meta_analyses

```
library(dmetar)
```

```
## Extensive documentation for the dmetar package can be found at:
##  www.bookdown.org/MathiasHarrer/Doing_Meta_Analysis_in_R/
```

```
library(esc)
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────── tidyverse 1.3.1 ──
```

```
## ✓ ggplot2 3.3.5     ✓ purrr   0.3.4
## ✓ tibble  3.1.6     ✓ dplyr   1.0.7
## ✓ tidyr   1.1.4     ✓ stringr 1.4.0
## ✓ readr   2.1.0     ✓ forcats 0.5.1
```

```
## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(metafor)
```

```
## Loading required package: Matrix
```

```
## 
## Attaching package: 'Matrix'
```

```
## The following objects are masked from 'package:tidyr':
## 
##     expand, pack, unpack
```

```
## 
## Loading the 'metafor' package (version 3.0-2). For an
## introduction to the package please type: help(metafor)
```

```
library(meta)
```

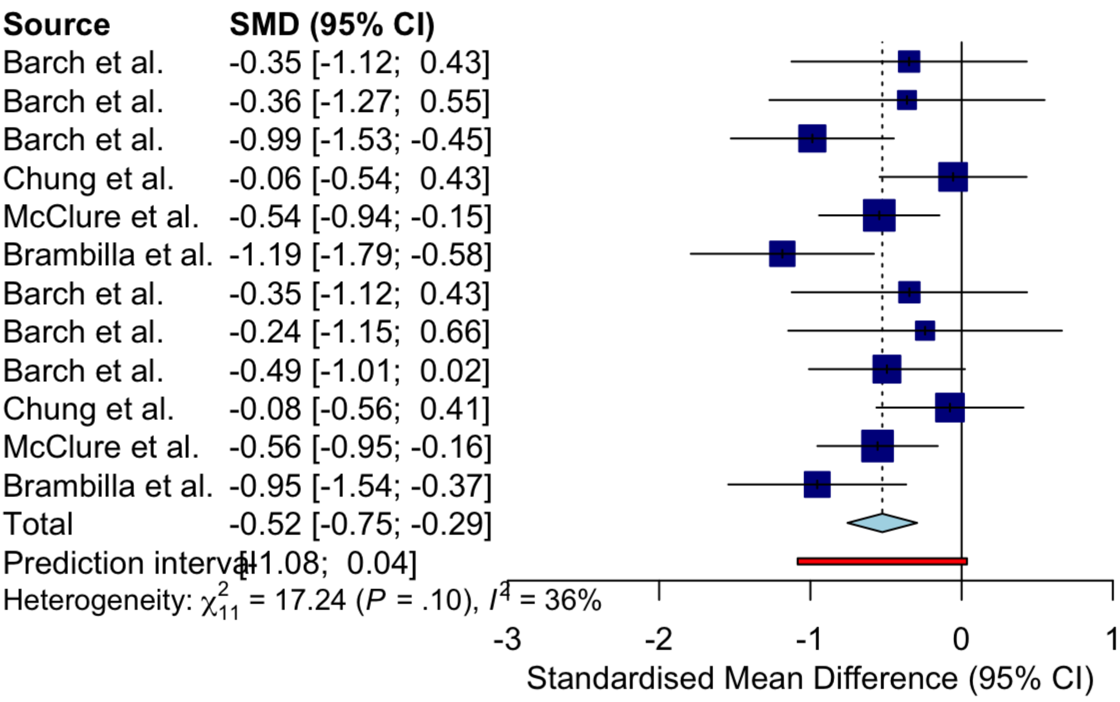
```
## Loading 'meta' package (version 5.1-1).
## Type 'help(meta)' for a brief overview.
## Readers of 'Meta-Analysis with R (Use R!)' should install
## older version of 'meta' package: https://tinyurl.com/dt4y5drs
```

```r
library(readxl)
setwd("~/Documents/<junior/the scientific research practice")
MetaAnalysis_data <- read_excel("MetaAnalysis_data.xlsx")
MetaAnalysis_data <- data.frame(MetaAnalysis_data)
```

```r
m.result <- metacont(data = MetaAnalysis_data,
                     studlab = Author,
                     n.e = e.n,
                     mean.e = e.PBI.mean,
                     sd.e = e.PBI.sd,
                     n.c = c.n,
                     mean.c = c.PBI.mean,
                     sd.c = c.PBI.sd,
                     sm = "SMD", # summary measure: Standardized Mean Difference
                     method.smd = "Hedges", # calculate the Hedge's g
                     fixed = FALSE,
                     random = TRUE, # use random-effects model
                     method.tau = "REML", # estimate tau by Restricted Maximum Likeli
hood method
                     hakn = TRUE, # Knapp-Hartung adjustment
                     prediction = TRUE, # calculate prediction interval
                     title = "meta analysis result")
summary(m.result)
```

```
## Review:     meta analysis result
##
##                        SMD             95%-CI %W(random)
## Barch et al.     -0.3471 [-1.1249;  0.4306]        2.7
## Barch et al.     -0.3612 [-1.2708;  0.5484]        2.0
## Barch et al.     -0.9871 [-1.5258; -0.4484]        5.1
## Chung et al.     -0.0563 [-0.5422;  0.4296]        6.0
## Edwards et al.   -0.2267 [-0.8990;  0.4457]        3.5
## Lesh et al.      -0.2500 [-0.6522;  0.1522]        7.9
## MacDonald et al. -0.6930 [-1.3875;  0.0016]        3.3
## McClure et al.   -0.5445 [-0.9420; -0.1469]        8.1
## Yoon et al.      -0.2064 [-0.5956;  0.1828]        8.3
## Brambilla et al. -1.1855 [-1.7906; -0.5804]        4.2
## Rush et al.      -0.4791 [-0.8640; -0.0941]        8.4
## Lesh et al.      -0.4128 [-0.9461;  0.1204]        5.2
## Dijk et al.      -0.7528 [-1.4222; -0.0835]        3.5
## Dias et al.      -0.7391 [-1.4884;  0.0102]        2.9
## Barch et al.     -0.3454 [-1.1231;  0.4323]        2.7
## Barch et al.     -0.2416 [-1.1462;  0.6630]        2.1
## Barch et al.     -0.4939 [-1.0093;  0.0216]        5.5
## Chung et al.     -0.0771 [-0.5631;  0.4088]        6.0
## McClure et al.   -0.5559 [-0.9537; -0.1580]        8.1
## Brambilla et al. -0.9547 [-1.5426; -0.3668]        4.4
##
## Number of studies combined: k = 20
## Number of observations: o = 1172
##
##                            SMD             95%-CI     t  p-value
## Random effects model -0.4750 [-0.6164; -0.3337] -7.03 < 0.0001
## Prediction interval          [-0.7877; -0.1624]
##
## Quantifying heterogeneity:
##  tau^2 = 0.0176 [0.0000; 0.1180]; tau = 0.1326 [0.0000; 0.3436]
##  I^2 = 16.2% [0.0%; 50.8%]; H = 1.09 [1.00; 1.43]
##
## Test of heterogeneity:
##      Q d.f. p-value
##  22.67   19  0.2522
##
## Details on meta-analytical method:
## - Inverse variance method
## - Restricted maximum-likelihood estimator for tau^2
## - Q-profile method for confidence interval of tau^2 and tau
## - Hartung-Knapp adjustment for random effects model
## - Hedges' g (bias corrected standardised mean difference; using exact formulae)
```

```
forest.meta(m.result,
            xlim = c(-2,1),
            layout = "JAMA")
```

