METASEM with 3 variables

Guillaume Christe (modified by Mike Cheung)

7 Sep 2018

```
##Model 2: PSY --> MOV;PAIN --> PSY; PAIN-->MOV

## Load the library
library(metaSEM)
```

```
## Loading required package: OpenMx
```

```
## To take full advantage of multiple cores, use:
##   mxOption(NULL, 'Number of Threads', parallel::detectCores()) #now
##   Sys.setenv(OMP_NUM_THREADS=parallel::detectCores()) #before library(OpenMx)
```

```
## "SLSQP" is set as the default optimizer in OpenMx.
```

```
## mxOption(NULL, "Gradient algorithm") is set at "central".
```

```
## mxOption(NULL, "Optimality tolerance") is set at "6.3e-14".
```

```
## mxOption(NULL, "Gradient iterations") is set at "2".
```

```
## Create the matrix ##

Studiestest10 <-

structure(list(data = structure(list(`Trost2012` = structure(c(1,-0.38,-0.11,-0.38,1,0.14,-0.11,0.14,1)
                                                              .Dim = c(3L, 3L), .Dimnames = list(c("Mover
"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Thomas2008A` = structure(c(1,-0.54,-0.24,-0.54,1,0.28,-0.1

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Thomas2008B` = structure(c(1,-0.41,-0.24,-0.41,1,0.28,-0.1

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Thomas2008C` = structure(c(1,-0.35,-0.24,-0.35,1,0.28,-0.1

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Watson1997A` = structure(c(1,-0.28,-0.2,-0.28,1,0.28,-0.2

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Watson1997B` = structure(c(1,-0.27,-0.2,-0.27,1,0.28,-0.2

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Alschuler2009` = structure(c(1,-0.45,-0.11,-0.45,1,0.28,-0

"Psychological_factor", "Pain_intensity"), c("Movement",
```

```
"Psychological_factor", "Pain_intensity"))), `Grotle2004A` = structure(c(1,-0.08,-0.19,-0.08,1,0.13,-0.

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Grotle2004B` = structure(c(1,-0.11,-0.23,-0.11,1,0.21,-0.

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity"))), `Kim2017` = structure(c(1,-0.03,-0.02,-0.03,1,0.25,-0.02,0

"Psychological_factor", "Pain_intensity"), c("Movement",

"Psychological_factor", "Pain_intensity")))), .Names = c("Trost2012", "Thomas2008A", "Thomas2008B", "Th

"Questionnaire"))

## show the studies ##

head(Studiestest10$data)
```

```
## $Trost2012
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.38          -0.11
## Psychological_factor    -0.38                 1.00           0.14
## Pain_intensity          -0.11                 0.14           1.00
##
## $Thomas2008A
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.54          -0.24
## Psychological_factor    -0.54                 1.00           0.28
## Pain_intensity          -0.24                 0.28           1.00
##
## $Thomas2008B
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.41          -0.24
## Psychological_factor    -0.41                 1.00           0.28
## Pain_intensity          -0.24                 0.28           1.00
##
## $Thomas2008C
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.35          -0.24
## Psychological_factor    -0.35                 1.00           0.28
## Pain_intensity          -0.24                 0.28           1.00
##
## $Watson1997A
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.28          -0.20
## Psychological_factor    -0.28                 1.00           0.28
## Pain_intensity          -0.20                 0.28           1.00
##
## $Watson1997B
##                      Movement Psychological_factor Pain_intensity
## Movement                 1.00                -0.27          -0.20
```

```
## Psychological_factor    -0.27                 1.00          0.28
## Pain_intensity          -0.20                 0.28          1.00
```

```
## Display the sample sizes
Studiestest10$n
```

```
##  [1]  51  36  36  36  36  36  76 123 233  30
```

```
## Variables used in the analysis
var.names <- c("Mov", "Psy", "Pai")

##############################################################################


