Ejercicio.R

fa

2024-10-18

```
setwd("/Users/fa/Dropbox/Docencia/2024/Doctorado/Optativo Doctorado UTalca/Ejercicios")

base<- read.csv("ejercicio1.csv", header = T, sep= ";")

names(base) # nombre de las variables
```

```
##  [1] "id"      "sexo"    "psp1.T1" "psp1.T2" "psp1.T3" "psp1.T4" "psp1.T5"
##  [8] "psp2.T1" "psp2.T2" "psp2.T3" "psp2.T4" "psp2.T5" "psp3.T1" "psp3.T2"
## [15] "psp3.T3" "psp3.T4" "psp3.T5"
```

```
str(base) # estructura de la base de datos y variables
```

```
## 'data.frame':    251 obs. of  17 variables:
##  $ id     : int  15 18 19 20 21 22 25 26 27 30 ...
##  $ sexo   : int  2 2 1 2 2 2 1 2 2 1 ...
##  $ psp1.T1: int  6 6 4 6 2 7 5 6 5 7 ...
##  $ psp1.T2: int  6 5 4 5 1 7 5 6 5 6 ...
##  $ psp1.T3: int  5 6 4 5 1 7 5 7 NA 6 ...
##  $ psp1.T4: int  3 5 5 4 3 7 NA 6 5 5 ...
##  $ psp1.T5: int  1 5 5 5 1 6 5 6 NA 6 ...
##  $ psp2.T1: int  6 6 4 5 2 7 5 5 5 7 ...
##  $ psp2.T2: int  3 5 5 5 1 7 5 5 5 6 ...
##  $ psp2.T3: int  5 5 4 6 3 7 4 7 NA 6 ...
##  $ psp2.T4: int  3 5 5 5 1 7 NA 6 5 5 ...
##  $ psp2.T5: int  2 5 5 5 1 6 4 5 NA 5 ...
##  $ psp3.T1: int  5 6 4 6 1 7 4 5 6 7 ...
##  $ psp3.T2: int  3 6 4 6 1 7 5 5 5 4 ...
##  $ psp3.T3: int  6 7 4 5 3 7 4 5 NA 5 ...
##  $ psp3.T4: int  5 5 5 5 1 7 NA 5 5 4 ...
##  $ psp3.T5: int  2 4 5 4 1 6 3 5 NA 5 ...
```

```
library(psych)
describe(base) # descriptivos
```

```
##         vars   n   mean    sd median trimmed    mad min max range  skew
## id         1 251 174.68 89.70    177  174.92 115.64  15 334   319 -0.02
## sexo       2 251   1.53  0.50      2    1.54   0.00   1   2     1 -0.13
## psp1.T1    3 221   3.87  2.07      4    3.84   2.97   1   7     6  0.00
## psp1.T2    4 217   3.74  2.12      4    3.67   2.97   1   7     6  0.04
## psp1.T3    5 213   3.68  2.18      4    3.60   2.97   1   7     6  0.15
## psp1.T4    6 219   3.59  2.08      4    3.50   2.97   1   7     6  0.19
## psp1.T5    7 213   3.67  2.12      4    3.59   2.97   1   7     6  0.11
## psp2.T1    8 221   3.67  2.05      4    3.58   2.97   1   7     6  0.09
## psp2.T2    9 217   3.64  2.15      3    3.55   2.97   1   7     6  0.16
```

```