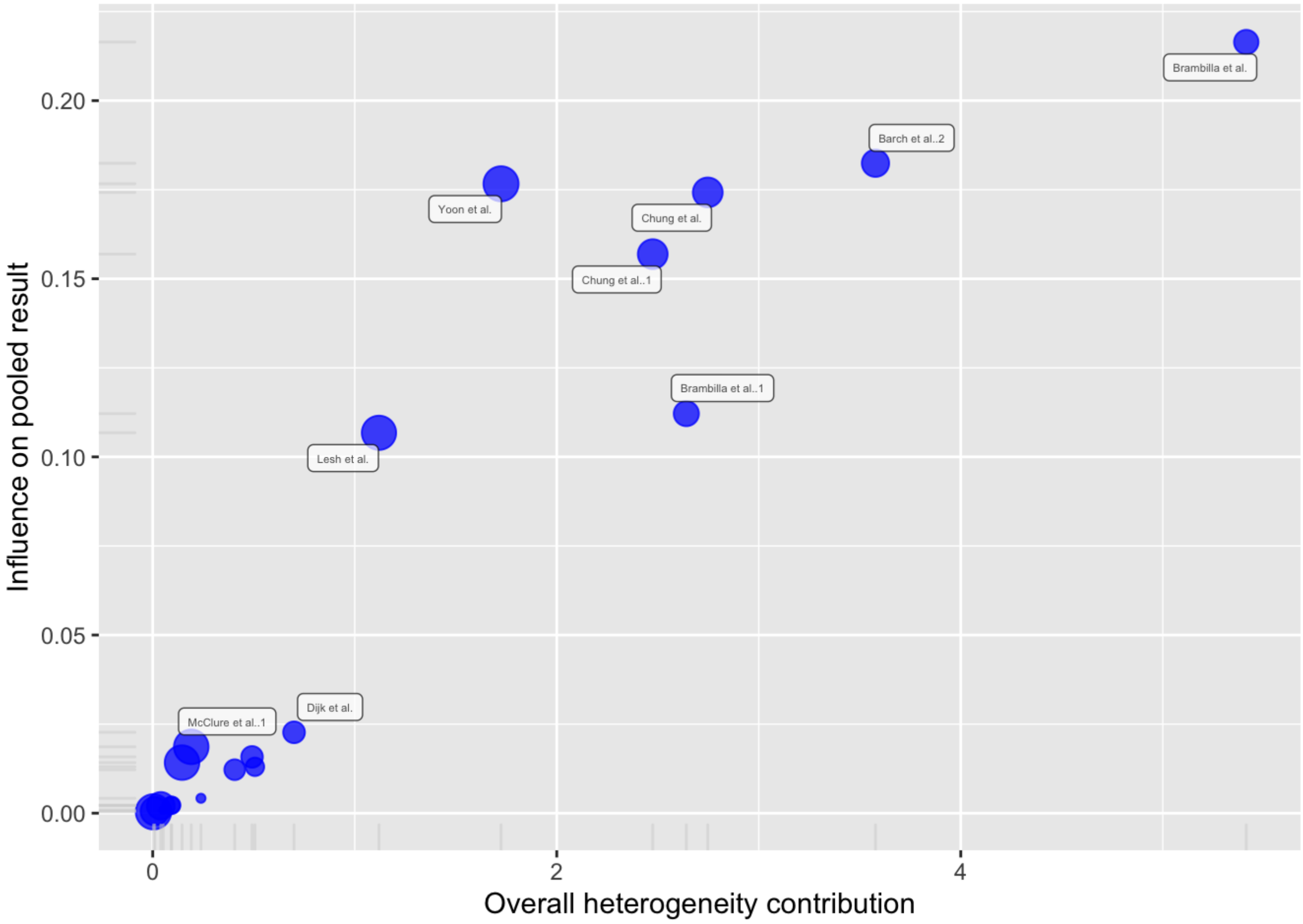



```
m.inf <- InfluenceAnalysis(m.result, random = TRUE)
```

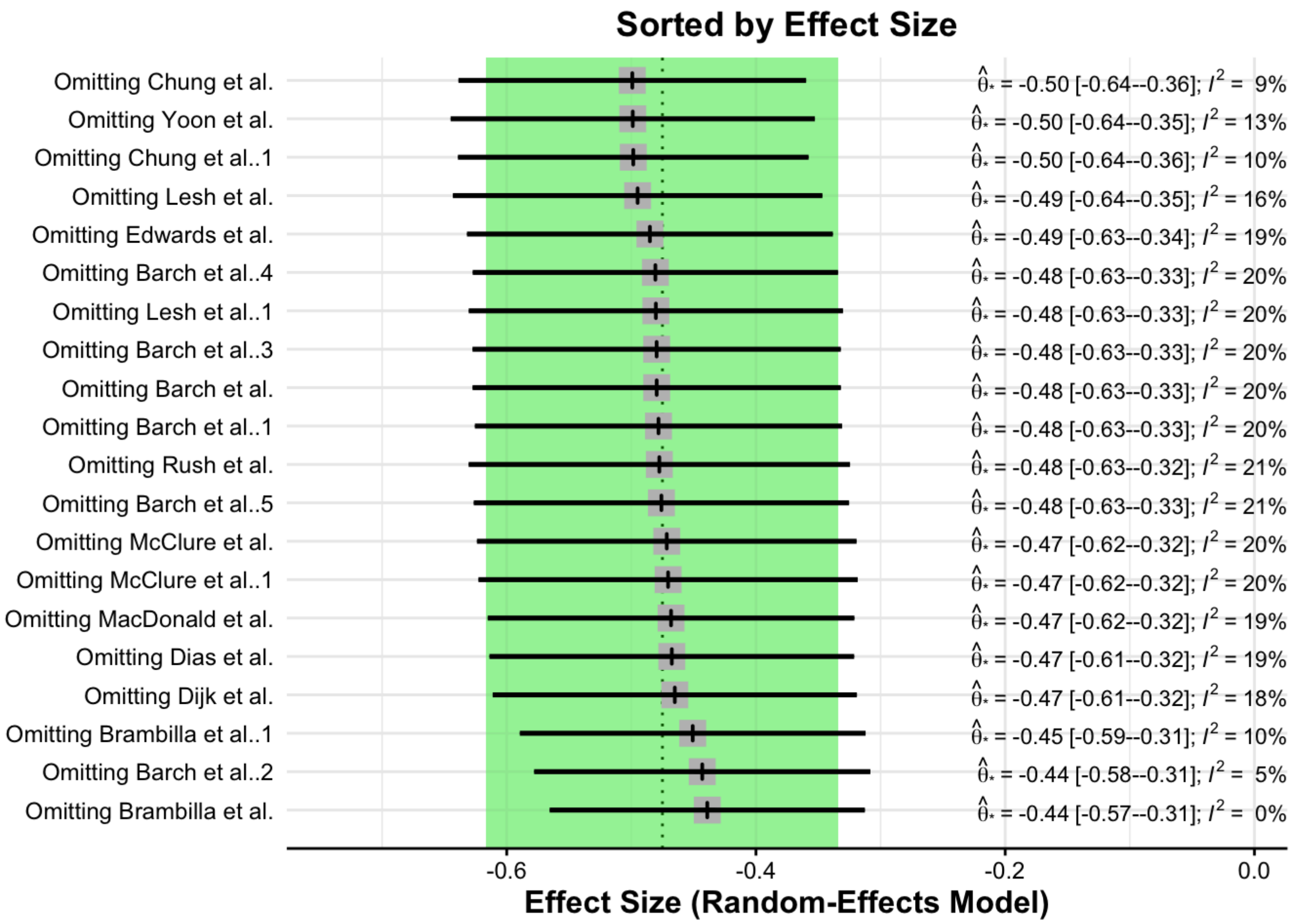
```
## [===========================================================================] DONE
```

```
plot(m.inf,"baujat")
```

