

```

library(metaSEM)

Verbal_ForMultivariate_HedgesG <- read.csv("Verbal_ForMultivariate_HedgesG.csv")

## Most data are read as string. You need to convert them to numeric before analyses.
str(Verbal_ForMultivariate_HedgesG)

## 'data.frame': 28 obs. of 12 variables:
## $ Study.id : int 1 2 3 4 5 6 7 8 9 10 ...
## $ Authors : chr "Andin et al. " "Andin et al. " "Andin et al. " "Andin et al. " ...
## $ Year : int 2013 2013 2013 2013 2015 2008 2008 1957 2004 2004 ...
## $ age : chr "28" "28" "36.375" "36.375" ...
## $ Country : chr "Sweden" "Sweden" "Sweden" "Sweden" ...
## $ Total_N : int 36 36 54 54 58 32 40 106 24 40 ...
## $ FWD_G : chr "-0.680287649" "-0.333892487" "-0.092811694" "0.025041387" ...
## $ FWD_SE : chr "0.335220624" "0.328189043" "0.270035746" "0.269902722" ...
## $ BWD_G : chr "-0.649772487" "-0.107072982" "-0.297818124" "-0.25947582" ...
## $ BWD_SE : chr "0.334415809" "0.326159381" "0.271365922" "0.271011634" ...
## $ Stimuli : chr "Digits" "Letters" "Digits " "Letters" ...
## $ stimuli_code: int 1 2 1 2 1 1 2 1 1 1 ...

Verbal_ForMultivariate_HedgesG$FWD_G <- as.numeric(Verbal_ForMultivariate_HedgesG$FWD_G)

## Warning: NAs introduced by coercion

Verbal_ForMultivariate_HedgesG$BWD_G <- as.numeric(Verbal_ForMultivariate_HedgesG$BWD_G)

## Warning: NAs introduced by coercion

Verbal_ForMultivariate_HedgesG$FWD_SE <- as.numeric(Verbal_ForMultivariate_HedgesG$FWD_SE)

## Warning: NAs introduced by coercion

Verbal_ForMultivariate_HedgesG$BWD_SE <- as.numeric(Verbal_ForMultivariate_HedgesG$BWD_SE)

## Warning: NAs introduced by coercion

## Univariate meta-analysis for Forward Verbal
summary(meta(y=FWD_G, v=FWD_SE^2, data=Verbal_ForMultivariate_HedgesG))

##
## Call:
## meta(y = FWD_G, v = FWD_SE^2, data = Verbal_ForMultivariate_HedgesG)
##
## 95% confidence intervals: z statistic approximation (robust=FALSE)
## Coefficients:
## Estimate Std.Error lbound ubound z value Pr(>|z|)
## Intercept1 -1.47224 0.22106 -1.90551 -1.03898 -6.6600 2.738e-11 ***
## Tau2_1_1 1.09567 0.42299 0.26663 1.92471 2.5903 0.009589 **

```

```

## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 181.0531
## Degrees of freedom of the Q statistic: 25
## P value of the Q statistic: 0
##
## Heterogeneity indices (based on the estimated Tau2):
##                               Estimate
## Intercept1: I2 (Q statistic)    0.91
##
## Number of studies (or clusters): 28
## Number of observed statistics: 2
## Number of estimated parameters: 2
## Degrees of freedom: 0
## -2 log likelihood: 87.10285
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)

```

```
##Univariate meta-analysis for Backward Verbal
```

```
fit1 <- meta(y=BWD_G, v=BWD_SE^2, data=Verbal_ForMultivariate_HedgesG)
summary (fit1)
```

```

##
## Call:
## meta(y = BWD_G, v = BWD_SE^2, data = Verbal_ForMultivariate_HedgesG)
##
## 95% confidence intervals: z statistic approximation (robust=FALSE)
## Coefficients:
##           Estimate Std.Error   lbound   ubound z value Pr(>|z|)
## Intercept1 -0.526652  0.113100 -0.748324 -0.304980 -4.6565 3.216e-06 ***
## Tau2_1_1    0.059430  0.065772 -0.069482  0.188341  0.9036  0.3662
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 21.34227
## Degrees of freedom of the Q statistic: 11
## P value of the Q statistic: 0.02999359
##
## Heterogeneity indices (based on the estimated Tau2):
##                               Estimate
## Intercept1: I2 (Q statistic)    0.41
##
## Number of studies (or clusters): 28
## Number of observed statistics: 2
## Number of estimated parameters: 2
## Degrees of freedom: 0
## -2 log likelihood: 13.21401
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)

