
## 13  1.7841  0.2469 0.0579 0.9721  0.0203 593.9925 0.0204 2.0426  0.2466
## 14  0.1192  0.0226 0.0005 1.0457  0.0221 640.2908 0.0204 2.0391  0.0226
## 15  0.4582  0.0699 0.0050 1.0406  0.0219 638.1770 0.0201 2.0058  0.0699
## 16  0.9771  0.1409 0.0199 1.0232  0.0215 628.2896 0.0202 2.0210  0.1409
## 17 -0.0977 -0.0088 0.0001 1.0456  0.0221 640.0378 0.0204 2.0442 -0.0088
## 18 -0.0643 -0.0039 0.0000 1.0464  0.0221 640.1261 0.0207 2.0708 -0.0039
## 19 -0.2381 -0.0293 0.0009 1.0443  0.0220 638.9789 0.0205 2.0497 -0.0294
## 20  1.7284  0.2416 0.0557 0.9761  0.0204 584.3803 0.0207 2.0719  0.2413
```

```

## 21 -0.6035 -0.0842 0.0072 1.0360 0.0218 632.5465 0.0206 2.0585 -0.0842
## 22 -0.5856 -0.0817 0.0068 1.0368 0.0218 632.0172 0.0207 2.0717 -0.0817
## 23 -1.0957 -0.1592 0.0252 1.0141 0.0213 621.5247 0.0203 2.0287 -0.1592
## 24 1.7715 0.2386 0.0544 0.9746 0.0204 614.5310 0.0194 1.9390 0.2386
## 25 1.0989 0.1587 0.0251 1.0176 0.0214 619.4297 0.0206 2.0622 0.1587
## 26 -0.7979 -0.1082 0.0118 1.0259 0.0216 635.6377 0.0185 1.8545 -0.1081
## 27 -0.5408 -0.0746 0.0057 1.0379 0.0219 634.2299 0.0205 2.0537 -0.0746
## 28 0.4512 0.0692 0.0049 1.0410 0.0219 638.0592 0.0202 2.0199 0.0692
## 29 1.2310 0.1747 0.0302 1.0101 0.0212 620.3127 0.0203 2.0268 0.1747
## 30 0.7939 0.1170 0.0138 1.0313 0.0217 630.9590 0.0205 2.0465 0.1170
## 31 0.1231 0.0233 0.0006 1.0464 0.0221 640.2515 0.0207 2.0715 0.0234
## 32 -0.6862 -0.0969 0.0095 1.0333 0.0218 630.0120 0.0206 2.0634 -0.0969
## 33 1.6066 0.2242 0.0485 0.9856 0.0206 602.5539 0.0204 2.0422 0.2241
## 34 0.6509 0.0988 0.0099 1.0373 0.0218 629.1473 0.0210 2.1041 0.0988
## 35 -0.1344 -0.0141 0.0002 1.0456 0.0220 639.7749 0.0206 2.0581 -0.0141
## 36 -0.8960 -0.1283 0.0165 1.0242 0.0216 627.0507 0.0203 2.0327 -0.1283
## 37 0.0872 0.0180 0.0003 1.0459 0.0221 640.3503 0.0204 2.0414 0.0180
## 38 -0.5969 -0.0829 0.0070 1.0360 0.0218 633.5607 0.0204 2.0440 -0.0829
## 39 0.6864 0.1041 0.0110 1.0363 0.0218 624.5020 0.0212 2.1188 0.1041
## 40 1.6947 0.1879 0.0347 0.9872 0.0209 633.6358 0.0131 1.3134 0.1887
## 41 -0.9440 -0.1388 0.0193 1.0229 0.0215 599.2734 0.0212 2.1239 -0.1388
## 42 0.0028 0.0059 0.0000 1.0468 0.0221 640.3371 0.0208 2.0807 0.0059
## 43 -0.2794 -0.0349 0.0012 1.0421 0.0220 639.2346 0.0198 1.9754 -0.0349
## 44 0.0937 0.0176 0.0003 1.0406 0.0220 640.3638 0.0181 1.8077 0.0175
## 45 0.9804 0.1374 0.0189 1.0219 0.0215 633.2630 0.0191 1.9109 0.1374
## 46 0.9872 0.1380 0.0191 1.0215 0.0215 633.3308 0.0190 1.9045 0.1380
## 47 -2.5513 -0.3993 0.1396 0.8976 0.0186 554.8992 0.0203 2.0278 -0.3985
## 48 -0.7050 -0.0816 0.0067 1.0215 0.0217 638.9041 0.0137 1.3707 -0.0815
## 49 -0.8280 -0.1189 0.0142 1.0277 0.0216 624.6021 0.0207 2.0710 -0.1190
## 50 -1.9535 -0.2816 0.0748 0.9573 0.0200 615.6463 0.0185 1.8506 -0.2821
## 51 1.6398 0.1527 0.0231 0.9932 0.0211 635.9753 0.0092 0.9155 0.1533
## 52 -0.5807 -0.0507 0.0026 1.0139 0.0216 639.8005 0.0079 0.7915 -0.0506
## 53 -1.0514 -0.0793 0.0063 1.0043 0.0214 638.8303 0.0056 0.5630 -0.0794

```

Statistics

```

cooks.distance.rma.uni(rma(g,
                        vg,
                        data = dat,
                        method = "REML"), 4)

```

```

##          1          2          3          4          5          6
## 1.239066e-02 1.065214e-02 4.579525e-02 7.530968e-02 6.165499e-02 1.795772e-02
##          7          8          9         10         11         12
## 1.304017e-02 8.943603e-05 1.287370e-04 1.192228e-03 1.276405e-03 6.983431e-03
##          13         14         15         16         17         18
## 5.791820e-02 5.220297e-04 4.983804e-03 1.990243e-02 7.867321e-05 1.550186e-05
##          19         20         21         22         23         24
## 8.820412e-04 5.567095e-02 7.193289e-03 6.781512e-03 2.516770e-02 5.441873e-02
##          25         26         27         28         29         30
## 2.509830e-02 1.177689e-02 5.656837e-03 4.882621e-03 3.020755e-02 1.382918e-02
##          31         32         33         34         35         36
## 5.588939e-04 9.503220e-03 4.847649e-02 9.914036e-03 2.047958e-04 1.651792e-02
##          37         38         39         40         41         42
## 3.320643e-04 6.974958e-03 1.100076e-02 3.470265e-02 1.928389e-02 3.619234e-05

```

```
##          43          44          45          46          47          48
## 1.244246e-03 3.144981e-04 1.891482e-02 1.908837e-02 1.396183e-01 6.696325e-03
##          49          50          51          52          53
## 1.424180e-02 7.480066e-02 2.313787e-02 2.579800e-03 6.290962e-03
```

```
dfbetas.rma.uni(rma(g,
                    vg,
                    data = dat,
                    method = "REML"), 4)
```

```
##
##   intrcpt
## 1 -0.1108
## 2 -0.1026
## 3 -0.2188
## 4 -0.2832
## 5 -0.2551
## 6  0.1336
## 7  0.1136
## 8  0.0093
## 9  0.0112
## 10 0.0341
## 11 0.0353
## 12 0.0828
## 13 0.2466
## 14 0.0226
## 15 0.0699
## 16 0.1409
## 17 -0.0088
## 18 -0.0039
## 19 -0.0294
## 20 0.2413
## 21 -0.0842
## 22 -0.0817
## 23 -0.1592
## 24 0.2386
## 25 0.1587
## 26 -0.1081
## 27 -0.0746
## 28 0.0692
## 29 0.1747
## 30 0.1170
## 31 0.0234
## 32 -0.0969
## 33 0.2241
## 34 0.0988
## 35 -0.0141
## 36 -0.1283
## 37 0.0180
## 38 -0.0829
## 39 0.1041
## 40 0.1887
## 41 -0.1388
## 42 0.0059
```

```
## 43 -0.0349
## 44  0.0175
## 45  0.1374
## 46  0.1380
## 47 -0.3985
## 48 -0.0815
## 49 -0.1190
## 50 -0.2821
## 51  0.1533
## 52 -0.0506
## 53 -0.0794
```

```
hatvalues.rma.uni(rma(g,
                      vg,
                      data = dat,
                      method = "REML"),
                  type="diagonal")
```

```
##          1          2          3          4          5          6
## 0.021033472 0.021039149 0.006383384 0.018432639 0.012920009 0.021031232
##          7          8          9         10         11         12
## 0.020558161 0.020434676 0.020523673 0.019688900 0.020085454 0.019973304
##          13         14         15         16         17         18
## 0.020425982 0.020390610 0.020058345 0.020210373 0.020442302 0.020708353
##          19         20         21         22         23         24
## 0.020497493 0.020719185 0.020584814 0.020716559 0.020287095 0.019390342
##          25         26         27         28         29         30
## 0.020621815 0.018545182 0.020537151 0.020199105 0.020268463 0.020465088
##          31         32         33         34         35         36
## 0.020714805 0.020634040 0.020422138 0.021041024 0.020581309 0.020327027
##          37         38         39         40         41         42
## 0.020413823 0.020439589 0.021188088 0.013134493 0.021238870 0.020807097
##          43         44         45         46         47         48
## 0.019753568 0.018077490 0.019108976 0.019044877 0.020277815 0.013707160
##          49         50         51         52         53
## 0.020710421 0.018505532 0.009154637 0.007915336 0.005629576
```

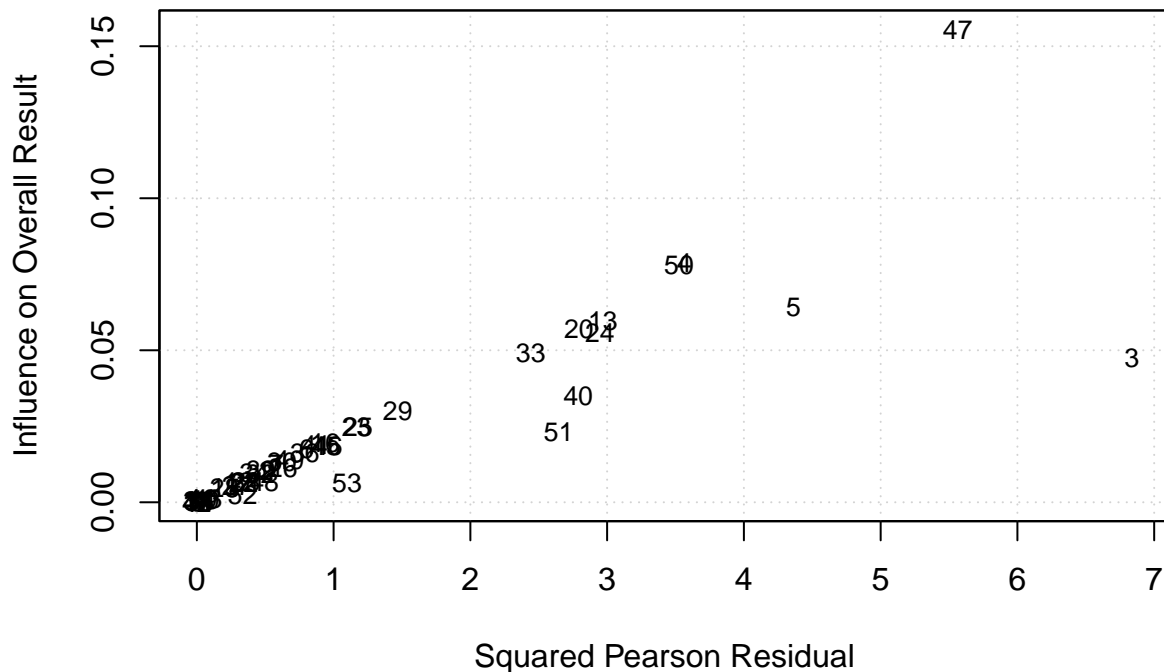
```
# Leave-one-out analyses
leave1out(rma(g,
              vg,
              data = dat,
              method = "REML"))
```