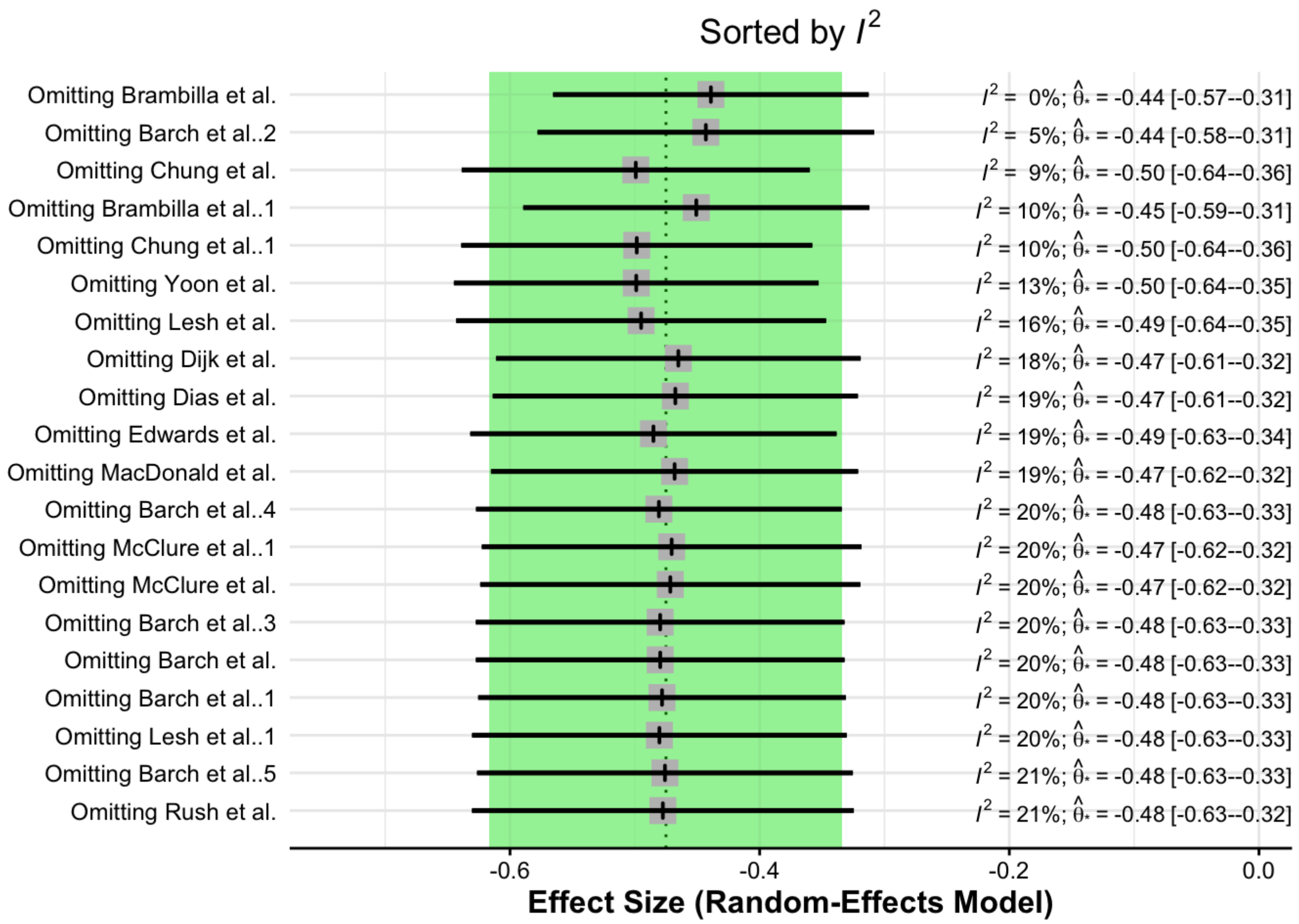
```
## Warning: ggrepel: 11 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```


Brambilla et al.
Barch et al..2
Yoon et al.
Chung et al.
Chung et al..1
Brambilla et al..1
Lesh et al.
Dijk et al.
McClure et al..1
0.20
0.15
0.10
0.05
0.00
Influence on pooled result
0
2
4
Overall heterogeneity contribution