## psp2.T3   10 213   3.60  2.14      3    3.50   2.97   1   7     6  0.21
## psp2.T4   11 219   3.53  2.04      3    3.42   2.97   1   7     6  0.19
## psp2.T5   12 213   3.51  2.06      4    3.39   2.97   1   7     6  0.20
## psp3.T1   13 220   3.57  2.02      3    3.47   2.97   1   7     6  0.20
## psp3.T2   14 217   3.44  2.08      3    3.31   2.97   1   7     6  0.31
## psp3.T3   15 213   3.45  2.09      3    3.31   2.97   1   7     6  0.32
## psp3.T4   16 218   3.40  2.00      3    3.27   2.97   1   7     6  0.28
## psp3.T5   17 213   3.32  2.05      3    3.16   2.97   1   7     6  0.39
##         kurtosis   se
## id         -1.19 5.66
## sexo       -1.99 0.03
## psp1.T1    -1.33 0.14
## psp1.T2    -1.39 0.14
## psp1.T3    -1.44 0.15
## psp1.T4    -1.32 0.14
## psp1.T5    -1.43 0.14
## psp2.T1    -1.32 0.14
## psp2.T2    -1.42 0.15
## psp2.T3    -1.33 0.15
## psp2.T4    -1.31 0.14
## psp2.T5    -1.30 0.14
## psp3.T1    -1.29 0.14
## psp3.T2    -1.26 0.14
## psp3.T3    -1.21 0.14
## psp3.T4    -1.15 0.14
## psp3.T5    -1.18 0.14
```

```
library(MVN)
mvn(base[3:17], desc = F)
```

```
## $multivariateNormality
##            Test       HZ p value MVN
## 1 Henze-Zirkler 4.548569       0  NO
##
## $univariateNormality
##                Test  Variable Statistic   p value Normality
## 1  Anderson-Darling  psp1.T1     5.0128  <0.001      NO
## 2  Anderson-Darling  psp1.T2     7.2233  <0.001      NO
## 3  Anderson-Darling  psp1.T3     7.5552  <0.001      NO
## 4  Anderson-Darling  psp1.T4     6.0644  <0.001      NO
## 5  Anderson-Darling  psp1.T5     6.0921  <0.001      NO
## 6  Anderson-Darling  psp2.T1     5.2789  <0.001      NO
## 7  Anderson-Darling  psp2.T2     7.9267  <0.001      NO
## 8  Anderson-Darling  psp2.T3     6.8501  <0.001      NO
## 9  Anderson-Darling  psp2.T4     5.4928  <0.001      NO
## 10 Anderson-Darling  psp2.T5     5.9200  <0.001      NO
## 11 Anderson-Darling  psp3.T1     5.3140  <0.001      NO
## 12 Anderson-Darling  psp3.T2     7.8666  <0.001      NO
## 13 Anderson-Darling  psp3.T3     6.7935  <0.001      NO
## 14 Anderson-Darling  psp3.T4     5.9206  <0.001      NO
## 15 Anderson-Darling  psp3.T5     6.5554  <0.001      NO
```

```
mvn(base[c(3,8,13)], desc = F)
```

```
## $multivariateNormality
```

```
##            Test       HZ p value MVN
## 1 Henze-Zirkler 10.24042       0  NO
##
## $univariateNormality
##               Test  Variable Statistic   p value Normality
## 1 Anderson-Darling  psp1.T1     6.1901  <0.001      NO
## 2 Anderson-Darling  psp2.T1     6.6841  <0.001      NO
## 3 Anderson-Darling  psp3.T1     6.5249  <0.001      NO
```

```
#### 1. Estime el modelo factorial confirmatorio de esta escala en el tiempo 1 (psp1.T1, psp2.T1, psp3.

  library(lavaan)
```