## Mike: There is an error message (OpenMx status1: 6).
##       The reason seems to be related to Tau2_2_2 and Tau2_3_3, which
##       are too small. Since the p value of the homogeneity test is .57,
##       it seems reasonable to apply the fixed-effects model.
random1 <- tssem1(Studiestest10$data, Studiestest10$n, method="REM",
                  RE.type="Diag", acov="weighted")
summary(random1)
```

```
##
## Call:
## meta(y = ES, v = acovR, RE.constraints = Diag(paste0(RE.startvalues,
##     "*Tau2_", 1:no.es, "_", 1:no.es)), RE.lbound = RE.lbound,
##     I2 = I2, model.name = model.name, suppressWarnings = TRUE,
##     silent = silent, run = run)
##
## 95% confidence intervals: z statistic approximation
## Coefficients:
##               Estimate   Std.Error      lbound      ubound  z value
## Intercept1 -2.6959e-01  5.5461e-02 -3.7830e-01 -1.6089e-01  -4.8610
## Intercept2 -1.9026e-01  1.7027e-02 -2.2363e-01 -1.5689e-01 -11.1742
## Intercept3  2.1824e-01  3.4400e-02  1.5082e-01  2.8566e-01   6.3442
## Tau2_1_1    1.3085e-02  1.0824e-02 -8.1288e-03  3.4299e-02   1.2089
## Tau2_2_2    1.0000e-10          NA          NA          NA       NA
## Tau2_3_3    1.0000e-10          NA          NA          NA       NA
##             Pr(>|z|)
## Intercept1 1.168e-06 ***
## Intercept2 < 2.2e-16 ***
## Intercept3 2.236e-10 ***
## Tau2_1_1      0.2267
## Tau2_2_2          NA
## Tau2_3_3          NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Q statistic on the homogeneity of effect sizes: 25.07557
## Degrees of freedom of the Q statistic: 27
## P value of the Q statistic: 0.5702266
##
## Heterogeneity indices (based on the estimated Tau2):
##                              Estimate
## Intercept1: I2 (Q statistic)   0.4793
## Intercept2: I2 (Q statistic)   0.0000
```

```
## Intercept3: I2 (Q statistic)   0.0000
##
## Number of studies (or clusters): 10
## Number of observed statistics: 30
## Number of estimated parameters: 6
## Degrees of freedom: 24
## -2 log likelihood: -47.77287
## OpenMx status1: 5 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)
```

```
## Warning in print.summary.meta(x): OpenMx status1 is neither 0 or 1. You are advised to 'rerun' it ag
```

```
## Mike: Fixed-effects model
fix1 <- tssem1(Studiestest10$data, Studiestest10$n, method="FEM")
summary(fix1)
```

```
##
## Call:
## tssem1FEM(Cov = Cov, n = n, cor.analysis = cor.analysis, model.name = model.name,
##     cluster = cluster, suppressWarnings = suppressWarnings, silent = silent,
##     run = run)
##
## Coefficients:
##         Estimate Std.Error z value  Pr(>|z|)
## S[1,2] -0.231751  0.036473 -6.3540 2.098e-10 ***
## S[1,3] -0.190623  0.036670 -5.1983 2.011e-07 ***
## S[2,3]  0.219447  0.036223  6.0583 1.376e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Goodness-of-fit indices:
##                                       Value
## Sample size                        693.0000
## Chi-square of target model          26.2991
## DF of target model                  27.0000
## p value of target model              0.5021
## Chi-square of independence model   113.2081
## DF of independence model           30.0000
## RMSEA                               0.0000
## RMSEA lower 95% CI                  0.0000
## RMSEA upper 95% CI                  0.0915
## SRMR                                0.0968
## TLI                                 1.0094
## CFI                                 1.0000
## AIC                               -27.7009
## BIC                              -150.3087
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values may indicate problems.)
```

```
## stage 2
## Regression coefficients --> why 0.2 (same as Hagger) ???
A1 <- create.mxMatrix(c(0, "0.2*PsytoMov", "0.2*PaitoMov",
0, 0, "0.2*PaitoPsy",
0, 0, 0),
type="Full", byrow=TRUE, ncol=3, nrow=3,
as.mxMatrix=FALSE)
```

```
## This step is not necessary but it is useful for inspecting the model.
dimnames(A1)[[1]] <- dimnames(A1)[[2]] <- c("Mov","Psy","Pai")
A1
```

```
##     Mov Psy            Pai
## Mov "0" "0.2*PsytoMov" "0.2*PaitoMov"
## Psy "0" "0"            "0.2*PaitoPsy"
## Pai "0" "0"            "0"
```

```
## Covariance matrix among the variables (CAUTION: NOT SURE FOR THIS STEP --> why 0.2 ???)