```
plot(m.inf,"es")
```


Sorted by Effect Size
Omitting Chung et al.
Omitting Yoon et al.
Omitting Chung et al..1
Omitting Lesh et al.
Omitting Edwards et al.
Omitting Barch et al..4
Omitting Lesh et al..1
Omitting Barch et al..3
Omitting Barch et al.
Omitting Barch et al..1
Omitting Rush et al.
Omitting Barch et al..5
Omitting McClure et al.
Omitting McClure et al..1
Omitting MacDonald et al.
Omitting Dias et al.
Omitting Dijk et al.
Omitting Brambilla et al..1
Omitting Barch et al..2
Omitting Brambilla et al.
$\hat{\theta}_*$ = -0.50 [-0.64--0.36]; I^2 = 9%
$\hat{\theta}_*$ = -0.50 [-0.64--0.35]; I^2 = 13%
$\hat{\theta}_*$ = -0.50 [-0.64--0.36]; I^2 = 10%
$\hat{\theta}_*$ = -0.49 [-0.64--0.35]; I^2 = 16%
$\hat{\theta}_*$ = -0.49 [-0.63--0.34]; I^2 = 19%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 20%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 20%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 20%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 20%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 20%
$\hat{\theta}_*$ = -0.48 [-0.63--0.32]; I^2 = 21%
$\hat{\theta}_*$ = -0.48 [-0.63--0.33]; I^2 = 21%
$\hat{\theta}_*$ = -0.47 [-0.62--0.32]; I^2 = 20%
$\hat{\theta}_*$ = -0.47 [-0.62--0.32]; I^2 = 20%
$\hat{\theta}_*$ = -0.47 [-0.62--0.32]; I^2 = 19%
$\hat{\theta}_*$ = -0.47 [-0.61--0.32]; I^2 = 19%
$\hat{\theta}_*$ = -0.47 [-0.61--0.32]; I^2 = 18%
$\hat{\theta}_*$ = -0.45 [-0.59--0.31]; I^2 = 10%
$\hat{\theta}_*$ = -0.44 [-0.58--0.31]; I^2 = 5%
$\hat{\theta}_*$ = -0.44 [-0.57--0.31]; I^2 = 0%
-0.6
-0.4
-0.2
0.0
Effect Size (Random-Effects Model)

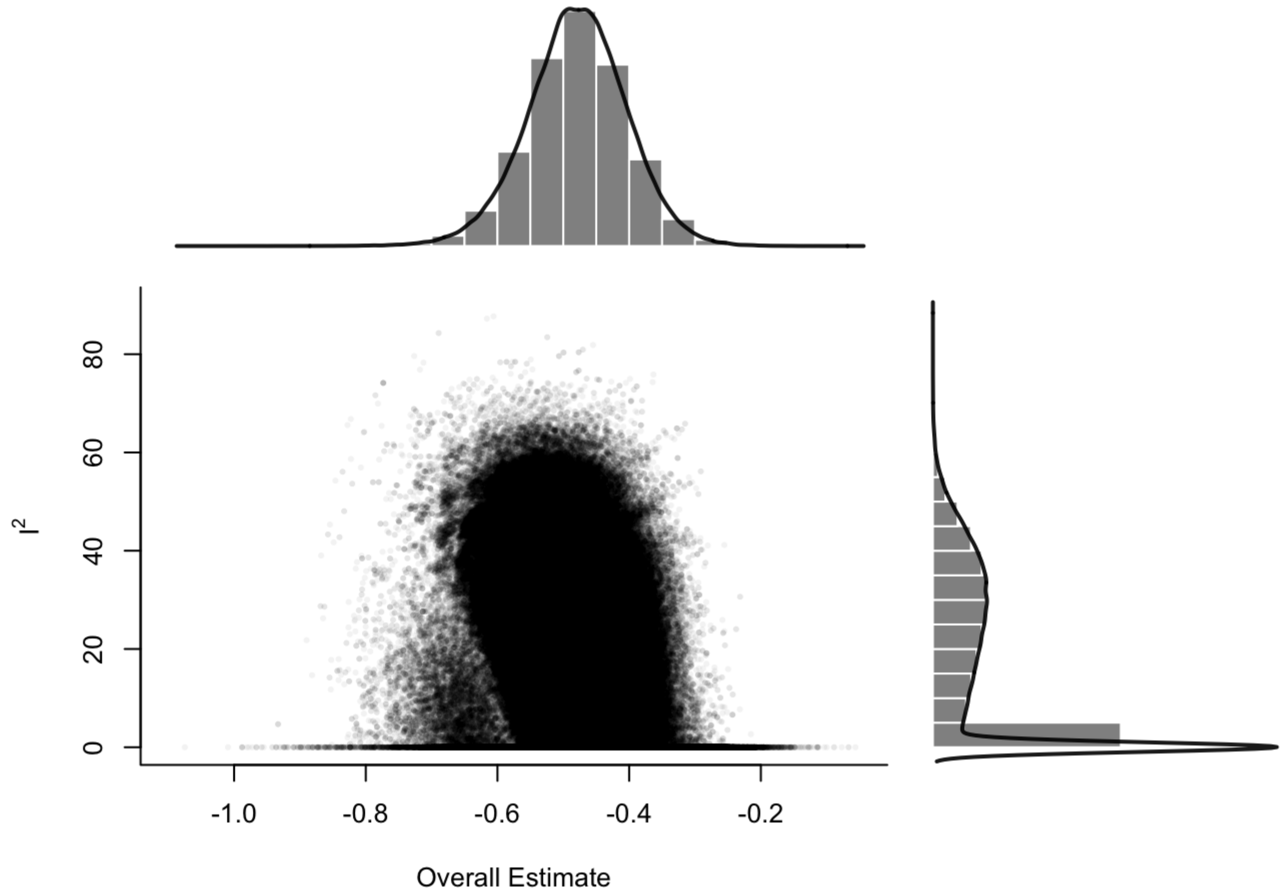
```
plot(m.inf,"i2")
```




```
m.rma <- rma(yi = m.result$TE,
             sei = m.result$seTE,
             method = m.result$method.tau,
             test = "knha")
res.gosh <- gosh(m.rma)
```