```
## This is lavaan 0.6-18
## lavaan is FREE software! Please report any bugs.

##
## Attaching package: 'lavaan'

## The following object is masked from 'package:psych':
##
##     cor2cov
```

```
#### Especificación del modelo

mod1<- '# Modelo de medición
        perfecT1=~ psp1.T1 + psp2.T1 + psp3.T1
        '

# Estimación del modelo con MLR
# varianza de los factores fijas en 1 (std.lv= T)
fit1<- sem(mod1, estimator = "MLR",
           std.lv= T, sample.mean = T,
           data=base)

# Obtención del output con:
# índices de ajuste, resultados estandarizados y R2
summary(fit1, fit.measures = T, standardized = T, rsquare = T)
```

```
## lavaan 0.6-18 ended normally after 16 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                         9
##
##                                                   Used       Total
##   Number of observations                           220         251
##
## Model Test User Model:
##                                                Standard      Scaled
##   Test Statistic                                  0.000       0.000
##   Degrees of freedom                                  0           0
##
## Model Test Baseline Model:
##
##   Test statistic                                523.460     144.318
```

```
##   Degrees of freedom                                3           3
##   P-value                                       0.000       0.000
##   Scaling correction factor                                 3.627
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   1.000       1.000
##   Tucker-Lewis Index (TLI)                      1.000       1.000
##
##   Robust Comparative Fit Index (CFI)                           NA
##   Robust Tucker-Lewis Index (TLI)                              NA
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)             -1146.996   -1146.996
##   Loglikelihood unrestricted model (H1)     -1146.996   -1146.996
##
##   Akaike (AIC)                               2311.992    2311.992
##   Bayesian (BIC)                             2342.535    2342.535
##   Sample-size adjusted Bayesian (SABIC)      2314.014    2314.014
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.000          NA
##   90 Percent confidence interval - lower        0.000          NA
##   90 Percent confidence interval - upper        0.000          NA
##   P-value H_0: RMSEA <= 0.050                      NA          NA
##   P-value H_0: RMSEA >= 0.080                      NA          NA
##
##   Robust RMSEA                                                0.000
##   90 Percent confidence interval - lower                      0.000
##   90 Percent confidence interval - upper                      0.000
##   P-value H_0: Robust RMSEA <= 0.050                             NA
##   P-value H_0: Robust RMSEA >= 0.080                             NA
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                          0.000       0.000
##
## Parameter Estimates:
##
##   Standard errors                            Sandwich
##   Information bread                          Observed
##   Observed information based on               Hessian
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   perfecT1 =~
##     psp1.T1           1.756    0.089   19.736    0.000    1.756    0.849
##     psp2.T1           1.956    0.081   24.141    0.000    1.956    0.954
##     psp3.T1           1.791    0.086   20.736    0.000    1.791    0.888
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
```

```
##    .psp1.T1          3.864    0.140   27.696    0.000    3.864    1.867
##    .psp2.T1          3.659    0.138   26.462    0.000    3.659    1.784
##    .psp3.T1          3.568    0.136   26.255    0.000    3.568    1.770
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .psp1.T1          1.196    0.223    5.370    0.000    1.196    0.279
##    .psp2.T1          0.381    0.220    1.729    0.084    0.381    0.091
##    .psp3.T1          0.856    0.196    4.364    0.000    0.856    0.211
##     perfecT1         1.000                               1.000    1.000
##
## R-Square:
##                   Estimate
##     psp1.T1          0.721
##     psp2.T1          0.909
##     psp3.T1          0.789
```