```
##
## estimate se zval pval ci.lb ci.ub Q Qp tau2 I2
## 1 0.1833 0.0220 8.3486 0.0000 0.1402 0.2263 620.3382 0.0000 0.0217 93.3050
## 2 0.1831 0.0220 8.3320 0.0000 0.1400 0.2262 622.6639 0.0000 0.0217 93.3173
## 3 0.1855 0.0212 8.7428 0.0000 0.1439 0.2271 630.5164 0.0000 0.0204 93.1746
## 4 0.1868 0.0211 8.8320 0.0000 0.1453 0.2282 615.9370 0.0000 0.0200 92.9956
## 5 0.1862 0.0212 8.7928 0.0000 0.1447 0.2277 629.2640 0.0000 0.0202 93.0943
## 6 0.1780 0.0219 8.1190 0.0000 0.1350 0.2209 618.3848 0.0000 0.0216 93.2850
## 7 0.1784 0.0220 8.1192 0.0000 0.1353 0.2215 630.9386 0.0000 0.0217 93.4170
## 8 0.1807 0.0221 8.1688 0.0000 0.1373 0.2240 640.3740 0.0000 0.0221 93.5202
```

| | | | | | | | | | | |
|-------|---------|--------|--------|--------|--------|--------|----------|--------|--------|---------|
| ## 9 | 0.1806 | 0.0221 | 8.1661 | 0.0000 | 0.1373 | 0.2240 | 640.3789 | 0.0000 | 0.0221 | 93.5112 |
| ## 10 | 0.1801 | 0.0221 | 8.1537 | 0.0000 | 0.1368 | 0.2234 | 640.1056 | 0.0000 | 0.0220 | 93.5581 |
| ## 11 | 0.1801 | 0.0221 | 8.1493 | 0.0000 | 0.1368 | 0.2234 | 640.0180 | 0.0000 | 0.0220 | 93.5402 |
| ## 12 | 0.1791 | 0.0220 | 8.1268 | 0.0000 | 0.1359 | 0.2222 | 637.2134 | 0.0000 | 0.0219 | 93.5074 |
| ## 13 | 0.1757 | 0.0213 | 8.2391 | 0.0000 | 0.1339 | 0.2174 | 593.9925 | 0.0000 | 0.0203 | 93.0096 |
| ## 14 | 0.1804 | 0.0221 | 8.1568 | 0.0000 | 0.1370 | 0.2237 | 640.2908 | 0.0000 | 0.0221 | 93.5228 |
| ## 15 | 0.1793 | 0.0221 | 8.1301 | 0.0000 | 0.1361 | 0.2226 | 638.1770 | 0.0000 | 0.0219 | 93.5174 |
| ## 16 | 0.1778 | 0.0219 | 8.1292 | 0.0000 | 0.1349 | 0.2207 | 628.2896 | 0.0000 | 0.0215 | 93.3916 |
| ## 17 | 0.1811 | 0.0221 | 8.1883 | 0.0000 | 0.1377 | 0.2244 | 640.0378 | 0.0000 | 0.0221 | 93.5167 |
| ## 18 | 0.1809 | 0.0221 | 8.1804 | 0.0000 | 0.1376 | 0.2243 | 640.1261 | 0.0000 | 0.0221 | 93.4861 |
| ## 19 | 0.1815 | 0.0221 | 8.2138 | 0.0000 | 0.1382 | 0.2248 | 638.9789 | 0.0000 | 0.0220 | 93.5020 |
| ## 20 | 0.1758 | 0.0214 | 8.2271 | 0.0000 | 0.1339 | 0.2176 | 584.3803 | 0.0000 | 0.0204 | 92.9969 |
| ## 21 | 0.1827 | 0.0220 | 8.3008 | 0.0000 | 0.1396 | 0.2258 | 632.5465 | 0.0000 | 0.0218 | 93.4370 |
| ## 22 | 0.1826 | 0.0220 | 8.2951 | 0.0000 | 0.1395 | 0.2258 | 632.0172 | 0.0000 | 0.0218 | 93.4223 |
| ## 23 | 0.1843 | 0.0218 | 8.4631 | 0.0000 | 0.1416 | 0.2270 | 621.5247 | 0.0000 | 0.0213 | 93.3236 |
| ## 24 | 0.1758 | 0.0213 | 8.2360 | 0.0000 | 0.1340 | 0.2177 | 614.5310 | 0.0000 | 0.0204 | 93.0986 |
| ## 25 | 0.1774 | 0.0218 | 8.1345 | 0.0000 | 0.1347 | 0.2202 | 619.4297 | 0.0000 | 0.0214 | 93.3082 |
| ## 26 | 0.1832 | 0.0219 | 8.3648 | 0.0000 | 0.1403 | 0.2261 | 635.6377 | 0.0000 | 0.0216 | 93.4822 |
| ## 27 | 0.1825 | 0.0220 | 8.2839 | 0.0000 | 0.1393 | 0.2257 | 634.2299 | 0.0000 | 0.0219 | 93.4553 |
| ## 28 | 0.1794 | 0.0221 | 8.1291 | 0.0000 | 0.1361 | 0.2226 | 638.0592 | 0.0000 | 0.0219 | 93.5098 |
| ## 29 | 0.1771 | 0.0217 | 8.1493 | 0.0000 | 0.1345 | 0.2197 | 620.3127 | 0.0000 | 0.0212 | 93.2975 |
| ## 30 | 0.1783 | 0.0220 | 8.1204 | 0.0000 | 0.1353 | 0.2214 | 630.9590 | 0.0000 | 0.0217 | 93.4207 |
| ## 31 | 0.1803 | 0.0221 | 8.1533 | 0.0000 | 0.1370 | 0.2237 | 640.2515 | 0.0000 | 0.0221 | 93.4852 |
| ## 32 | 0.1830 | 0.0220 | 8.3243 | 0.0000 | 0.1399 | 0.2260 | 630.0120 | 0.0000 | 0.0218 | 93.4118 |
| ## 33 | 0.1761 | 0.0215 | 8.2033 | 0.0000 | 0.1340 | 0.2182 | 602.5539 | 0.0000 | 0.0206 | 93.1089 |
| ## 34 | 0.1787 | 0.0220 | 8.1147 | 0.0000 | 0.1355 | 0.2219 | 629.1473 | 0.0000 | 0.0218 | 93.3469 |
| ## 35 | 0.1812 | 0.0221 | 8.1935 | 0.0000 | 0.1378 | 0.2245 | 639.7749 | 0.0000 | 0.0220 | 93.5001 |
| ## 36 | 0.1836 | 0.0219 | 8.3917 | 0.0000 | 0.1407 | 0.2265 | 627.0507 | 0.0000 | 0.0216 | 93.3878 |
| ## 37 | 0.1805 | 0.0221 | 8.1607 | 0.0000 | 0.1371 | 0.2238 | 640.3503 | 0.0000 | 0.0221 | 93.5216 |
| ## 38 | 0.1827 | 0.0220 | 8.2996 | 0.0000 | 0.1395 | 0.2258 | 633.5607 | 0.0000 | 0.0218 | 93.4544 |
| ## 39 | 0.1786 | 0.0220 | 8.1131 | 0.0000 | 0.1354 | 0.2217 | 624.5020 | 0.0000 | 0.0218 | 93.2777 |
| ## 40 | 0.1768 | 0.0215 | 8.2308 | 0.0000 | 0.1347 | 0.2189 | 633.6358 | 0.0000 | 0.0209 | 93.2930 |
| ## 41 | 0.1839 | 0.0219 | 8.4071 | 0.0000 | 0.1410 | 0.2267 | 599.2734 | 0.0000 | 0.0215 | 93.1566 |
| ## 42 | 0.1807 | 0.0221 | 8.1689 | 0.0000 | 0.1374 | 0.2241 | 640.3371 | 0.0000 | 0.0221 | 93.4710 |
| ## 43 | 0.1816 | 0.0221 | 8.2279 | 0.0000 | 0.1384 | 0.2249 | 639.2346 | 0.0000 | 0.0220 | 93.5452 |
| ## 44 | 0.1805 | 0.0221 | 8.1817 | 0.0000 | 0.1372 | 0.2237 | 640.3638 | 0.0000 | 0.0220 | 93.5878 |
| ## 45 | 0.1779 | 0.0219 | 8.1381 | 0.0000 | 0.1350 | 0.2207 | 633.2630 | 0.0000 | 0.0215 | 93.4392 |
| ## 46 | 0.1779 | 0.0219 | 8.1389 | 0.0000 | 0.1350 | 0.2207 | 633.3308 | 0.0000 | 0.0215 | 93.4389 |
| ## 47 | 0.1889 | 0.0205 | 9.2228 | 0.0000 | 0.1488 | 0.2291 | 554.8992 | 0.0000 | 0.0186 | 92.4235 |
| ## 48 | 0.1826 | 0.0219 | 8.3564 | 0.0000 | 0.1398 | 0.2255 | 638.9041 | 0.0000 | 0.0217 | 93.5204 |
| ## 49 | 0.1834 | 0.0219 | 8.3683 | 0.0000 | 0.1405 | 0.2264 | 624.6021 | 0.0000 | 0.0216 | 93.3628 |
| ## 50 | 0.1868 | 0.0212 | 8.8279 | 0.0000 | 0.1453 | 0.2282 | 615.6463 | 0.0000 | 0.0200 | 92.9988 |
| ## 51 | 0.1776 | 0.0216 | 8.2399 | 0.0000 | 0.1353 | 0.2198 | 635.9753 | 0.0000 | 0.0211 | 93.3698 |
| ## 52 | 0.1820 | 0.0218 | 8.3569 | 0.0000 | 0.1393 | 0.2246 | 639.8005 | 0.0000 | 0.0216 | 93.5191 |
| ## 53 | 0.1826 | 0.0217 | 8.4252 | 0.0000 | 0.1401 | 0.2250 | 638.8303 | 0.0000 | 0.0214 | 93.4726 |
| ## | H2 | | | | | | | | | |
| ## 1 | 14.9365 | | | | | | | | | |
| ## 2 | 14.9640 | | | | | | | | | |
| ## 3 | 14.6512 | | | | | | | | | |
| ## 4 | 14.2768 | | | | | | | | | |
| ## 5 | 14.4809 | | | | | | | | | |
| ## 6 | 14.8921 | | | | | | | | | |
| ## 7 | 15.1908 | | | | | | | | | |
| ## 8 | 15.4325 | | | | | | | | | |