```
## Fitting 1e+06 models (based on random subsets).
```

```
plot(res.gosh, alpha = 0.05)
```



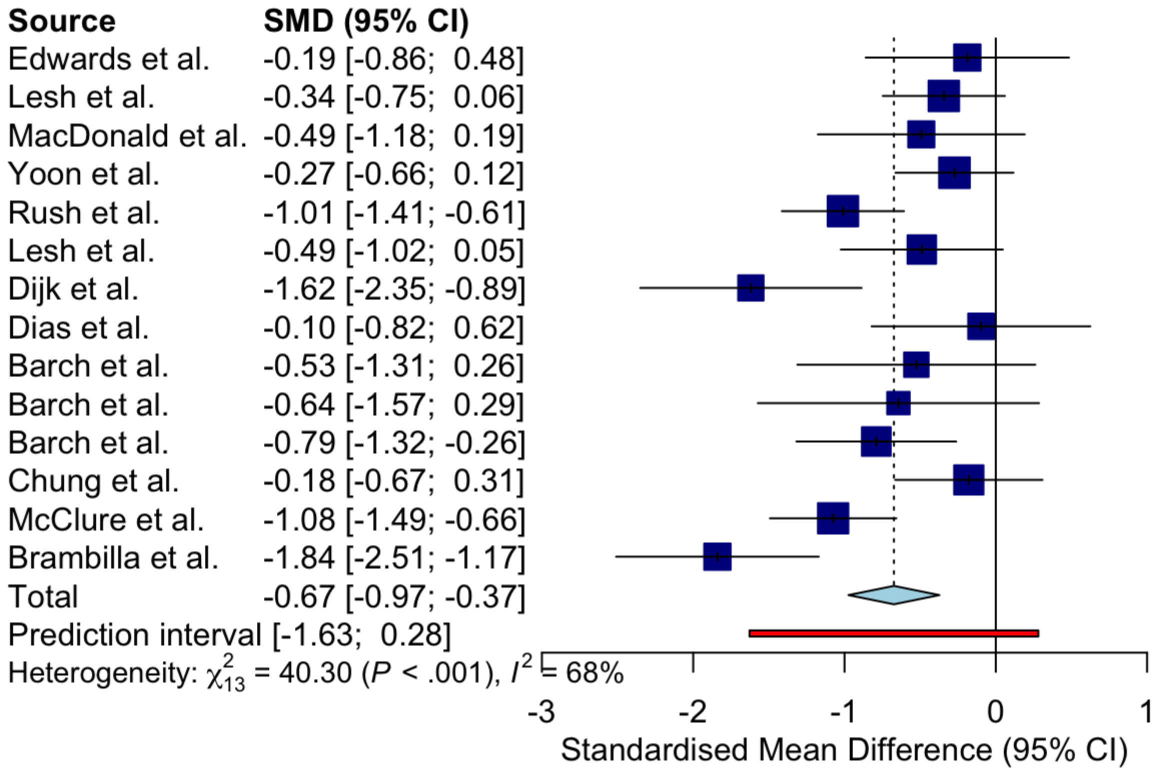

```
MetaAnalysis_data.all <- MetaAnalysis_data[!(MetaAnalysis_data$delay=="short"),]
m.result.proactive.index <- metacont(data = MetaAnalysis_data.all,
                     studlab = Author,
                     n.e = e.n,
                     mean.e = e.proactive.index.mean,
                     sd.e = e.proactive.index.sd,
                     n.c = c.n,
                     mean.c = c.proactive.index.mean,
                     sd.c = c.proactive.index.sd,
                     sm = "SMD", # summary measure: Standardized Mean Difference
                     method.smd = "Hedges", # calculate the Hedge's g
                     fixed = FALSE,
                     random = TRUE, # use random-effects model
                     method.tau = "REML", # estimate tau by Restricted Maximum Likeli
hood method
                     hakn = TRUE, # Knapp-Hartung adjustment
                     prediction = TRUE, # calculate prediction interval
                     title = "meta analysis result by proavtive index")
summary(m.result.proactive.index)
```

```
## Review:     meta analysis result by proavtive index
##
##                       SMD             95%-CI %W(random)
## Edwards et al.   -0.1883 [-0.8600;  0.4833]        6.5
## Lesh et al.      -0.3435 [-0.7471;  0.0602]        8.7
## MacDonald et al. -0.4925 [-1.1761;  0.1912]        6.4
## Yoon et al.      -0.2732 [-0.6632;  0.1168]        8.8
## Rush et al.      -1.0104 [-1.4140; -0.6068]        8.7
## Lesh et al.      -0.4890 [-1.0245;  0.0465]        7.6
## Dijk et al.      -1.6190 [-2.3505; -0.8874]        6.0
## Dias et al.      -0.0979 [-0.8205;  0.6247]        6.1
## Barch et al.     -0.5252 [-1.3116;  0.2611]        5.6
## Barch et al.     -0.6437 [-1.5727;  0.2854]        4.7
## Barch et al.     -0.7899 [-1.3176; -0.2622]        7.7
## Chung et al.     -0.1785 [-0.6653;  0.3082]        8.0
## McClure et al.   -1.0752 [-1.4928; -0.6576]        8.6
## Brambilla et al. -1.8400 [-2.5096; -1.1704]        6.5
##
## Number of studies combined: k = 14
## Number of observations: o = 843
##
##                           SMD             95%-CI     t p-value
## Random effects model -0.6734 [-0.9739; -0.3728] -4.84  0.0003
## Prediction interval          [-1.6278;  0.2810]
##
## Quantifying heterogeneity:
##  tau^2 = 0.1725 [0.0505; 0.6337]; tau = 0.4153 [0.2247; 0.7961]
##  I^2 = 67.7% [43.7%; 81.5%]; H = 1.76 [1.33; 2.33]
##
## Test of heterogeneity:
##      Q d.f. p-value
##  40.30   13  0.0001
##
## Details on meta-analytical method:
## - Inverse variance method
## - Restricted maximum-likelihood estimator for tau^2
## - Q-profile method for confidence interval of tau^2 and tau
## - Hartung-Knapp adjustment for random effects model
## - Hedges' g (bias corrected standardised mean difference; using exact formulae)
```

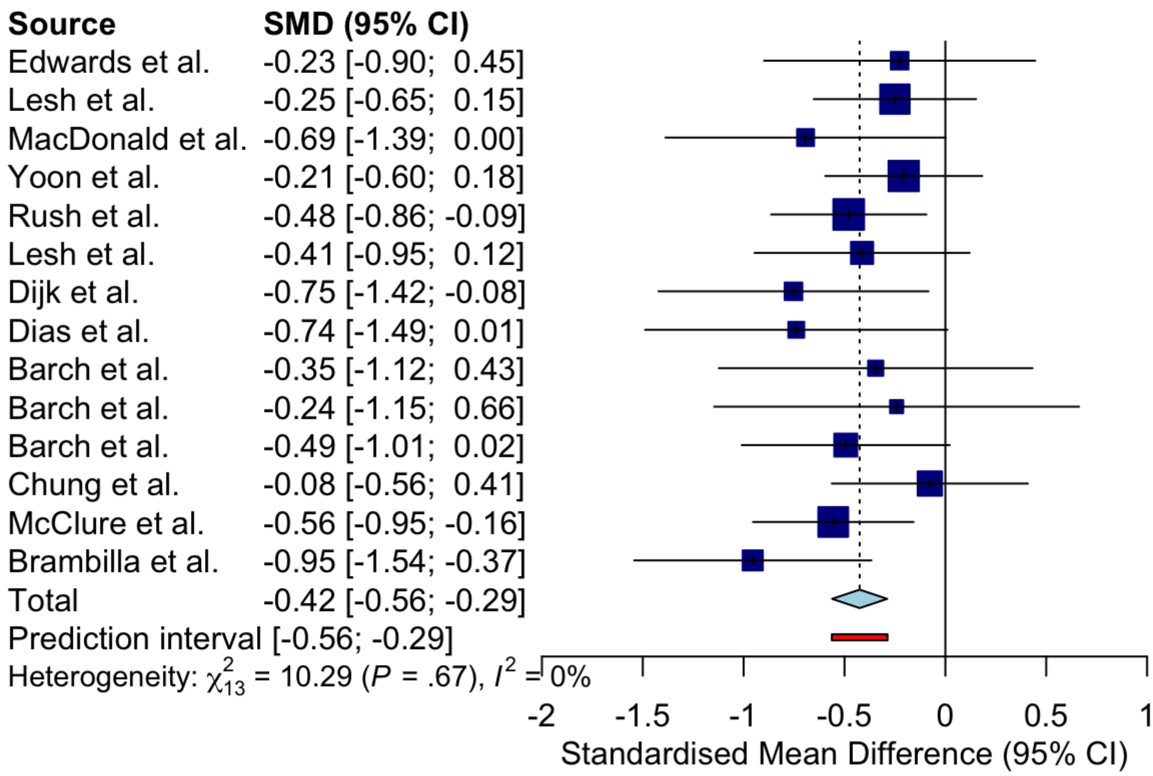
```
m.result.PBI <- metacont(data = MetaAnalysis_data.all,
                     studlab = Author,
                     n.e = e.n,
                     mean.e = e.PBI.mean,
                     sd.e = e.PBI.sd,
                     n.c = c.n,
                     mean.c = c.PBI.mean,
                     sd.c = c.PBI.sd,
                     sm = "SMD", # summary measure: Standardized Mean Difference
                     method.smd = "Hedges", # calculate the Hedge's g
                     fixed = FALSE,
                     random = TRUE, # use random-effects model
                     method.tau = "REML", # estimate tau by Restricted Maximum Likeli
hood method
                     hakn = TRUE, # Knapp-Hartung adjustment
                     prediction = TRUE, # calculate prediction interval
                     title = "meta analysis result by PBI")
summary(m.result.PBI)
```