## Mike: Since Pai is an independent variable, its variance should be fixed at 1.0.
##       0.2 is just the starting value. You may use other sensible values, e.g., 0.3, 0.4...
S1 <- create.mxMatrix(c("0.2*e_Mov",0,0,
0, "0.2*e_Psy", 0,
0, 0, 1),
type="Full", byrow=TRUE, ncol=3, nrow=3, as.mxMatrix=FALSE)

## This step is not necessary but it is useful for inspecting the model.
dimnames(S1)[[1]] <- dimnames(S1)[[2]] <- c("Mov","Psy","Pai")
S1
```

```
##     Mov         Psy         Pai
## Mov "0.2*e_Mov" "0"         "0"
## Psy "0"         "0.2*e_Psy" "0"
## Pai "0"         "0"         "1"
```

```
## Stage 2 analysis: different option are in the website from Cheung and in its paper

## option 1 (works, from Cheung)
fix2 <- tssem2(fix1, Amatrix=A1, Smatrix=S1, intervals.type="z")
summary(fix2)
```

```
##
## Call:
## wls(Cov = coef.tssem1FEM(tssem1.obj), aCov = vcov.tssem1FEM(tssem1.obj),
##     n = sum(tssem1.obj$n), Amatrix = Amatrix, Smatrix = Smatrix,
##     Fmatrix = Fmatrix, diag.constraints = diag.constraints, cor.analysis = tssem1.obj$cor.analysis,
##     intervals.type = intervals.type, mx.algebras = mx.algebras,
##     model.name = model.name, suppressWarnings = suppressWarnings,
##     silent = silent, run = run)
##
## 95% confidence intervals: z statistic approximation
## Coefficients:
##           Estimate Std.Error    lbound    ubound z value  Pr(>|z|)
## PaitoMov -0.146837  0.037204 -0.219755 -0.073919 -3.9468 7.920e-05 ***
## PsytoMov -0.199528  0.037333 -0.272699 -0.126357 -5.3446 9.062e-08 ***
## PaitoPsy  0.219447  0.036223  0.148453  0.290442  6.0583 1.376e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Goodness-of-fit indices:
##                                           Value
## Sample size                             693.000
## Chi-square of target model                0.000
```

```
## DF of target model                              0.000
## p value of target model                         0.000
## Number of constraints imposed on "Smatrix"      0.000
## DF manually adjusted                            0.000
## Chi-square of independence model               76.112
## DF of independence model                        3.000
## RMSEA                                           0.000
## RMSEA lower 95% CI                              0.000
## RMSEA upper 95% CI                              0.000
## SRMR                                            0.000
## TLI                                              -Inf
## CFI                                             1.000
## AIC                                             0.000
## BIC                                             0.000
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values indicate problems.)
```

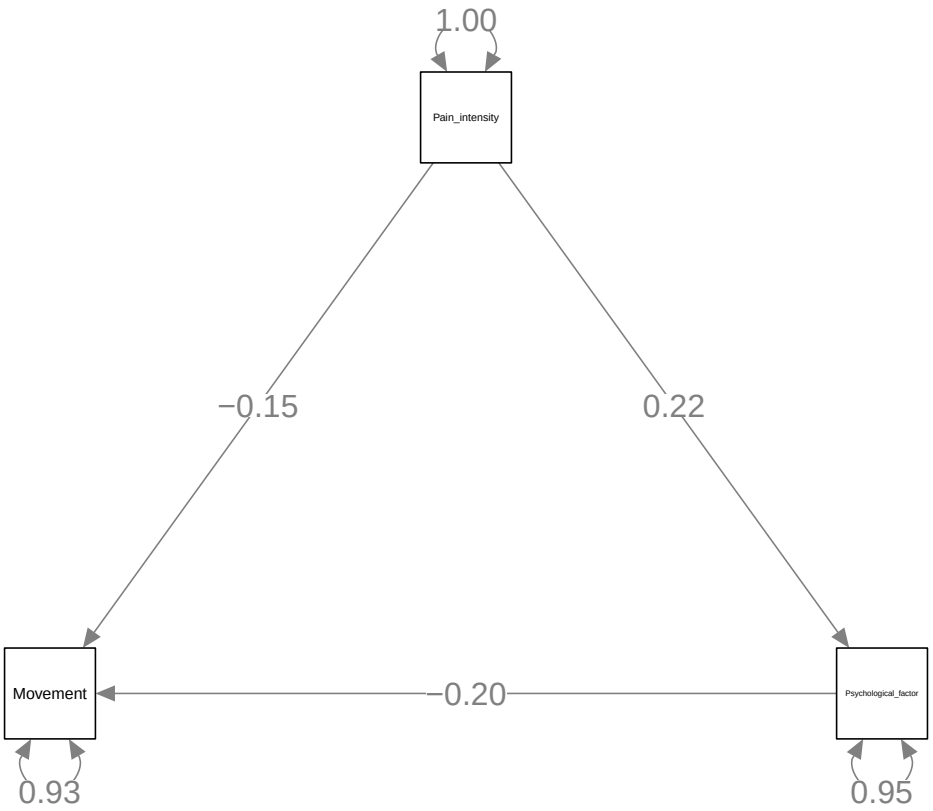
```
plot(fix2)