```
## 9 15.4112
## 10 15.5233
## 11 15.4804
## 12 15.4021
## 13 14.3053
## 14 15.4389
## 15 15.4260
## 16 15.1322
## 17 15.4243
## 18 15.3518
## 19 15.3893
## 20 14.2793
## 21 15.2369
## 22 15.2028
## 23 14.9781
## 24 14.4899
## 25 14.9438
## 26 15.3426
## 27 15.2796
## 28 15.4078
## 29 14.9197
## 30 15.1992
## 31 15.3497
## 32 15.1787
## 33 14.5115
## 34 15.0306
## 35 15.3849
## 36 15.1236
## 37 15.4358
## 38 15.2774
## 39 14.8760
## 40 14.9097
## 41 14.6126
## 42 15.3162
## 43 15.4923
## 44 15.5954
## 45 15.2421
## 46 15.2413
## 47 13.1987
## 48 15.4331
## 49 15.0666
## 50 14.2833
## 51 15.0825
## 52 15.4299
## 53 15.3200
```

```
# Baujat plot
baujat(rma(g,
          vg,
          data = dat,
          method = "REML"))
```



There is no evidence for extreme values or influential effect sizes in the data set.

Worst-case sensitivity analyses

```
## Source: Mathur & VanderWeele (2019)
## https://doi.org/10.31219/osf.io/s9dp6
## https://osf.io/prwyc/

## Worst-case sensitivity analysis with the clustering in studies
PublicationBias::svalue(yi = dat$g,
                       vi = dat$vg,
                       clustervar = dat$IDSTUDY,
                       q = 0, ## Threshold to shift to
                       model = "robust",
                       favor.positive = FALSE, ## Not favoring positive effects
                       return.worst.meta = TRUE)
```

```
## $stats
##   sval.est sval.ci k.affirmative k.nonaffirmative signs.recoded
## 1 1.000066 > 200           2           51           TRUE
##
## $meta.worst
## RVE: User Specified Weights with Small-Sample Corrections
##
```

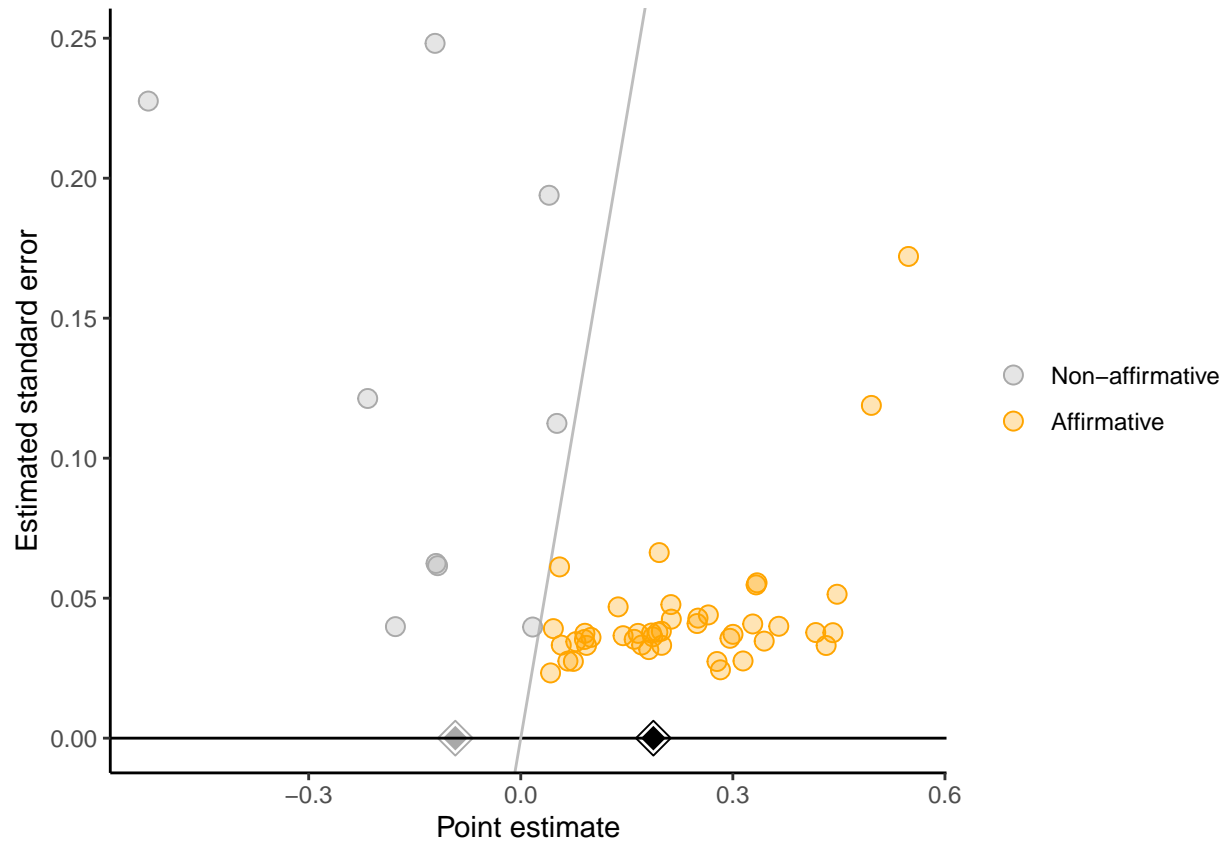
```
## Model: yi ~ 1
##
## Number of studies = 19
## Number of outcomes = 51 (min = 1 , mean = 2.68 , median = 1 , max = 21 )
##           Estimate StdErr t-value  dfs P(|t|>) 95% CI.L 95% CI.U Sig
## 1 X.Intercept.  -0.193 0.0246  -7.83 3.03 0.00418  -0.271  -0.115 ***
## ---
## Signif. codes: < .01 *** < .05 ** < .10 *
## ---
## Note: If df < 4, do not trust the results
```

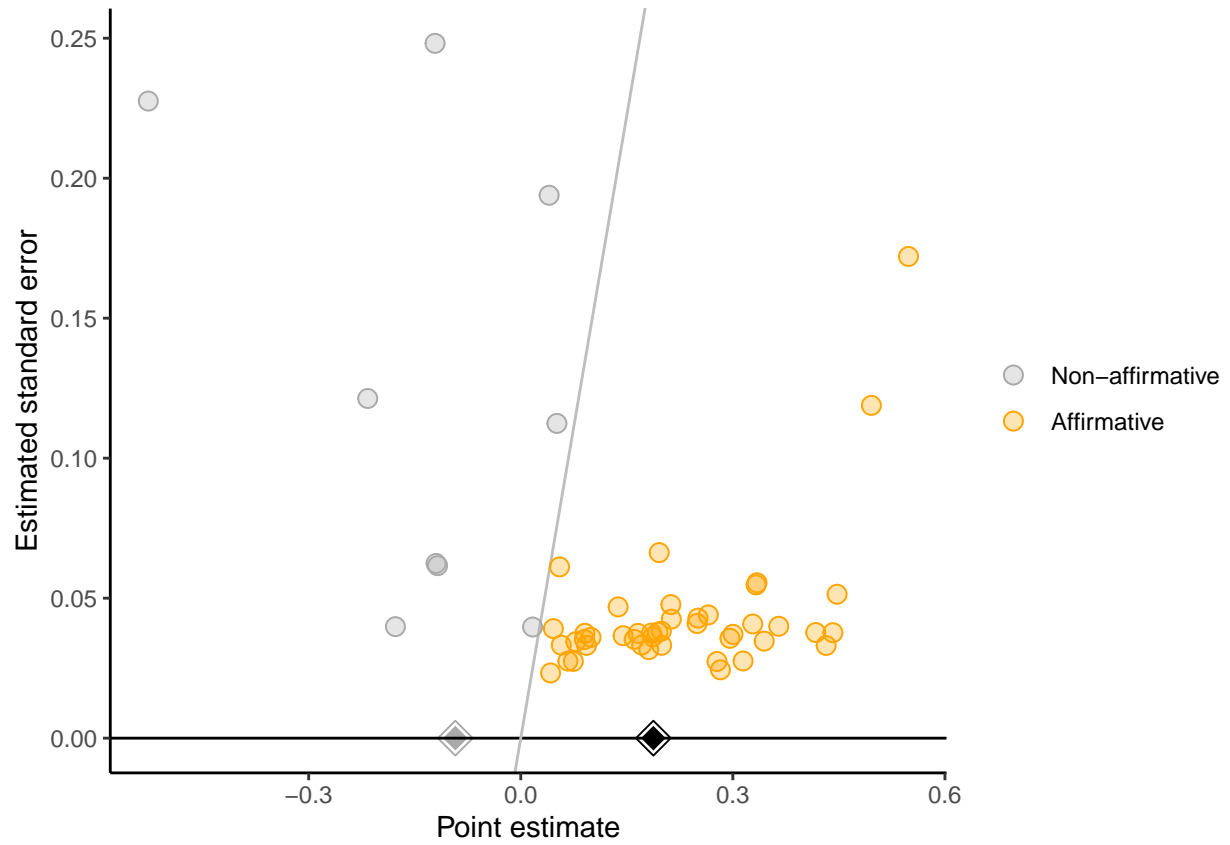
```
## Worst-case sensitivity analysis with the clustering in countries
PublicationBias::svalue(yi = dat$g,
                       vi = dat$vg,
                       clustervar = dat$IDCOUNTRY,
                       q = 0, ## Threshold to shift to
                       model = "robust",
                       favor.positive = FALSE, ## Not favoring positive effects
                       return.worst.meta = TRUE)
```

```
## $stats
##   sval.est  sval.ci k.affirmative k.nonaffirmative signs.recoded
## 1 1.000066 1.000066           2           51           TRUE
##
## $meta.worst
## RVE: User Specified Weights with Small-Sample Corrections
##
## Model: yi ~ 1
##
## Number of studies = 30
## Number of outcomes = 51 (min = 1 , mean = 1.7 , median = 1 , max = 6 )
##           Estimate StdErr t-value  dfs      P(|t|>) 95% CI.L 95% CI.U Sig
## 1 X.Intercept.  -0.193 0.0187  -10.3 19 0.0000000031  -0.232  -0.154 ***
## ---
## Signif. codes: < .01 *** < .05 ** < .10 *
## ---
## Note: If df < 4, do not trust the results
```

```
## ?svalue
## From the description of the function in the R package documentation:
## Estimates the S-value, defined as the severity of publication bias
## (i.e., the ratio by which affirmative studies are more likely to be published ## than nonaffirmative

## Significance funnel plot
PublicationBias::significance_funnel(yi = dat$g,
                                    vi = dat$vg,
                                    favor.positive = TRUE,
                                    alpha.select = 0.50,
                                    plot.pooled = TRUE)
```





The worst-case estimates are close to one (see `sva1.est`) and indicate little or no publication bias.

Sensitivity analyses

As a sensitivity analyses, we examine the effects of excluding either the AD or IPD from the meta-analytic data on the pooled effect size. Moreover, we compare the pooled effect sizes between AD and IPD.

IPD meta-analysis

Given that only two studies (ICILS 2013 and ICILS 2018) exist in this subset of the meta-analytic data, we do not estimate a three-level random-effects model with samples nested in studies (IDSTUDY/IDSAMPLE). Nevertheless, several countries provide two effect sizes in the IPD, so that a nesting in countries can be assumed (IDCOUNTRY/IDSAMPLE).