```
## Review:     meta analysis result by PBI
##
##                      SMD            95%-CI %W(random)
## Edwards et al.   -0.2267 [-0.8990;  0.4457]        4.3
## Lesh et al.      -0.2500 [-0.6522;  0.1522]       12.0
## MacDonald et al. -0.6930 [-1.3875;  0.0016]        4.0
## Yoon et al.      -0.2064 [-0.5956;  0.1828]       12.8
## Rush et al.      -0.4791 [-0.8640; -0.0941]       13.1
## Lesh et al.      -0.4128 [-0.9461;  0.1204]        6.8
## Dijk et al.      -0.7528 [-1.4222; -0.0835]        4.3
## Dias et al.      -0.7391 [-1.4884;  0.0102]        3.5
## Barch et al.     -0.3454 [-1.1231;  0.4323]        3.2
## Barch et al.     -0.2416 [-1.1462;  0.6630]        2.4
## Barch et al.     -0.4939 [-1.0093;  0.0216]        7.3
## Chung et al.     -0.0771 [-0.5631;  0.4088]        8.2
## McClure et al.   -0.5559 [-0.9537; -0.1580]       12.3
## Brambilla et al. -0.9547 [-1.5426; -0.3668]        5.6
##
## Number of studies combined: k = 14
## Number of observations: o = 843
##
##                          SMD            95%-CI     t  p-value
## Random effects model -0.4249 [-0.5616; -0.2882] -6.71 < 0.0001
## Prediction interval          [-0.5628; -0.2870]
##
## Quantifying heterogeneity:
##  tau^2 = 0 [0.0000; 0.0795]; tau = 0 [0.0000; 0.2820]
##  I^2 = 0.0% [0.0%; 55.0%]; H = 1.00 [1.00; 1.49]
##
## Test of heterogeneity:
##      Q d.f. p-value
##  10.29   13  0.6702
##
## Details on meta-analytical method:
## - Inverse variance method
## - Restricted maximum-likelihood estimator for tau^2
## - Q-profile method for confidence interval of tau^2 and tau
## - Hartung-Knapp adjustment for random effects model
## - Hedges' g (bias corrected standardised mean difference; using exact formulae)
```

```
forest.meta(m.result.proactive.index,xlim = c(-3,1),layout = "JAMA")
```



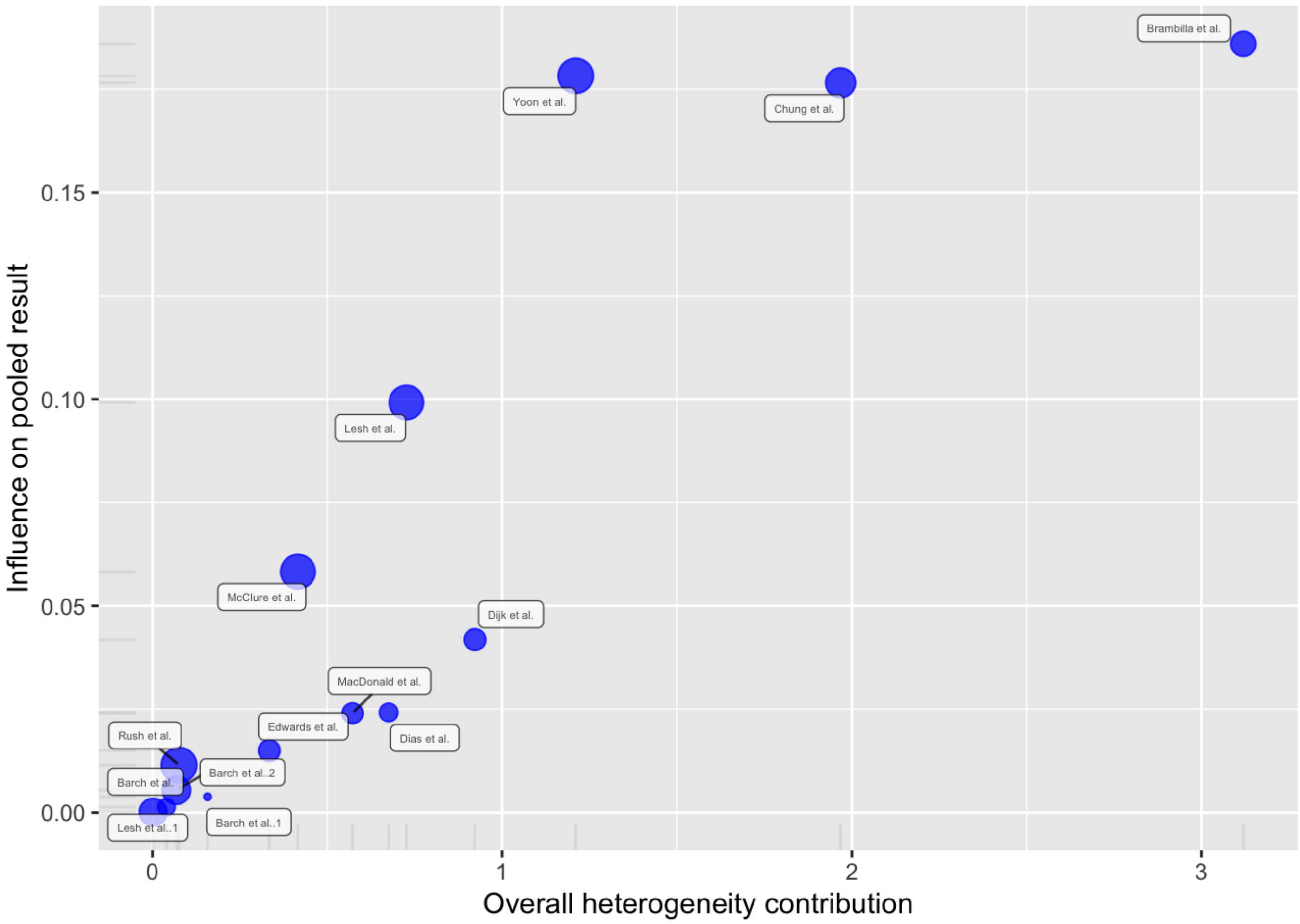