```
#### 2. Realice un análisis de invarianza longitudinal entre los tiempos 1, 3 y 5.}


  # Especificación del modelo CONFIGURAL

  mod2<- 'perfecT1=~ psp1.T1 + psp2.T1 + psp3.T1
        perfecT3=~ psp1.T3 + psp2.T3 + psp3.T3
        perfecT5=~ psp1.T5 + psp2.T5 + psp3.T5
        # Correlación de los residuos a lo largo del tiempo
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5'

# varianza de los factores fijas en 1 (std.lv= T)
fit2<- sem(mod2, estimator = "MLR",
           std.lv= F, sample.mean = T,
           data=base)

# Obtención del output con:
# índices de ajuste, resultados estandarizados y R2
summary(fit2, fit.measures = T, standardized = T, rsquare = T)
```

```
## lavaan 0.6-18 ended normally after 56 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        39
##
##                                                   Used       Total
##   Number of observations                           170         251
##
## Model Test User Model:
##                                               Standard      Scaled
##   Test Statistic                                32.581      16.348
##   Degrees of freedom                                15          15
```

```
##   P-value (Chi-square)                           0.005       0.359
##   Scaling correction factor                                  1.993
##     Yuan-Bentler correction (Mplus variant)
##
## Model Test Baseline Model:
##
##   Test statistic                              2012.007     822.917
##   Degrees of freedom                            36          36
##   P-value                                       0.000       0.000
##   Scaling correction factor                                  2.445
##
## User Model versus Baseline Model:
##
##   Comparative Fit Index (CFI)                   0.991       0.998
##   Tucker-Lewis Index (TLI)                      0.979       0.996
##
##   Robust Comparative Fit Index (CFI)                        0.999
##   Robust Tucker-Lewis Index (TLI)                           0.997
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -2324.258   -2324.258
##   Scaling correction factor                                  1.805
##       for the MLR correction
##   Loglikelihood unrestricted model (H1)      -2307.968   -2307.968
##   Scaling correction factor                                  1.857
##       for the MLR correction
##
##   Akaike (AIC)                                4726.517    4726.517
##   Bayesian (BIC)                              4848.813    4848.813
##   Sample-size adjusted Bayesian (SABIC)       4725.325    4725.325
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                         0.083       0.023
##   90 Percent confidence interval - lower        0.044       0.000
##   90 Percent confidence interval - upper        0.122       0.064
##   P-value H_0: RMSEA <= 0.050                   0.079       0.830
##   P-value H_0: RMSEA >= 0.080                   0.587       0.006
##
##   Robust RMSEA                                              0.032
##   90 Percent confidence interval - lower                    0.000
##   90 Percent confidence interval - upper                    0.110
##   P-value H_0: Robust RMSEA <= 0.050                        0.569
##   P-value H_0: Robust RMSEA >= 0.080                        0.199
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                          0.049       0.049
##
## Parameter Estimates:
##
##   Standard errors                             Sandwich
##   Information bread                           Observed
```

```
##   Observed information based on                Hessian
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   perfecT1 =~