```
## Select the IPD
datipd <- dat[dat$IPD==1,]
nrow(datipd)
```

Standard random-effects model

```
## [1] 34
```

```
table(datipd$IDSTUDY)
```

```
##
## 8 9
## 21 13
```

```
table(datipd$IDCOUNTRY)
```

```
##
## 32 36 124 152 191 203 208 246 250 276 344 380 398 410 440 442 528 576 616 620
## 1 1 2 2 1 1 2 1 1 2 1 1 1 2 1 1 1 1 1 1
## 643 703 705 756 764 792 840 858
## 2 1 1 1 1 1 1 1
```

```
## Model estimation
REM2ipd <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSAMPLE),
  method = "REML",
  data = datipd,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")

## Model summary
summary(REM2ipd, digits = 4)
```

```

##
## Multivariate Meta-Analysis Model (k = 34; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 23.6127 -47.2255 -43.2255 -40.2325 -42.8255
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed  factor
## sigma^2  0.0124 0.1114   34    no  IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 33) = 323.8695, p-val < .0001
##
## Model Results:
##
## estimate      se      tval  df    pval   ci.lb  ci.ub
## 0.2242  0.0202  11.1001  33  <.0001  0.1831  0.2653 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Variances: 95 % confidence intervals
confint(REM2ipd, digits = 4)

```

```

##
##      estimate  ci.lb  ci.ub
## sigma^2  0.0124 0.0074 0.0220
## sigma    0.1114 0.0860 0.1484

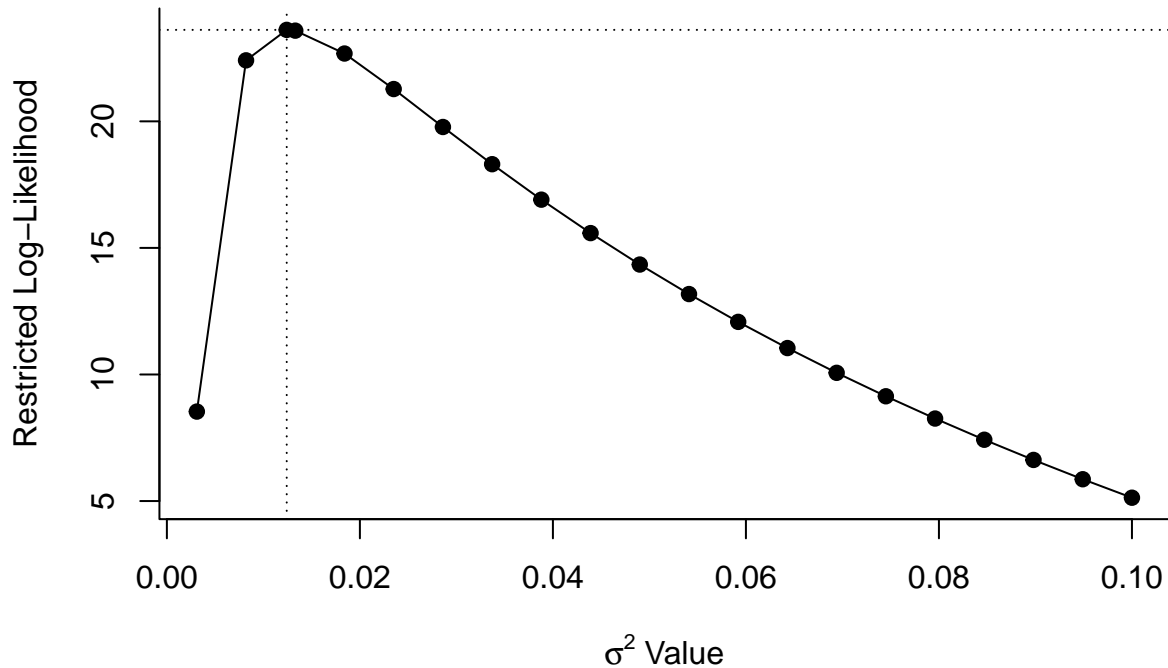
```

```

## Profile plots of the variance component(s)
profile.rma.mv(REM2ipd, sigma2 = 1)

```

Profile Plot for σ^2



```
## Robust standard errors
coef_test(REM2ipd, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.224 0.0202   11.1  33    <0.001 ***
```

The pooled effect size for IPD obtained from model REM2ipd is $\bar{g} = 0.224$.

```
## Model estimation
REM3ipd <- rma.mv(g,
  vg,
  random = list(~ 1 | IDCOUNTRY/IDSAMPLE),
  method = "REML",
  data = datipd,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")

## Model summary
summary(REM3ipd, digits = 4)
```

Three-level random-effects model with hierarchical country effects

```

##
## Multivariate Meta-Analysis Model (k = 34; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 25.7120 -51.4239 -45.4239 -40.9344 -44.5963
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed      factor
## sigma^2.1  0.0090  0.0949    28    no      IDCOUNTRY
## sigma^2.2  0.0032  0.0564    34    no  IDCOUNTRY/IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 33) = 323.8695, p-val < .0001
##
## Model Results:
##
## estimate      se      tval  df      pval  ci.lb  ci.ub  ***
## 0.2178  0.0216  10.0877  33 <.0001  0.1739  0.2617  ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Variances: 95 % confidence intervals
confint(REM3ipd, digits = 4)

```

```

##
##           estimate  ci.lb  ci.ub
## sigma^2.1  0.0090  0.0005  0.0196
## sigma.1    0.0949  0.0226  0.1401
##
##           estimate  ci.lb  ci.ub
## sigma^2.2  0.0032  0.0005  0.0133
## sigma.2    0.0564  0.0217  0.1155

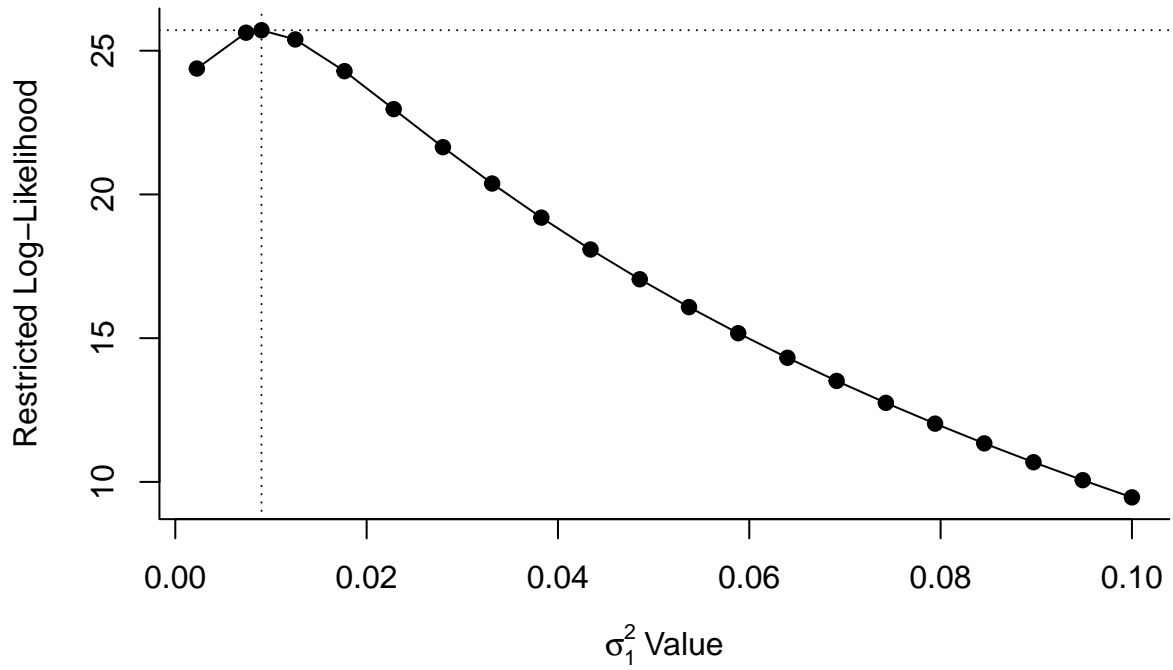
```

```

## Profile plots of the variance component(s)
profile.rma.mv(REM3ipd, sigma2 = 1)

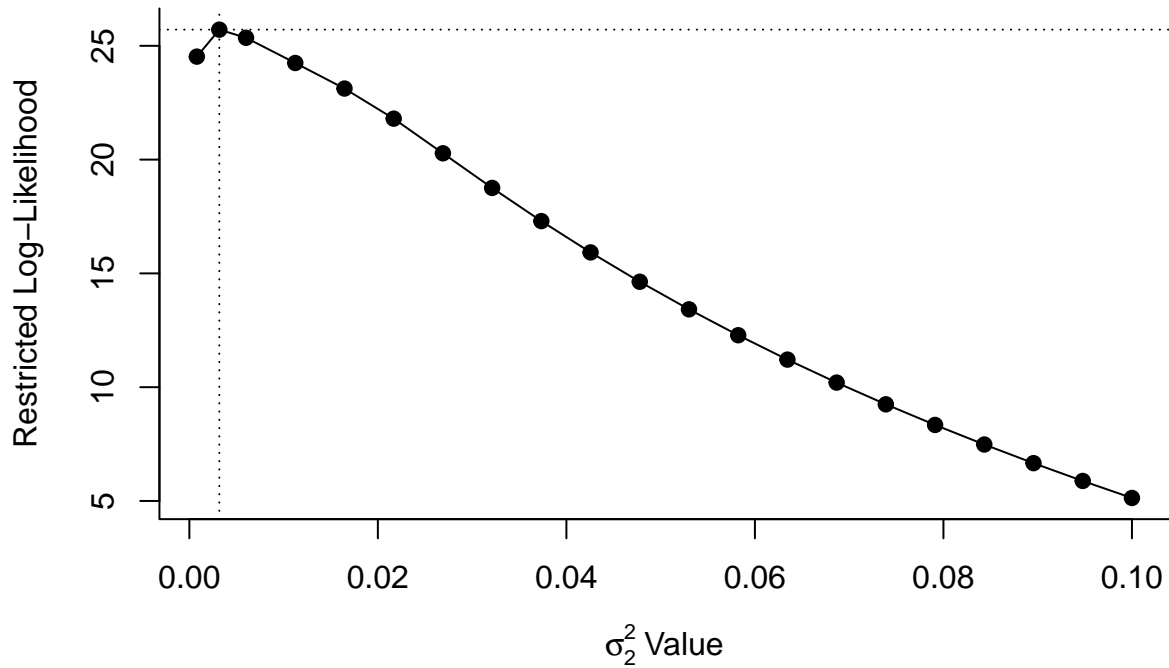
```

Profile Plot for σ_1^2



```
profile.rma.mv(REM3ipd, sigma2 = 2)
```

Profile Plot for σ_2^2



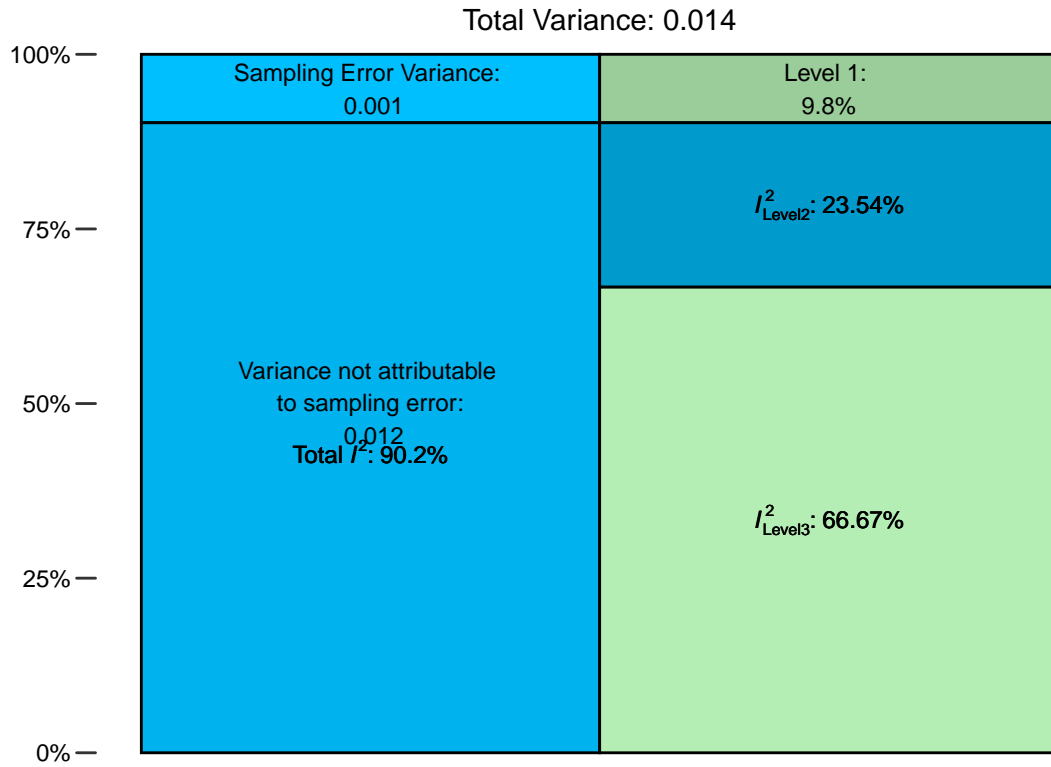
```
## Robust standard errors
coef_test(REM3ipd, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.218 0.0216   10.1 26.8   <0.001 ***
```