```
forest.meta(m.result.PBI,xlim = c(-2,1),layout = "JAMA")
```



```
m.inf.PBI <- InfluenceAnalysis(m.result.PBI, random = TRUE)
```

```
## [===========================================================================] DONE
```

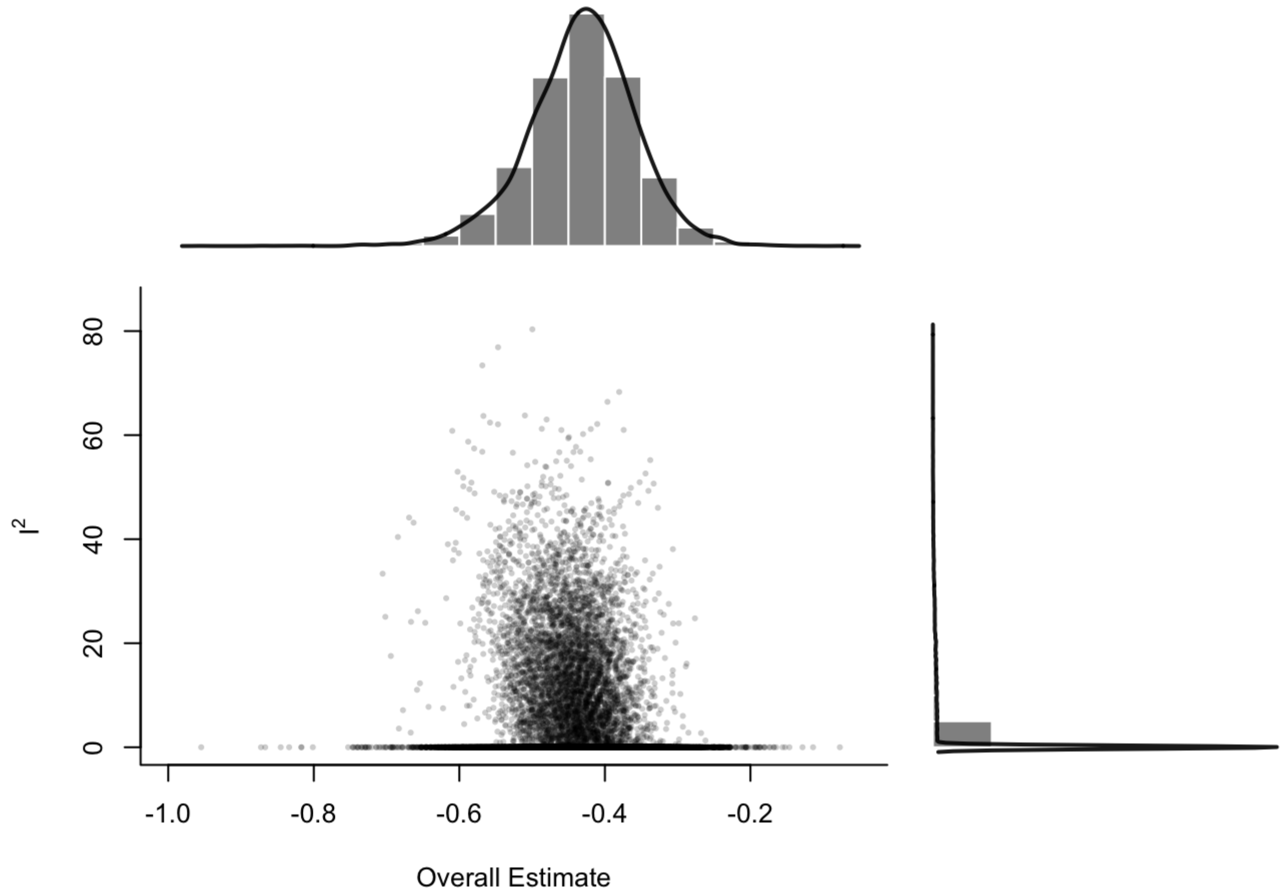
```
plot(m.inf.PBI,"baujat")
```




```
m.rma.PBI <- rma(yi = m.result.PBI$TE,
                 sei = m.result.PBI$seTE,
                 method = m.result.PBI$method.tau,
                 test = "knha")
res.gosh.PBI <- gosh(m.rma.PBI)
```

```
## Fitting 16383 models (based on all possible subsets).
```

```
plot(res.gosh.PBI, alpha = 0.2)
```

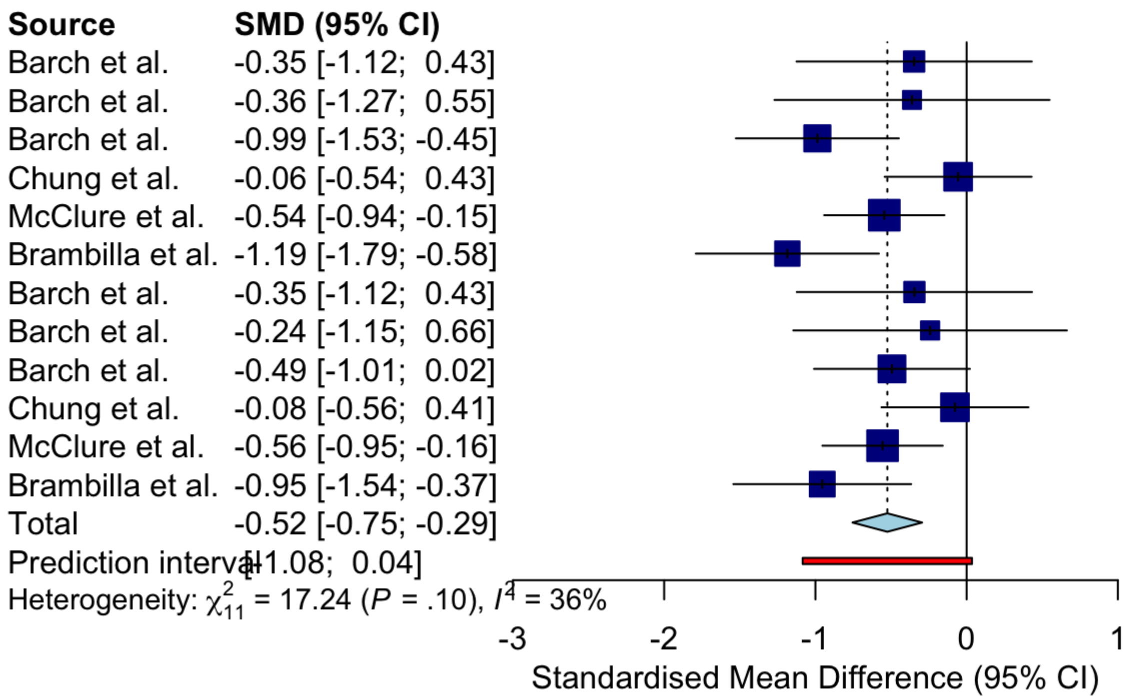