##     psp1.T1          1.000                               1.729    0.848
##     psp2.T1          1.152    0.075   15.361    0.000    1.991    0.948
##     psp3.T1          1.115    0.070   15.922    0.000    1.927    0.913
##   perfecT3 =~
##     psp1.T3          1.000                               1.884    0.889
##     psp2.T3          1.121    0.060   18.677    0.000    2.111    0.974
##     psp3.T3          1.033    0.061   16.909    0.000    1.946    0.911
##   perfecT5 =~
##     psp1.T5          1.000                               1.817    0.887
##     psp2.T5          1.102    0.066   16.732    0.000    2.004    0.973
##     psp3.T5          0.972    0.067   14.451    0.000    1.766    0.889
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##  .psp1.T1 ~~
##    .psp1.T3          0.765    0.237    3.231    0.001    0.765    0.731
##    .psp1.T5          0.567    0.202    2.810    0.005    0.567    0.554
##  .psp1.T3 ~~
##    .psp1.T5          0.508    0.205    2.476    0.013    0.508    0.553
##  .psp2.T1 ~~
##    .psp2.T3          0.025    0.142    0.176    0.860    0.025    0.076
##    .psp2.T5         -0.053    0.134   -0.393    0.694   -0.053   -0.167
##  .psp2.T3 ~~
##    .psp2.T5          0.043    0.118    0.364    0.716    0.043    0.185
##  .psp3.T1 ~~
##    .psp3.T3          0.008    0.124    0.061    0.952    0.008    0.010
##    .psp3.T5          0.363    0.128    2.848    0.004    0.363    0.465
##  .psp3.T3 ~~
##    .psp3.T5          0.263    0.109    2.419    0.016    0.263    0.329
##   perfecT1 ~~
##     perfecT3         2.637    0.390    6.761    0.000    0.810    0.810
##     perfecT5         2.534    0.385    6.585    0.000    0.806    0.806
##   perfecT3 ~~
##     perfecT5         2.669    0.395    6.752    0.000    0.779    0.779
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .psp1.T1          3.824    0.162   23.536    0.000    3.824    1.876
##    .psp2.T1          3.594    0.161   22.296    0.000    3.594    1.711
##    .psp3.T1          3.576    0.160   22.419    0.000    3.576    1.694
##    .psp1.T3          3.582    0.170   21.046    0.000    3.582    1.691
##    .psp2.T3          3.494    0.166   21.047    0.000    3.494    1.612
##    .psp3.T3          3.400    0.163   20.873    0.000    3.400    1.592
##    .psp1.T5          3.559    0.164   21.664    0.000    3.559    1.736
##    .psp2.T5          3.382    0.158   21.397    0.000    3.382    1.643
##    .psp3.T5          3.171    0.153   20.730    0.000    3.171    1.597
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
```

```
##    .psp1.T1          1.167    0.248    4.712    0.000    1.167    0.281
##    .psp2.T1          0.447    0.209    2.137    0.033    0.447    0.101
##    .psp3.T1          0.740    0.173    4.292    0.000    0.740    0.166
##    .psp1.T3          0.938    0.275    3.414    0.001    0.938    0.209
##    .psp2.T3          0.241    0.118    2.043    0.041    0.241    0.051
##    .psp3.T3          0.773    0.187    4.134    0.000    0.773    0.170
##    .psp1.T5          0.898    0.272    3.307    0.001    0.898    0.214
##    .psp2.T5          0.223    0.134    1.664    0.096    0.223    0.053
##    .psp3.T5          0.823    0.185    4.454    0.000    0.823    0.209
##     perfecT1         2.989    0.405    7.376    0.000    1.000    1.000
##     perfecT3         3.549    0.445    7.972    0.000    1.000    1.000
##     perfecT5         3.303    0.417    7.919    0.000    1.000    1.000
##
## R-Square:
##                    Estimate
##     psp1.T1           0.719
##     psp2.T1           0.899
##     psp3.T1           0.834
##     psp1.T3           0.791
##     psp2.T3           0.949
##     psp3.T3           0.830
##     psp1.T5           0.786
##     psp2.T5           0.947
##     psp3.T5           0.791
```

```
modificationIndices(fit2, sort. = T, minimum.value = 3.84)
```

```
##         lhs op     rhs    mi    epc sepc.lv sepc.all sepc.nox
## 49 perfecT1 =~ psp1.T5 8.926  0.233   0.403    0.197    0.197
## 90  psp2.T5 ~~ psp3.T5 8.397  0.294   0.294    0.685    0.685
## 59 perfecT5 =~ psp2.T1 8.103 -0.227  -0.412   -0.196   -0.196
## 70  psp2.T1 ~~ psp3.T1 7.943  0.336   0.336    0.584    0.584
## 65  psp1.T1 ~~ psp3.T1 6.568 -0.228  -0.228   -0.245   -0.245
## 74  psp2.T1 ~~ psp3.T5 5.767 -0.184  -0.184   -0.303   -0.303
## 52 perfecT3 =~ psp1.T1 5.463  0.184   0.347    0.170    0.170
## 51 perfecT1 =~ psp3.T5 4.771 -0.177  -0.306   -0.154   -0.154
## 61 perfecT5 =~ psp1.T3 4.640  0.135   0.246    0.116    0.116
## 58 perfecT5 =~ psp1.T1 4.299  0.157   0.286    0.140    0.140
## 77  psp3.T1 ~~ psp1.T5 4.156  0.145   0.145    0.177    0.177
```