```
## Variance components: Overview
dmetar::var.comp(REM3ipd)
```

```
##          % of total variance      I2
## Level 1          9.795684      ---
## Level 2         23.537644 23.54
## Level 3         66.666671 66.67
## Total I2: 90.2%
```

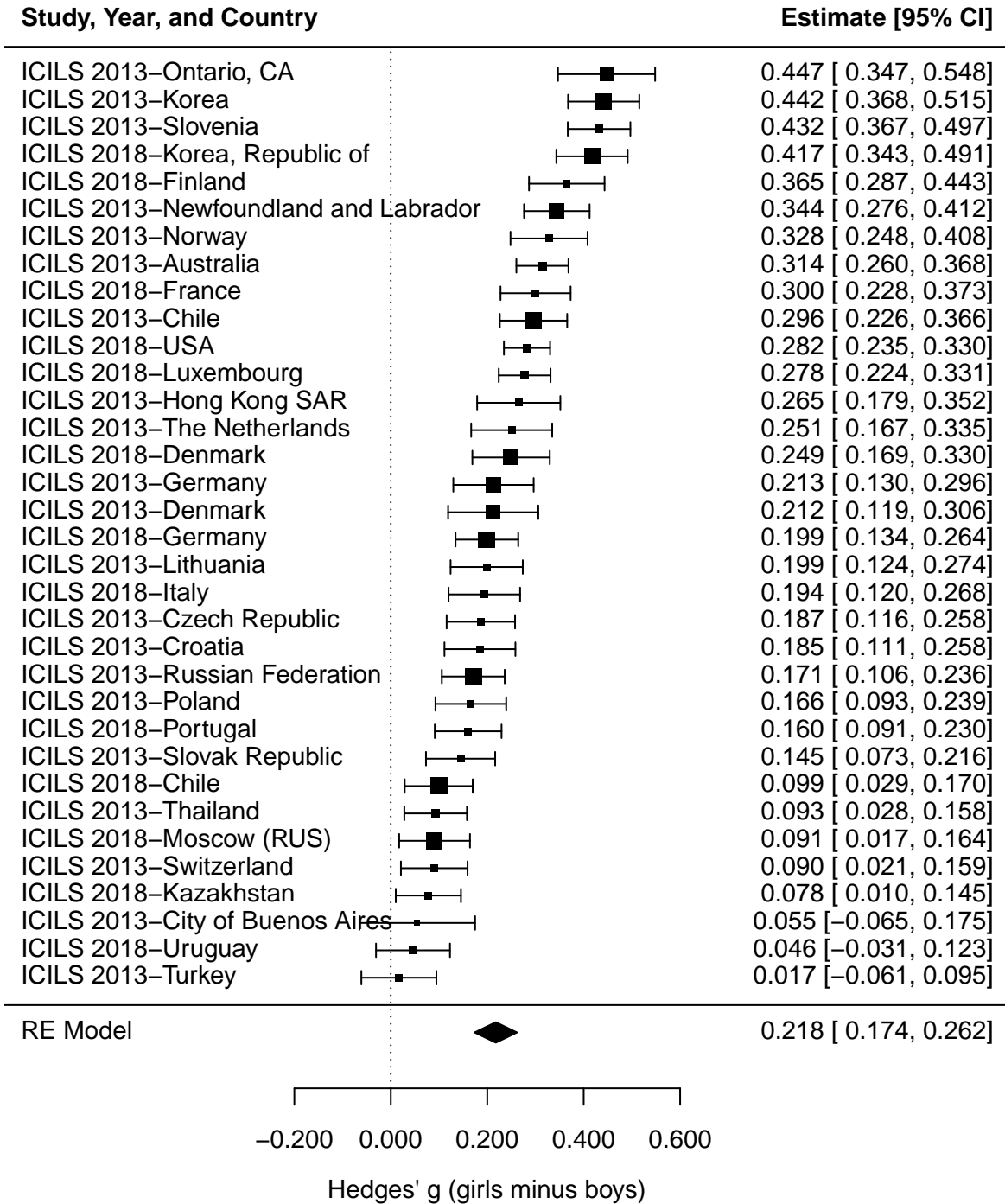
```
plot(dmetar::var.comp(REM3ipd))
```



```
#pdf(file = "ForestPlot-IPD.pdf", height = 8, width = 8)
```

```
## Forest plot
```

```
forest.rma(REM3ipd,
  addfit = TRUE,
  order = "obs",
  header = "Study, Year, and Country",
  refline = 0,
  rows = 1:REM3ipd$k,
  digits = 3,
  level = 95,
  cex = .9,
  xlab = "Hedges' g (girls minus boys)")
```



```
#dev.off()
```

The pooled effect size for IPD obtained from model REM3ipd is $\bar{g} = 0.218$.

```
## Model comparison
anova(REM2ipd, REM3ipd)
```

Model comparison

```
##
##          df      AIC      BIC      AICc  logLik    LRT   pval      QE
## Full      3 -45.4239 -40.9344 -44.5963 25.7120
## Reduced   2 -43.2255 -40.2325 -42.8255 23.6127 4.1984 0.0405 323.8695
```

The information criteria, likelihood-ratio test, and the confidence intervals of the variance components suggest the preference of the three-level over the standard random-effects model.

AD meta-analysis

For AD, each primary study provides only one effect size. Similar to the IPD, some countries provide multiple effect sizes.

```
## Select the AD
datad <- dat[dat$IPD==0,]
nrow(datad)
```

Standard random-effects model

```
## [1] 19
```

```
table(datad$IDSTUDY)
```

```
##
##  1  2  4  5  6 10 11 12 13 14 15 16 18 19 20 21 22 23 24
##  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
```

```
table(datad$IDCOUNTRY)
```

```
##
##  36 156 276 348 380 410 528 576 840
##   3  1  2  1  1  1  2  5  3
```

```

## Model estimation
REM2ad <- rma.mv(g,
  vg,
  random = list(~ 1 | IDSAMPLE),
  method = "REML",
  data = datad,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t")

## Model summary
summary(REM2ad, digits = 4)

##
## Multivariate Meta-Analysis Model (k = 19; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
##   0.5634  -1.1269    2.8731    4.6539    3.6731
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed  factor
## sigma^2    0.0367  0.1917    19     no  IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 18) = 156.0066, p-val < .0001
##
## Model Results:
##
## estimate      se    tval  df    pval    ci.lb  ci.ub
##   0.0813  0.0489  1.6629  18  0.1136  -0.0214  0.1841
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

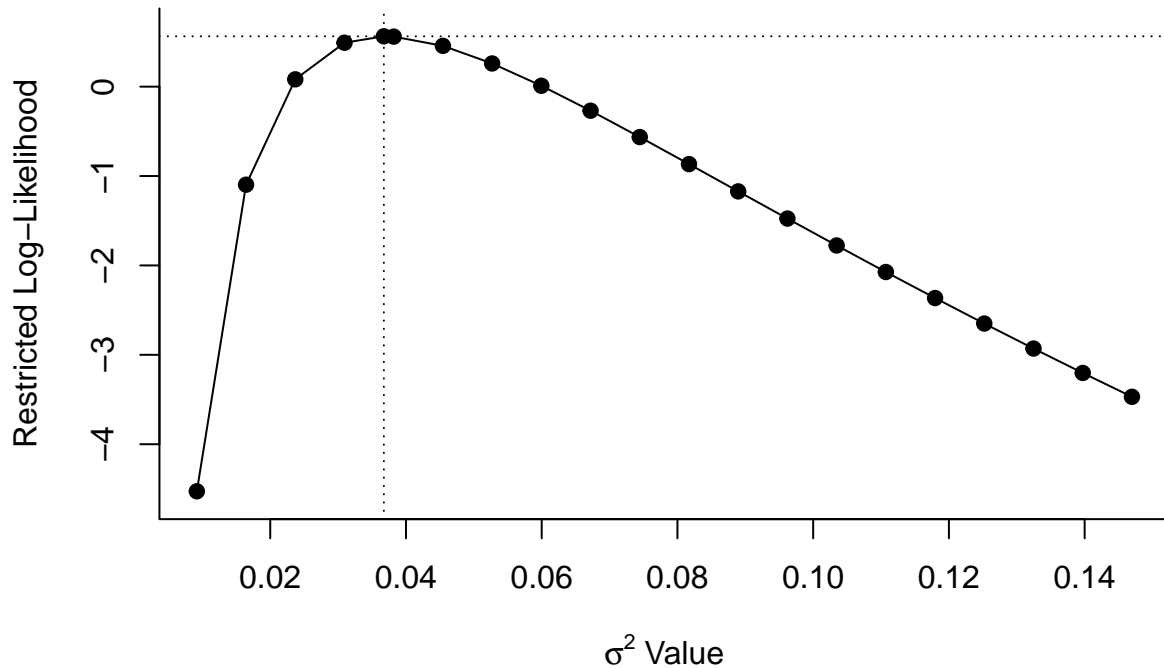
## Variances: 95 % confidence intervals
confint(REM2ad, digits = 4)

##
##           estimate  ci.lb  ci.ub
## sigma^2    0.0367  0.0155  0.0934
## sigma      0.1917  0.1246  0.3055

## Profile plots of the variance component(s)
profile.rma.mv(REM2ad, sigma2 = 1)

```

Profile Plot for σ^2



```
## Robust standard errors
coef_test(REM2ad, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt  0.0813 0.0488  1.67 16.9  0.114
```

```
## I-squared
## Source: https://www.metafor-project.org/doku.php/tips:i2\_multilevel\_multivariate
kad <- REM2ad$k
wi <- 1/REM2ad$vi
vt <- (kad-1)*sum(wi)/(sum(wi)^2 - sum(wi^2))
100*REM2ad$sigma2/(REM2ad$sigma2 + vt)
```