## option 2 (not working, from Cheung)
## Mike: it works fine now.
fix2 <- tssem2(fix1, Amatrix=A1, Smatrix=S1, intervals.type="LB",
               diag.constraints=TRUE)
summary(fix2)
```

```
##
## Call:
## wls(Cov = coef.tssem1FEM(tssem1.obj), aCov = vcov.tssem1FEM(tssem1.obj),
##     n = sum(tssem1.obj$n), Amatrix = Amatrix, Smatrix = Smatrix,
##     Fmatrix = Fmatrix, diag.constraints = diag.constraints, cor.analysis = tssem1.obj$cor.analysis,
##     intervals.type = intervals.type, mx.algebras = mx.algebras,
##     model.name = model.name, suppressWarnings = suppressWarnings,
##     silent = silent, run = run)
##
## 95% confidence intervals: Likelihood-based statistic
## Coefficients:
##           Estimate Std.Error    lbound    ubound z value Pr(>|z|)
## PaitoMov -0.146837        NA -0.219832 -0.073895      NA       NA
## PsytoMov -0.199528        NA -0.272798 -0.126354      NA       NA
## PaitoPsy  0.219447        NA  0.148453  0.290442      NA       NA
## e_Mov     0.925769        NA  0.883231  0.958920      NA       NA
## e_Psy     0.951843        NA  0.915643  0.977962      NA       NA
##
## Goodness-of-fit indices:
##                                             Value
## Sample size                                693.000
## Chi-square of target model                   0.000
## DF of target model                           0.000
## p value of target model                      0.000
## Number of constraints imposed on "Smatrix"   2.000
## DF manually adjusted                         0.000
## Chi-square of independence model            76.112
## DF of independence model                     3.000
## RMSEA                                        0.000
## RMSEA lower 95% CI                           0.000
```

```
## RMSEA upper 95% CI                                0.000
## SRMR                                              0.000
## TLI                                                -Inf
## CFI                                               1.000
## AIC                                               0.000
## BIC                                               0.000
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values indicate problems.)
```

```
plot(fix2)
```




```
## option 3 (Cheung/Hagger) --> works like option 1; but cannot have the indirect effect

## Mike: I think that you want PaitoPsy*PsytoMov for the indirect effect.
##       It works fine now.
fix2 <- tssem2(fix1, Amatrix=A1, Smatrix=S1, diag.constraints=TRUE,
               intervals.type="LB",
               mx.algebras=list(Ind=mxAlgebra(PaitoPsy*PsytoMov, name="Ind")))
summary(fix2)
```

```
##
## Call:
## wls(Cov = coef.tssem1FEM(tssem1.obj), aCov = vcov.tssem1FEM(tssem1.obj),
##     n = sum(tssem1.obj$n), Amatrix = Amatrix, Smatrix = Smatrix,
##     Fmatrix = Fmatrix, diag.constraints = diag.constraints, cor.analysis = tssem1.obj$cor.analysis,
##     intervals.type = intervals.type, mx.algebras = mx.algebras,
##     model.name = model.name, suppressWarnings = suppressWarnings,
##     silent = silent, run = run)
##
```

```
## 95% confidence intervals: Likelihood-based statistic
## Coefficients:
##           Estimate Std.Error    lbound    ubound z value Pr(>|z|)
## PaitoMov -0.146837        NA -0.219832 -0.073895      NA       NA
## PsytoMov -0.199528        NA -0.272798 -0.126354      NA       NA
## PaitoPsy  0.219447        NA  0.148453  0.290442      NA       NA
## e_Mov     0.925769        NA  0.883231  0.958920      NA       NA
## e_Psy     0.951843        NA  0.915643  0.977962      NA       NA
##
## mxAlgebras objects (and their 95% likelihood-based CIs):
##               lbound    Estimate      ubound
## Ind[1,1] -0.06843142 -0.04378588 -0.02498684
##
## Goodness-of-fit indices:
##                                              Value
## Sample size                                693.000
## Chi-square of target model                   0.000
## DF of target model                           0.000
## p value of target model                      0.000
## Number of constraints imposed on "Smatrix"   2.000
## DF manually adjusted                         0.000
## Chi-square of independence model            76.112
## DF of independence model                     3.000
## RMSEA                                        0.000
## RMSEA lower 95% CI                           0.000
## RMSEA upper 95% CI                           0.000
## SRMR                                         0.000
## TLI                                           -Inf
## CFI                                          1.000
## AIC                                          0.000
## BIC                                          0.000
## OpenMx status1: 0 ("0" or "1": The optimization is considered fine.
## Other values indicate problems.)
```

```
plot(fix2)
```