```
#####   Invarianza débil

 mod3<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
       perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
       perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
       # interceptos libremente estimados
       psp1.T1 ~1
       psp2.T1 ~1
       psp3.T1 ~1
       psp1.T3 ~1
       psp2.T3 ~1
       psp3.T3 ~1
       psp1.T5 ~1
       psp2.T5 ~1
       psp3.T5 ~1
```

```
        # Residuos libremente estimados
        psp1.T1 ~~ psp1.T1
        psp2.T1 ~~ psp2.T1
        psp3.T1 ~~ psp3.T1
        psp1.T3 ~~ psp1.T3
        psp2.T3 ~~ psp2.T3
        psp3.T3 ~~ psp3.T3
        psp1.T5 ~~ psp1.T5
        psp2.T5 ~~ psp2.T5
        psp3.T5 ~~ psp3.T5
        # Varianza de los factores libre (menos 1 por identificación)
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ perfecT3
        perfecT5 ~~ perfecT5
        # Medias de los factores fijos en 0 (identificación)
        perfecT1 ~0*1
        perfecT3 ~0*1
        perfecT5 ~0*1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores
        perfecT1 ~~ perfecT3 + perfecT5
        perfecT3 ~~ perfecT5
        '

fit3<- sem(mod3, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
#### Invarianza fuerte

  mod4<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
        perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
        perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
        # interceptos fijos a iguales entre los tiempos
        psp1.T1 ~i1*1
        psp2.T1 ~i2*1
        psp3.T1 ~i3*1
        psp1.T3 ~i1*1
        psp2.T3 ~i2*1
        psp3.T3 ~i3*1
        psp1.T5 ~i1*1
        psp2.T5 ~i2*1
        psp3.T5 ~i3*1
        ## Residuos libremente estimados
        psp1.T1 ~~ psp1.T1
```

```
        psp2.T1 ~~ psp2.T1
        psp3.T1 ~~ psp3.T1
        psp1.T3 ~~ psp1.T3
        psp2.T3 ~~ psp2.T3
        psp3.T3 ~~ psp3.T3
        psp1.T5 ~~ psp1.T5
        psp2.T5 ~~ psp2.T5
        psp3.T5 ~~ psp3.T5
        ## Varianza de los factores libre (menos 1 por identificación)
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ perfecT3
        perfecT5 ~~ perfecT5
        # Medias de los factores libres (menos 1 por identificación)
        perfecT1 ~0*1
        perfecT3 ~1
        perfecT5 ~1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores
        perfecT1 ~~ perfecT3 + perfecT5
        perfecT3 ~~ perfecT5
        '

fit4<- sem(mod4, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
#### Invarianza estricta

  mod5<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
        perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
        perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
        # interceptos fijos a iguales entre los tiempos
        psp1.T1 ~i1*1
        psp2.T1 ~i2*1
        psp3.T1 ~i3*1
        psp1.T3 ~i1*1
        psp2.T3 ~i2*1
        psp3.T3 ~i3*1
        psp1.T5 ~i1*1
        psp2.T5 ~i2*1
        psp3.T5 ~i3*1
        ## Residuos fijos a iguales entre los tiempos
        psp1.T1 ~~ r1*psp1.T1
        psp2.T1 ~~ r2*psp2.T1
        psp3.T1 ~~ r3*psp3.T1
```

```
        psp1.T3 ~~ r1*psp1.T3
        psp2.T3 ~~ r2*psp2.T3
        psp3.T3 ~~ r3*psp3.T3
        psp1.T5 ~~ r1*psp1.T5
        psp2.T5 ~~ r2*psp2.T5
        psp3.T5 ~~ r3*psp3.T5
        ## Varianza de los factores libre (menos 1 por identificación)
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ perfecT3
        perfecT5 ~~ perfecT5
        # Medias de los factores libres (menos 1 por identificación)
        perfecT1 ~0*1
        perfecT3 ~1
        perfecT5 ~1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores
        perfecT1 ~~ perfecT3 + perfecT5
        perfecT3 ~~ perfecT5
        '

fit5<- sem(mod5, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
#### Invarianza de las varianza de los factores latentes

  mod6<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
        perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
        perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
        # interceptos fijos a iguales entre los tiempos
        psp1.T1 ~i1*1
        psp2.T1 ~i2*1
        psp3.T1 ~i3*1
        psp1.T3 ~i1*1
        psp2.T3 ~i2*1
        psp3.T3 ~i3*1
        psp1.T5 ~i1*1
        psp2.T5 ~i2*1
        psp3.T5 ~i3*1
        ## Residuos fijos a iguales entre los tiempos
        psp1.T1 ~~ r1*psp1.T1
        psp2.T1 ~~ r2*psp2.T1
        psp3.T1 ~~ r3*psp3.T1
        psp1.T3 ~~ r1*psp1.T3
        psp2.T3 ~~ r2*psp2.T3
```

```
        psp3.T3 ~~ r3*psp3.T3
        psp1.T5 ~~ r1*psp1.T5
        psp2.T5 ~~ r2*psp2.T5
        psp3.T5 ~~ r3*psp3.T5
        ## Varianza de los factores fijos en 1
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ 1*perfecT3
        perfecT5 ~~ 1*perfecT5
        # Medias de los factores libres (menos 1 por identificación)
        perfecT1 ~0*1
        perfecT3 ~1
        perfecT5 ~1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores fijas a iguales
        perfecT1 ~~ perfecT3 + perfecT5
        perfecT3 ~~ perfecT5
        '


fit6<- sem(mod6, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
#### Invarianza de las covarianzas entre factores latentes

  mod7<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
        perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
        perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
        # interceptos fijos a iguales entre los tiempos
        psp1.T1 ~i1*1
        psp2.T1 ~i2*1
        psp3.T1 ~i3*1
        psp1.T3 ~i1*1
        psp2.T3 ~i2*1
        psp3.T3 ~i3*1
        psp1.T5 ~i1*1
        psp2.T5 ~i2*1
        psp3.T5 ~i3*1
        ## Residuos fijos a iguales entre los tiempos
        psp1.T1 ~~ r1*psp1.T1
        psp2.T1 ~~ r2*psp2.T1
        psp3.T1 ~~ r3*psp3.T1
        psp1.T3 ~~ r1*psp1.T3
        psp2.T3 ~~ r2*psp2.T3
        psp3.T3 ~~ r3*psp3.T3
```

```
        psp1.T5 ~~ r1*psp1.T5
        psp2.T5 ~~ r2*psp2.T5
        psp3.T5 ~~ r3*psp3.T5
        ## Varianza de los factores fijos en 1
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ 1*perfecT3
        perfecT5 ~~ 1*perfecT5
        # Medias de los factores libres (menos 1 por identificación)
        perfecT1 ~0*1
        perfecT3 ~1
        perfecT5 ~1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores fijas a iguales
        perfecT1 ~~ c*perfecT3 + c*perfecT5
        perfecT3 ~~ c*perfecT5
        '

fit7<- sem(mod7, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
#### Invarianza de las medias de factores latentes

  mod8<- 'perfecT1=~ NA*psp1.T1 + l1*psp1.T1 + l2*psp2.T1 + l3*psp3.T1
        perfecT3=~ NA*psp1.T3 + l1*psp1.T3 + l2*psp2.T3 + l3*psp3.T3
        perfecT5=~ NA*psp1.T5 + l1*psp1.T5 + l2*psp2.T5 + l3*psp3.T5
        # interceptos fijos a iguales entre los tiempos
        psp1.T1 ~i1*1
        psp2.T1 ~i2*1
        psp3.T1 ~i3*1
        psp1.T3 ~i1*1
        psp2.T3 ~i2*1
        psp3.T3 ~i3*1
        psp1.T5 ~i1*1
        psp2.T5 ~i2*1
        psp3.T5 ~i3*1
        ## Residuos fijos a iguales entre los tiempos
        psp1.T1 ~~ r1*psp1.T1
        psp2.T1 ~~ r2*psp2.T1
        psp3.T1 ~~ r3*psp3.T1
        psp1.T3 ~~ r1*psp1.T3
        psp2.T3 ~~ r2*psp2.T3
        psp3.T3 ~~ r3*psp3.T3
        psp1.T5 ~~ r1*psp1.T5
        psp2.T5 ~~ r2*psp2.T5
```

```
        psp3.T5 ~~ r3*psp3.T5
        ## Varianza de los factores fijos en 1
        perfecT1 ~~ 1*perfecT1
        perfecT3 ~~ 1*perfecT3
        perfecT5 ~~ 1*perfecT5
        # Medias de los factores libres (menos 1 por identificación)
        perfecT1 ~0*1
        perfecT3 ~0*1
        perfecT5 ~0*1
        # Residuos de los ítems en el tiempo correlacionados
        psp1.T1 ~~ psp1.T3 + psp1.T5
        psp1.T3 ~~ psp1.T5
        psp2.T1 ~~ psp2.T3 + psp2.T5
        psp2.T3 ~~ psp2.T5
        psp3.T1 ~~ psp3.T3 + psp3.T5
        psp3.T3 ~~ psp3.T5
        # Covarianza entre los factores fijas a iguales
        perfecT1 ~~ c*perfecT3 + c*perfecT5
        perfecT3 ~~ c*perfecT5
        '

fit8<- sem(mod8, estimator = "MLR",
           sample.mean = T, mimic= "mplus",
           data=base)
```