```
## [1] 94.32587
```

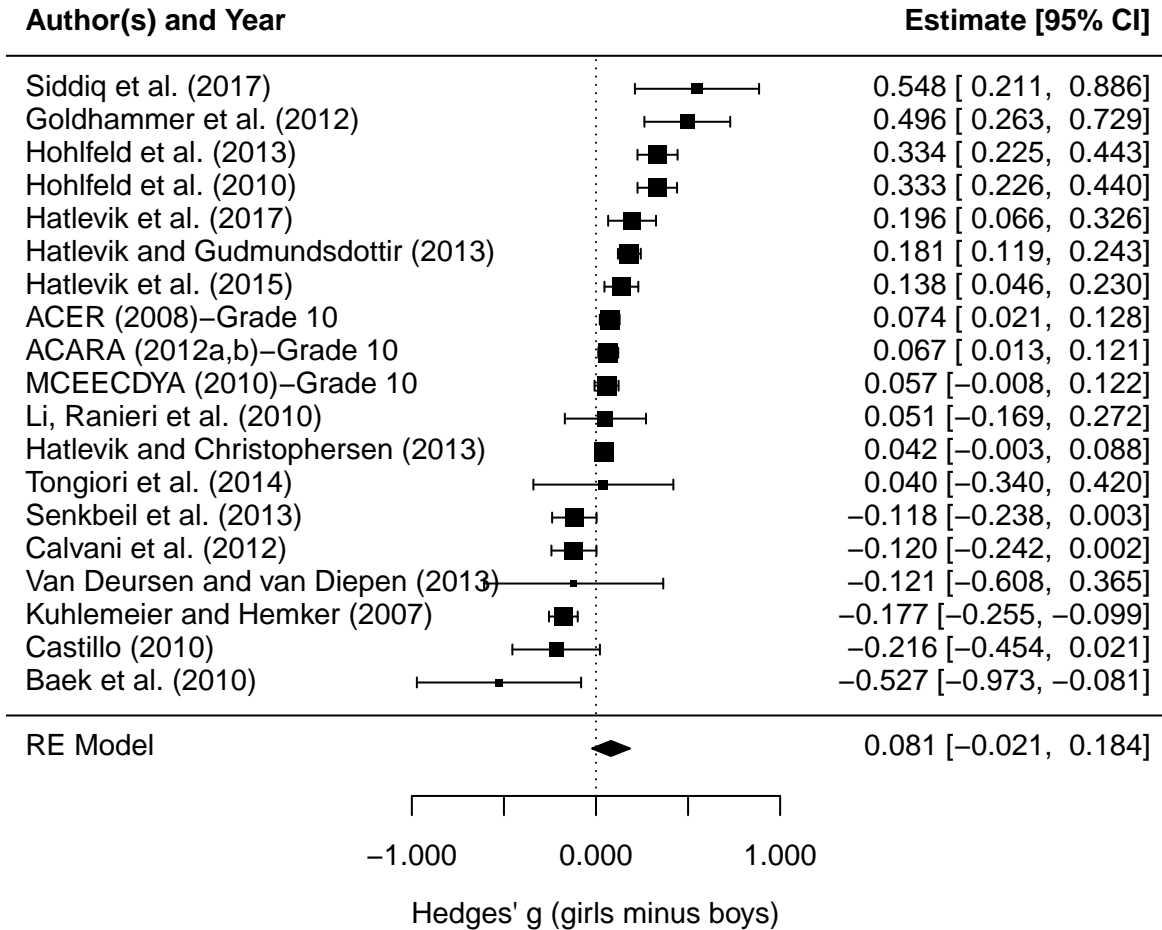
```
##pdf(file = "ForestPlot-AD.pdf", height = 5.5, width = 8)
```

```
## Forest plot
forest.rma(REM2ad,
  addfit = TRUE,
  order = "obs",
  header = "Author(s) and Year",
  refline = 0,
  rows = 1:REM2ad$k,
```

```

digits = 3,
level = 95,
cex = .9,
xlab = "Hedges' g (girls minus boys)"

```



```
## dev.off()
```

The pooled effect size for AD obtained from model REM2ad is $\bar{g} = 0.081$. This is a lower effect size than those obtained from IPD. Notice that the models REM2ipd and REM2ad assume that AD and IPD can have different heterogeneity.

```
## Model estimation
REM3ad <- rma.mv(g,
```

```

      vg,
      random = list(~ 1 | IDCOUNTRY/IDSAMPLE),
      method = "REML",
      data = datad,
      slab = paste(Sample),
      tdist = TRUE,
      test = "t")

## Model summary
summary(REM3ad, digits = 4)

```

Three-level random-effects model with hierarchical country effects

```

##
## Multivariate Meta-Analysis Model (k = 19; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
##   0.5790  -1.1579   4.8421   7.5132   6.5563
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed          factor
## sigma^2.1  0.0023  0.0484     9    no          IDCOUNTRY
## sigma^2.2  0.0348  0.1865    19    no  IDCOUNTRY/IDSAMPLE
##
## Test for Heterogeneity:
## Q(df = 18) = 156.0066, p-val < .0001
##
## Model Results:
##
## estimate      se    tval  df    pval    ci.lb  ci.ub
##   0.0738  0.0517  1.4287  18  0.1702  -0.0347  0.1823
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Variances: 95 % confidence intervals
confint(REM3ad, digits = 4)

```

```

##
##           estimate  ci.lb  ci.ub
## sigma^2.1  0.0023  0.0000  0.0734
## sigma.1    0.0484  0.0000  0.2710
##
##           estimate  ci.lb  ci.ub
## sigma^2.2  0.0348  0.0106  0.0930
## sigma.2    0.1865  0.1029  0.3049

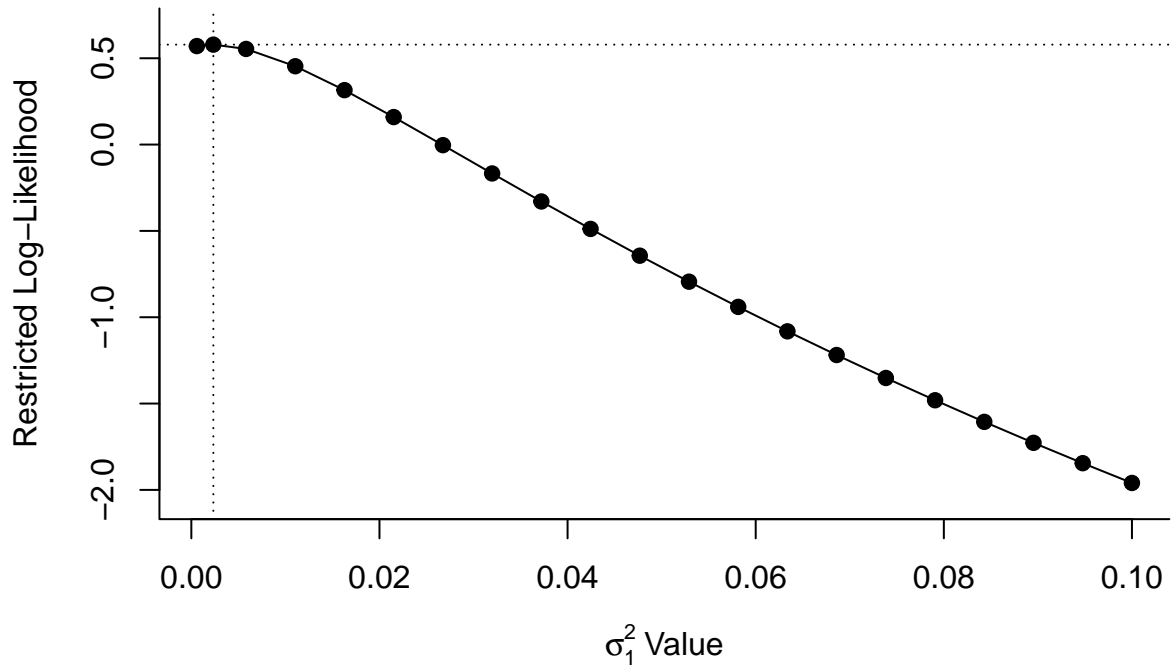
```

```

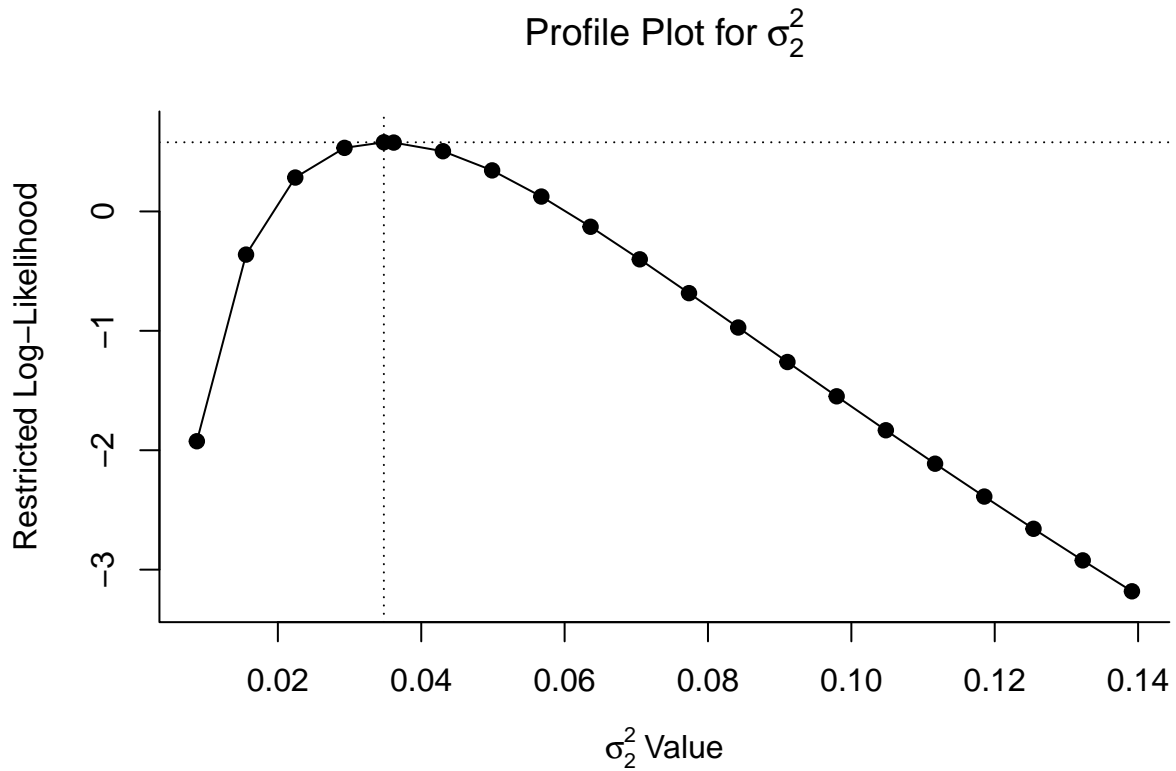
## Profile plots of the variance component(s)
profile.rma.mv(REM3ad, sigma2 = 1)

```

Profile Plot for σ_1^2



```
profile.rma.mv(REM3ad, sigma2 = 2)
```



```
## Robust standard errors
coef_test(REM3ad, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt  0.0738 0.0522   1.41 5.33   0.213
```

The pooled effect size for AD obtained from model REM3ad is $\bar{g} = 0.074$.