```

```
##Multivariate meta-analysis assuming cor = .05 btwn F & B
```

```
Verbal_ForMultivariate_HedgesG$FBcov <- with(Verbal_ForMultivariate_HedgesG, 0.5*FWD_SE*BWD_SE)
```

```
fit0a <- meta(y=cbind(FWD_G, BWD_G),
             v=cbind(FWD_SE^2,FBcov,BWD_SE^2),
             data=Verbal_ForMultivariate_HedgesG,
             model.name="Multi MA")
summary(fit0a)
```

```
##
## Call:
## meta(y = cbind(FWD_G, BWD_G), v = cbind(FWD_SE^2, FBcov, BWD_SE^2),
##     data = Verbal_ForMultivariate_HedgesG, model.name = "Multi MA")
##
## 95% confidence intervals: z statistic approximation (robust=FALSE)
## Coefficients:
##           Estimate Std.Error    lbound    ubound z value Pr(>|z|)
## Intercept1 -1.473728  0.219657 -1.904248 -1.043207 -6.7092 1.957e-11 ***
## Intercept2 -0.715616  0.127288 -0.965096 -0.466136 -5.6220 1.887e-08 ***
## Tau2_1_1    1.078956  0.418212  0.259275  1.898638  2.5799 0.009882 **
## Tau2_2_1    0.351121  0.200806 -0.042451  0.744692  1.7486 0.080367 .
## Tau2_2_2    0.131844  0.116648 -0.096782  0.360469  1.1303 0.258363
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 198.2588
## Degrees of freedom of the Q statistic: 36
## P value of the Q statistic: 0
##
## Heterogeneity indices (based on the estimated Tau2):
##           Estimate
## Intercept1: I2 (Q statistic)  0.9087
## Intercept2: I2 (Q statistic)  0.6066
##
## Number of studies (or clusters): 28
## Number of observed statistics: 5
## Number of estimated parameters: 5
## Degrees of freedom: 0
## -2 log likelihood: 93.1078
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)
```

```
## Correlation between the population effect sizes
cov2cor(VarCorr(fit0a))
```

```
##           [,1]      [,2]
## [1,] 1.0000000 0.9309467
## [2,] 0.9309467 1.0000000
```

```
sessionInfo()
```

```
## R version 4.2.0 (2022-04-22)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.4 LTS
```

```

##
## Matrix products: default
## BLAS: /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.9.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.9.0
##
## locale:
## [1] LC_CTYPE=en_SG.UTF-8 LC_NUMERIC=C
## [3] LC_TIME=en_SG.UTF-8 LC_COLLATE=en_SG.UTF-8
## [5] LC_MONETARY=en_SG.UTF-8 LC_MESSAGES=en_SG.UTF-8
## [7] LC_PAPER=en_SG.UTF-8 LC_NAME=C
## [9] LC_ADDRESS=C LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_SG.UTF-8 LC_IDENTIFICATION=C
##
## attached base packages:
## [1] stats graphics grDevices utils datasets methods base
##
## other attached packages:
## [1] metaSEM_1.2.6 OpenMx_2.20.6
##
## loaded via a namespace (and not attached):
## [1] Rcpp_1.0.8.3 rstudioapi_0.13 knitr_1.39 magrittr_2.0.3
## [5] MASS_7.3-57 mnormt_2.0.2 pbivnorm_0.6.0 ellipse_0.4.2
## [9] lattice_0.20-45 rlang_1.0.2 fastmap_1.1.0 stringr_1.4.0
## [13] tools_4.2.0 parallel_4.2.0 grid_4.2.0 tmvnsim_1.0-2
## [17] xfun_0.31 cli_3.3.0 htmltools_0.5.2 yaml_2.3.5
## [21] RcppParallel_5.1.5 digest_0.6.29 lifecycle_1.0.1 lavaan_0.6-11
## [25] Matrix_1.4-1 evaluate_0.15 rmarkdown_2.14 stringi_1.7.6
## [29] compiler_4.2.0 stats4_4.2.0 mvtnorm_1.1-3

```