```
## Warning: lavaan->lav_data_full():
##    some cases are empty and will be ignored: 116 235.
```

```
anova(fit2,fit3,fit4,fit5,fit6, fit7, fit8)
```

```
##
## Scaled Chi-Squared Difference Test (method = "satorra.bentler.2001")
##
## lavaan->lavTestLRT():
##    lavaan NOTE: The "Chisq" column contains standard test statistics, not the
##    robust test that should be reported per model. A robust difference test is
##    a function of two standard (not robust) statistics.
##      Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## fit2 15 4726.5 4848.8 32.581
## fit3 19 6039.3 6162.4 36.473     9.2506       4   0.055131 .
## fit4 23 6037.3 6146.4 42.555     5.8928       4   0.207300
## fit5 29 6035.3 6123.2 52.475     4.9821       6   0.546109
## fit6 31 6032.8 6113.7 54.050     3.3300       2   0.189192
## fit7 33 6029.7 6103.6 54.907     0.3679       2   0.831959
## fit8 35 6035.3 6102.2 64.545     9.6498       2   0.008028 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
### 3. Evalúe si el modelo de medición en T1 es invariante entre hombres y mujeres.}


  # factorizamos la Variable de agrupación
  base$sexo<- as.factor(base$sexo)
  str(base$sexo)
```

```
##  Factor w/ 2 levels "1","2": 2 2 1 2 2 2 1 2 2 1 ...
```

```
#### Invarianza del modelo de medición

# Estimación invarianza configural
# sobre el modelo especificado previamente "mod1"
config <- sem(mod1, data=base,
              estimator = "MLR",
              group="sexo") # Variable de agrupación

summary(config)
```

```
## lavaan 0.6-18 ended normally after 38 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        18
##
##   Number of observations per group:               Used       Total
##     2                                              117         134
##     1                                              103         117
##
## Model Test User Model:
##                                                Standard      Scaled
##   Test Statistic                                  0.000       0.000
##   Degrees of freedom                                  0           0
##   Test statistic for each group:
##     2                                             0.000       0.000
##     1                                             0.000       0.000
##
## Parameter Estimates:
##
##   Standard errors                               Sandwich
##   Information bread                             Observed
##   Observed information based on                  Hessian
##
##
## Group 1 [2]:
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   perfecT1 =~
##     psp1.T1           1.000
##     psp2.T1           0.995    0.076   13.016    0.000
##     psp3.T1           0.895    0.073   12.208    0.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .psp1.T1           3.829    0.197   19.413    0.000
##    .psp2.T1           3.547    0.188   18.844    0.000
##    .psp3.T1           3.462    0.185   18.740    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .psp1.T1           0.920    0.264    3.487    0.000
```

```
##    .psp2.T1          0.547    0.352    1.556    0.120
##    .psp3.T1          1.084    0.301    3.602    0.000
##     perfecT1         3.632    0.414    8.782    0.000
##
##
## Group 2 [1]:
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   perfecT1 =~
##     psp1.T1          1.000
##     psp2.T1          1.252    0.098   12.829    0.000
##     psp3.T1          1.173    0.089   13.112    0.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .psp1.T1          3.903    0.196   19.877    0.000
##    .psp2.T1          3.786    0.203   18.650    0.000
##    .psp3.T1          3.689    0.200   18.453    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .psp1.T1          1.397    0.354    3.943    0.000
##    .psp2.T1          0.212    0.202    1.051    0.293
##    .psp3.T1          0.578    0.193    2.991    0.003
##     perfecT1         2.574    0.463    5.554    0.000
```