```
## Model comparison
anova(REM2ad, REM3ad)
```

Model comparison

```
##
##      df    AIC    BIC    AICc logLik    LRT    pval    QE
## Full   3 4.8421 7.5132 6.5563 0.5790          156.0066
## Reduced 2 2.8731 4.6539 3.6731 0.5634 0.0311 0.8601 156.0066
```

For the AD, the standard meta-analytic model (REM2ad) is preferred over the three-level random-effects model.

Comparing pooled effect sizes between AD and IPD

To compare the pooled effect sizes and allow for different heterogeneity, we estimated several mixed-effects meta-regression models (see Viechtbauer, 2021). A detailed discussion of these models, including a simulation study of the respective model comparisons, is reported in Rubio-Aparicio et al. (2020).

Model assuming data-specific between-sample and between-country (residual) heterogeneity for IPD and AD This model assumes that IPD and AD can have specific between-country and between-sample residual heterogeneity.

```
## Source: Viechtbauer (2021)
## https://www.metafor-project.org/doku.php/tips:comp\_two\_independent\_estimates
```

```
## Model estimation
```

```
MEM2ipdadc <- rma.mv(g,
  vg,
  random = list(~ as.factor(IPD) | IDSAMPLE,
    ~ as.factor(IPD) | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods = ~ IPD,
  struct = "DIAG")
```

```
## Model summary
```

```
summary(MEM2ipdadc, digits = 4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik Deviance      AIC      BIC      AICc
## 26.2909 -52.5818 -40.5818 -28.9909 -38.6728
##
## Variance Components:
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##           estim  sqrt  k.lvl  fixed  level
## tau^2.1  0.0348  0.1865   19    no    0
## tau^2.2  0.0032  0.0564   34    no    1
##
## outer factor: IDCOUNTRY      (nlvls = 30)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##           estim  sqrt  k.lvl  fixed  level
## gamma^2.1 0.0023  0.0484   19    no    0
## gamma^2.2 0.0090  0.0949   34    no    1
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
```

```
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 6.6115, p-val = 0.0131
##
## Model Results:
##
##      estimate      se    tval  df    pval    ci.lb    ci.ub
## intrcpt    0.0738  0.0517  1.4287  51  0.1592  -0.0299  0.1775
## IPD        0.1440  0.0560  2.5713  51  0.0131   0.0316  0.2564 *
```

```
## Confidence intervals
confint(MEM2ipdadc, digits = 4)
```

```
##
##      estimate  ci.lb  ci.ub
## tau^2.1    0.0348 0.0106 0.0930
## tau.1      0.1865 0.1029 0.3049
##
##      estimate  ci.lb  ci.ub
## tau^2.2    0.0032 0.0005 0.0133
## tau.2      0.0564 0.0217 0.1155
##
##      estimate  ci.lb  ci.ub
## gamma^2.1   0.0023 0.0000 0.0734
## gamma.1     0.0484 0.0000 0.2710
##
##      estimate  ci.lb  ci.ub
## gamma^2.2   0.0090 0.0005 0.0196
## gamma.2     0.0949 0.0226 0.1401
```

```
## Robust standard errors
coef_test(MEM2ipdadc, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.0738 0.0522   1.41 5.33   0.2129
## 2 IPD        0.1440 0.0566   2.54 6.88   0.0391 *
```

This model indicates significant differences in the pooled effect sizes between IPD and AD. The variance components suggest that the IPD exhibit between country variation, yet not the AD (see γ^2). The between-sample heterogeneity is larger for AD than for IPD (see τ^2).

Model assuming data-specific between-sample and between-study (residual) heterogeneity for IPD and AD This model assumes that IPD and AD can have specific between-study and between-sample residual heterogeneity.

```
## Source: Viechtbauer (2021)
## https://www.metafor-project.org/doku.php/tips:comp\_two\_independent\_estimates
```

```

## Model estimation
MEM2ipdad <- rma.mv(g,
  vg,
  random = list(~ as.factor(IPD) | IDSAMPLE,
    ~ as.factor(IPD) | IDSTUDY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ IPD,
  struct = "DIAG")

## Model summary
summary(MEM2ipdad, digits = 4)

```

```

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC     AICc
## 24.1762 -48.3523 -36.3523 -24.7614 -34.4432
##
## Variance Components:
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##           estim  sqrt  k.lvl  fixed  level
## tau^2.1   0.0184 0.1355   19    no     0
## tau^2.2   0.0124 0.1114   34    no     1
##
## outer factor: IDSTUDY      (nlvls = 21)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##           estim  sqrt  k.lvl  fixed  level
## gamma^2.1 0.0184 0.1355   19    no     0
## gamma^2.2 0.0000 0.0000   34    no     1
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 7.2905, p-val = 0.0094
##
## Model Results:
##
##           estimate      se   tval  df   pval   ci.lb  ci.ub
## intrcpt   0.0813 0.0489 1.6629 51 0.1025 -0.0169 0.1795
## IPD       0.1429 0.0529 2.7001 51 0.0094 0.0366 0.2491 **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```
## Confidence intervals
confint(MEM2ipdad, digits = 4)
```

```
##
##      estimate ci.lb ci.ub
## tau^2.1  0.0184 0.0000 0.0934
## tau.1     0.1355 0.0000 0.3056
##
##      estimate ci.lb ci.ub
## tau^2.2  0.0124 0.0074 0.0220
## tau.2     0.1114 0.0860 0.1484
##
##      estimate ci.lb ci.ub
## gamma^2.1 0.0184 0.0000 0.0934
## gamma.1    0.1355 0.0000 0.3056
##
##      estimate ci.lb ci.ub
## gamma^2.2  0.0000 0.0000 0.0491
## gamma.2    0.0000 0.0000 0.2215
```

```
## Robust standard errors
coef_test(MEM2ipdad, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt  0.0813 0.0488   1.67 16.9   0.1137
## 2      IPD   0.1429 0.0496   2.88 15.5   0.0112  *
```

Model assuming data-specific between-sample (residual) heterogeneity for IPD and AD This model assumes that IPD and AD have the same between-country heterogeneity, yet different between-sample residual heterogeneity.

```
## Model estimation
MEM2ipdad2c <- rma.mv(g,
  vg,
  random = list(~ as.factor(IPD) | IDSAMPLE,
    ~ 1 | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ IPD,
  struct = "DIAG")
```

```
## Model summary
summary(MEM2ipdad2c, digits = 4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##      logLik Deviance      AIC      BIC      AICc
```

```

## 25.6824 -51.3649 -41.3649 -31.7057 -40.0315
##
## Variance Components:
##
##          estim      sqrt  nlvls  fixed      factor
## sigma^2    0.0085  0.0923    30     no  IDCOUNTRY
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##          estim      sqrt  k.lvl  fixed  level
## tau^2.1    0.0352  0.1877    19     no     0
## tau^2.2    0.0034  0.0584    34     no     1
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 12.2318, p-val = 0.0010
##
## Model Results:
##
##          estimate      se      tval  df      pval      ci.lb      ci.ub
## intrcpt    0.0308  0.0545  0.5648  51  0.5747  -0.0787  0.1403
## IPD        0.1873  0.0536  3.4974  51  0.0010   0.0798  0.2949 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Confidence intervals
confint(MEM2ipdad2c, digits = 4)

```

```

##
##          estimate  ci.lb  ci.ub
## sigma^2    0.0085  0.0000  0.0189
## sigma      0.0923  0.0000  0.1375
##
##          estimate  ci.lb  ci.ub
## tau^2.1    0.0352  0.0128  0.0954
## tau.1      0.1877  0.1132  0.3089
##
##          estimate  ci.lb  ci.ub
## tau^2.2    0.0034  0.0005  0.0161
## tau.2      0.0584  0.0213  0.1269

```

```

## Robust standard errors
coef_test(MEM2ipdad2c, vcov = "CR2")

```

```

##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt    0.0308  0.0501  0.614 6.02   0.5615
## 2 IPD        0.1873  0.0518  3.616 5.55   0.0128  *

```

Model assuming data-specific between-sample (residual) heterogeneity for IPD and AD This model assumes that IPD and AD have the same between-study heterogeneity, yet different between-sample residual heterogeneity.

```
## Model estimation
MEM2ipdad2 <- rma.mv(g,
                    vg,
                    random = list(~ as.factor(IPD) | IDSAMPLE,
                                   ~ 1 | IDSTUDY),
                    method = "REML",
                    data = dat,
                    slab = paste(Sample),
                    tdist = TRUE,
                    test = "t",
                    mods =~ IPD,
                    struct = "DIAG")

## Model summary
summary(MEM2ipdad2, digits = 4)
```

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 24.1762 -48.3523 -38.3523 -28.6932 -37.0190
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed  factor
## sigma^2  0.0000 0.0000    21     no  IDSTUDY
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##           estim  sqrt  k.lvl  fixed  level
## tau^2.1  0.0367 0.1917    19     no     0
## tau^2.2  0.0124 0.1114    34     no     1
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 7.2905, p-val = 0.0094
##
## Model Results:
##
##           estimate      se  tval  df  pval  ci.lb  ci.ub
## intrcpt  0.0813 0.0489 1.6629 51 0.1025 -0.0169 0.1795
## IPD      0.1429 0.0529 2.7001 51 0.0094 0.0366 0.2491 **
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Confidence intervals
confint(MEM2ipdad2, digits = 4)
```

```
##
##      estimate ci.lb ci.ub
## sigma^2  0.0000 0.0000 0.0432
## sigma    0.0000 0.0000 0.2078
##
##      estimate ci.lb ci.ub
## tau^2.1   0.0367 0.0000 0.0934
## tau.1     0.1917 0.0000 0.3055
##
##      estimate ci.lb ci.ub
## tau^2.2   0.0124 0.0074 0.0220
## tau.2     0.1114 0.0860 0.1484
```

```
## Robust standard errors
coef_test(MEM2ipdad2, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt  0.0813 0.0488   1.67 16.9   0.1137
## 2      IPD   0.1429 0.0496   2.88 15.5   0.0112  *
```

```
## Model estimation
MEM2ipdad3ac <- rma.mv(g,
  vg,
  random = list(~ as.factor(IPD) | IDSAMPLE,
               ~ 1 | IDCOUNTRY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods = ~ IPD,
  struct = "ID")
```

```
## Model summary
summary(MEM2ipdad3ac, digits = 4)
```

Model assuming the same between-country and between-sample (residual) heterogeneity for IPD and AD

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##      logLik Deviance      AIC      BIC      AICc
## 22.2168 -44.4335 -36.4335 -28.7062 -35.5639
##
## Variance Components:
```

```

##
##          estim  sqrt  nlvls  fixed  factor
## sigma^2  0.0023  0.0482   30    no  IDCOUNTRY
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##          estim  sqrt  fixed
## tau^2      0.0147  0.1211   no
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 13.1462, p-val = 0.0007
##
## Model Results:
##
##          estimate      se    tval  df    pval    ci.lb  ci.ub
## intrcpt    0.0648  0.0384  1.6868  51  0.0977  -0.0123  0.1420
## IPD        0.1578  0.0435  3.6258  51  0.0007   0.0704  0.2452 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

Confidence intervals

```
confint(MEM2ipdad3ac, digits = 4)
```

```

##
##          estimate  ci.lb  ci.ub
## sigma^2  0.0023  0.0000  0.0134
## sigma    0.0482  0.0000  0.1158
##
##          estimate  ci.lb  ci.ub
## tau^2    0.0147  0.0060  0.0282
## tau      0.1211  0.0775  0.1678