```
MetaAnalysis_data.subgroup <- MetaAnalysis_data[MetaAnalysis_data$delay!="-",]
MetaAnalysis_data.long <- MetaAnalysis_data.subgroup[MetaAnalysis_data.subgroup$delay
=="long",]
MetaAnalysis_data.short <- MetaAnalysis_data.subgroup[MetaAnalysis_data.subgroup$dela
y=="short",]
```

```
m.result.subgroup <- metacont(data = MetaAnalysis_data.subgroup,
                     studlab = Author,
                     n.e = e.n,
                     mean.e = e.PBI.mean,
                     sd.e = e.PBI.sd,
                     n.c = c.n,
                     mean.c = c.PBI.mean,
                     sd.c = c.PBI.sd,
                     sm = "SMD", # summary measure: Standardized Mean Difference
                     method.smd = "Hedges", # calculate the Hedge's g
                     fixed = FALSE,
                     random = TRUE, # use random-effects model
                     method.tau = "REML", # estimate tau by Restricted Maximum Likeli
hood method
                     hakn = TRUE, # Knapp-Hartung adjustment
                     prediction = TRUE, # calculate prediction interval
                     title = "meta analysis result combining long & short delay")
summary(m.result.subgroup)
```

```
## Review:     meta analysis result combining long & short delay
##
##                      SMD             95%-CI %W(random)
## Barch et al.     -0.3471 [-1.1249;  0.4306]        5.5
## Barch et al.     -0.3612 [-1.2708;  0.5484]        4.3
## Barch et al.     -0.9871 [-1.5258; -0.4484]        9.1
## Chung et al.     -0.0563 [-0.5422;  0.4296]       10.2
## McClure et al.   -0.5445 [-0.9420; -0.1469]       12.5
## Brambilla et al. -1.1855 [-1.7906; -0.5804]        7.9
## Barch et al.     -0.3454 [-1.1231;  0.4323]        5.5
## Barch et al.     -0.2416 [-1.1462;  0.6630]        4.4
## Barch et al.     -0.4939 [-1.0093;  0.0216]        9.6
## Chung et al.     -0.0771 [-0.5631;  0.4088]       10.2
## McClure et al.   -0.5559 [-0.9537; -0.1580]       12.5
## Brambilla et al. -0.9547 [-1.5426; -0.3668]        8.2
##
## Number of studies combined: k = 12
## Number of observations: o = 658
##
##                          SMD             95%-CI     t p-value
## Random effects model -0.5244 [-0.7548; -0.2941] -5.01  0.0004
## Prediction interval          [-1.0842;  0.0354]
##
## Quantifying heterogeneity:
##  tau^2 = 0.0522 [0.0000; 0.2845]; tau = 0.2284 [0.0000; 0.5334]
##  I^2 = 36.2% [0.0%; 67.8%]; H = 1.25 [1.00; 1.76]
##
## Test of heterogeneity:
##      Q d.f. p-value
##  17.24   11  0.1009
##
## Details on meta-analytical method:
## - Inverse variance method
## - Restricted maximum-likelihood estimator for tau^2
## - Q-profile method for confidence interval of tau^2 and tau
## - Hartung-Knapp adjustment for random effects model
## - Hedges' g (bias corrected standardised mean difference; using exact formulae)
```

```
forest.meta(m.result.subgroup,xlim = c(-3,1),layout = "JAMA")
```




```
update.meta(m.result.subgroup, subgroup = delay, tau.common = TRUE)
```

```
## Review:     meta analysis result combining long & short delay
##
## Number of studies combined: k = 12
## Number of observations: o = 658
##
##                          SMD             95%-CI     t p-value
## Random effects model -0.5244 [-0.7548; -0.2941] -5.01  0.0004
## Prediction interval          [-1.0842;  0.0354]
##
## Quantifying heterogeneity:
##  tau^2 = 0.0522 [0.0000; 0.2845]; tau = 0.2284 [0.0000; 0.5334]
##  I^2 = 36.2% [0.0%; 67.8%]; H = 1.25 [1.00; 1.76]
##
## Quantifying residual heterogeneity:
##  tau^2 = 0.0626; tau = 0.2503; I^2 = 40.3% [0.0%; 70.6%]; H = 1.29 [1.00; 1.84]
##
## Test of heterogeneity:
##      Q d.f. p-value
##  17.24   11  0.1009
##
## Results for subgroups (random effects model):
##                 k     SMD             95%-CI  tau^2    tau     Q   I^2
## delay = short   6 -0.5894 [-1.0439; -0.1350] 0.0626 0.2503 11.10 55.0%
## delay = long    6 -0.4606 [-0.7814; -0.1398] 0.0626 0.2503  5.65 11.5%
##
## Test for subgroup differences (random effects model):
##                     Q d.f. p-value
## Between groups  0.35    1  0.5516
## Within groups  16.75   10  0.0801
##
## Prediction intervals for subgroups:
##                          95%-PI
## delay = short [-1.4402; 0.2613]
## delay = long  [-1.2370; 0.3158]
##
## Details on meta-analytical method:
## - Inverse variance method
## - Restricted maximum-likelihood estimator for tau^2
##   (assuming common tau^2 in subgroups)
## - Q-profile method for confidence interval of tau^2 and tau
## - Hartung-Knapp adjustment for random effects model
## - Hedges' g (bias corrected standardised mean difference; using exact formulae)
```

```
years <- MetaAnalysis_data.all$Year
m.gen.reg <- metareg(m.result.PBI, ~years)
summary(m.gen.reg)
```

```
##
## Mixed-Effects Model (k = 14; tau^2 estimator: REML)
##
##   logLik  deviance       AIC       BIC      AICc
##  -0.7295    1.4591    7.4591    8.9138   10.4591
##
## tau^2 (estimated amount of residual heterogeneity):     0 (SE = 0.0266)
## tau (square root of estimated tau^2 value):             0
## I^2 (residual heterogeneity / unaccounted variability): 0.00%
## H^2 (unaccounted variability / sampling variability):   1.00
## R^2 (amount of heterogeneity accounted for):            0.00%
##
## Test for Residual Heterogeneity:
## QE(df = 12) = 9.3791, p-val = 0.6703
##
## Test of Moderators (coefficient 2):
## F(df1 = 1, df2 = 12) = 1.1632, p-val = 0.3020
##
## Model Results:
##
##          estimate       se     tval  df    pval      ci.lb    ci.ub
## intrcpt  -35.3464  32.3796  -1.0916  12  0.2964  -105.8955  35.2028
## years      0.0174   0.0161   1.0785  12  0.3020    -0.0177   0.0525
##
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
bubble(m.gen.reg, studlab = TRUE)
```