```

Robust standard errors

```
coef_test(MEM2ipdad3ac, vcov = "CR2")
```

```

##      Coef. Estimate      SE t-stat d.f. p-val (Satt) Sig.
## 1 intrcpt  0.0648  0.0485   1.34 5.22   0.2367
## 2   IPD    0.1578  0.0534   2.96 7.66   0.0192  *

```

####

Alternative model specification

Model estimation

```

MEM2ipdad3bc <- rma.mv(g,
                      vg,
                      random = list(~ 1 | IDSAMPLE,
                                     ~ 1 | IDCOUNTRY),
                      method = "REML",
                      data = dat,

```

```

      slab = paste(Sample),
      tdist = TRUE,
      test = "t",
      mods =~ IPD,
      struct = "DIAG")

## Model summary
summary(MEM2ipdad3bc, digits = 4)

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 22.2168 -44.4335 -36.4335 -28.7062 -35.5639
##
## Variance Components:
##
##           estim    sqrt  nlvls  fixed    factor
## sigma^2.1 0.0147 0.1211    53     no  IDSAMPLE
## sigma^2.2 0.0023 0.0482    30     no  IDCOUNTRY
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 13.1462, p-val = 0.0007
##
## Model Results:
##
##           estimate      se    tval  df    pval    ci.lb    ci.ub
## intrcpt    0.0648 0.0384  1.6868  51  0.0977  -0.0123  0.1420
## IPD        0.1578 0.0435  3.6258  51  0.0007   0.0704  0.2452 ***
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

## Model estimation
MEM2ipdad3a <- rma.mv(g,
  vg,
  random = list(~ as.factor(IPD) | IDSAMPLE,
    ~ 1 | IDSTUDY),
  method = "REML",
  data = dat,
  slab = paste(Sample),
  tdist = TRUE,
  test = "t",
  mods =~ IPD,
  struct = "ID")

## Model summary
summary(MEM2ipdad3a, digits = 4)

```

Model assuming the same between-country and between-sample (residual) heterogeneity for IPD and AD

```
##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC      AICc
## 22.6654 -45.3308 -37.3308 -29.6035 -36.4613
##
## Variance Components:
##
##      estim  sqrt  nlvls  fixed  factor
## sigma^2  0.0181 0.1344   21    no  IDSTUDY
##
## outer factor: IDSAMPLE      (nlvls = 53)
## inner factor: as.factor(IPD) (nlvls = 2)
##
##      estim  sqrt  fixed
## tau^2    0.0131 0.1144   no
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 1.6986, p-val = 0.1983
##
## Model Results:
##
##      estimate      se   tval  df   pval   ci.lb  ci.ub
## intrcpt    0.0820 0.0456  1.7992  51  0.0779 -0.0095  0.1735
## IPD        0.1401 0.1075  1.3033  51  0.1983 -0.0757  0.3560
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
## Confidence intervals
confint(MEM2ipdad3a, digits = 4)
```

```
##
##      estimate  ci.lb  ci.ub
## sigma^2    0.0181 0.0000 0.0674
## sigma      0.1344 0.0000 0.2596
##
##      estimate  ci.lb  ci.ub
## tau^2    0.0131 0.0077 0.0263
## tau      0.1144 0.0876 0.1620
```

```
## Robust standard errors
coef_test(MEM2ipdad3a, vcov = "CR2")
```

```
##      Coef. Estimate      SE t-stat  d.f. p-val (Satt) Sig.
## 1 intrcpt    0.082 0.0480   1.71 16.70   0.106
## 2 IPD        0.140 0.0489   2.86  1.48   0.144
```

```

####
## Alternative model specification
## Model estimation
MEM2ipdad3b <- rma.mv(g,
                    vg,
                    random = list(~ 1 | IDSAMPLE,
                                   ~ 1 | IDSTUDY),
                    method = "REML",
                    data = dat,
                    slab = paste(Sample),
                    tdist = TRUE,
                    test = "t",
                    mods =~ IPD,
                    struct = "DIAG")

## Model summary
summary(MEM2ipdad3b, digits = 4)

##
## Multivariate Meta-Analysis Model (k = 53; method: REML)
##
##   logLik  Deviance      AIC      BIC     AICc
## 22.6654 -45.3308 -37.3308 -29.6035 -36.4613
##
## Variance Components:
##
##           estim  sqrt  nlvls  fixed  factor
## sigma^2.1 0.0131 0.1144   53    no  IDSAMPLE
## sigma^2.2 0.0181 0.1344   21    no  IDSTUDY
##
## Test for Residual Heterogeneity:
## QE(df = 51) = 479.8761, p-val < .0001
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 51) = 1.6986, p-val = 0.1983
##
## Model Results:
##
##           estimate      se   tval  df   pval   ci.lb  ci.ub
## intrcpt    0.0820 0.0456  1.7992  51  0.0779 -0.0095  0.1735
## IPD         0.1401 0.1075  1.3033  51  0.1983 -0.0757  0.3560
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Model comparisons: IDSAMPLE and IDCOUNTRY
anova(MEM2ipdad3b, MEM2ipdad2c)

```

Model comparisons

```
##
##          df          AIC          BIC          AICc  logLik      LRT    pval      QE
## Full      6 -40.5818 -28.9909 -38.6728 26.2909                479.8761
## Reduced   5 -41.3649 -31.7057 -40.0315 25.6824 1.2170 0.2700 479.8761
```

```
anova(MEM2ipdad2c, MEM2ipdad3ac)
```

```
##
##          df          AIC          BIC          AICc  logLik      LRT    pval      QE
## Full      5 -41.3649 -31.7057 -40.0315 25.6824                479.8761
## Reduced   4 -36.4335 -28.7062 -35.5639 22.2168 6.9314 0.0085 479.8761
```

```
anova(MEM2ipdad3c, MEM2ipdad3ac)
```

```
##
##          df          AIC          BIC          AICc  logLik      LRT    pval      QE
## Full      6 -40.5818 -28.9909 -38.6728 26.2909                479.8761
## Reduced   4 -36.4335 -28.7062 -35.5639 22.2168 8.1483 0.0170 479.8761
```

```
AIC.rma(MEM2ipdad3c)
```

```
## [1] -40.58184
```

```
AIC.rma(MEM2ipdad2c)
```

```
## [1] -41.36487
```

```
AIC.rma(MEM2ipdad3ac)
```

```
## [1] -36.43351
```

```
## Model comparisons: IDSAMPLE and IDSTUDY
```

```
anova(MEM2ipdad, MEM2ipdad2)
```

```
##
##          df          AIC          BIC          AICc  logLik      LRT    pval      QE
## Full      6 -36.3523 -24.7614 -34.4432 24.1762                479.8761
## Reduced   5 -38.3523 -28.6932 -37.0190 24.1762 0.0000 1.0000 479.8761
```

```
anova(MEM2ipdad2, MEM2ipdad3a)
```

```
##
##          df          AIC          BIC          AICc  logLik      LRT    pval      QE
## Full      5 -38.3523 -28.6932 -37.0190 24.1762                479.8761
## Reduced   4 -37.3308 -29.6035 -36.4613 22.6654 3.0215 0.0822 479.8761
```

```
anova(MEM2ipdad, MEM2ipdad3a)
```

```
##  
##           df          AIC          BIC          AICc  logLik      LRT    pval      QE  
## Full      6 -36.3523 -24.7614 -34.4432 24.1762  
## Reduced  4 -37.3308 -29.6035 -36.4613 22.6654 3.0215 0.2207 479.8761
```

```
AIC.rma(MEM2ipdad)
```

```
## [1] -36.35233
```

```
AIC.rma(MEM2ipdad2)
```

```
## [1] -38.35233
```

```
AIC.rma(MEM2ipdad3a)
```

```
## [1] -37.33083
```

Conclusion These models and their comparison suggest that the pooled effect sizes differ significantly across data sources (i.e., IPD vs. AD), and between-sample residual heterogeneity estimates differ significantly as well.

R session info

```
sessionInfo()
```

```
## R version 4.1.1 (2021-08-10)
## Platform: x86_64-apple-darwin17.0 (64-bit)
## Running under: macOS Big Sur 10.16
##
## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/4.1/Resources/lib/libRlapack.dylib
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] grid      stats      graphics  grDevices  utils      datasets  methods
## [8] base
##
## other attached packages:
## [1] dmetar_0.0.9000      PublicationBias_2.2.0 zcurve_1.0.9
## [4] clubSandwich_0.5.3  devtools_2.4.3        usethis_2.0.1
## [7] forestplot_2.0.1    checkmate_2.1.0      magrittr_2.0.3
## [10] robumeta_2.0         meta_5.1-1           metafor_3.0-2
## [13] Matrix_1.3-4        pacman_0.5.1
##
## loaded via a namespace (and not attached):
## [1] nlme_3.1-152      fs_1.5.0             MetaUtility_2.1.1   prabclus_2.3-2
## [5] rprojroot_2.0.3  tools_4.1.1          backports_1.4.1     utf8_1.2.2
## [9] R6_2.5.1          DBI_1.1.1            colorspace_2.0-3    nnet_7.3-16
## [13] withr_2.5.0       netmeta_2.0-1        tidymodels_1.1.1    gridExtra_2.3
## [17] prettyunits_1.1.1 processx_3.5.3        compiler_4.1.1      cli_3.3.0
## [21] xml2_1.3.3        desc_1.4.1           sandwich_3.0-1      diptest_0.76-0
## [25] scales_1.2.0      DEoptimR_1.0-9       robustbase_0.93-9   callr_3.7.0
## [29] stringr_1.4.0     digest_0.6.29        minqa_1.2.4         rmarkdown_2.14
## [33] pkgconfig_2.0.3  htmltools_0.5.2     MuMIn_1.43.17       lme4_1.1-29
## [37] sessioninfo_1.1.1 fastmap_1.1.0        rlang_1.0.2         rstudioapi_0.13
## [41] generics_0.1.0   zoo_1.8-9            mclust_5.4.8        dplyr_1.0.9
## [45] modeltools_0.2-23 Rcpp_1.0.8.3         munsell_0.5.0       fansi_1.0.3
## [49] abind_1.4-5       lifecycle_1.0.1     stringi_1.7.6       yaml_2.2.1
## [53] CompQuadForm_1.4.3 mathjaxr_1.4-0       MASS_7.3-54         flexmix_2.3-17
## [57] pkgbuild_1.3.1    parallel_4.1.1      ggrepel_0.9.1       crayon_1.5.1
## [61] lattice_0.20-44  splines_4.1.1        poibin_1.5          knitr_1.36
## [65] ps_1.7.0          pillar_1.7.0         boot_1.3-28         fpc_2.2-9
## [69] codetools_0.2-18 stats4_4.1.1         pkgload_1.2.1       magic_1.5-9
## [73] glue_1.6.2        evaluate_0.14        remotes_2.4.2       vctrs_0.4.1
## [77] nloptr_1.2.2.3    Rdpack_2.1.2         testthat_3.0.4      gtable_0.3.0
## [81] purrr_0.3.4       tidyr_1.1.4         kernlab_0.9-29      assertthat_0.2.1
## [85] cachem_1.0.6      ggplot2_3.3.6        xfun_0.31           rbibutils_2.2.4
## [89] class_7.3-19      tibble_3.1.7         memoise_2.0.0       cluster_2.1.2
## [93] ellipsis_0.3.2
```