

# addhealth\_semtools

```
library(dplyr)
library(doParallel)
library(ggplot2)
library(here)
library(lavaan)
library(parallel)
library(snow)
library(tibble)
library(tidyverse)
source(here("read_format_addhealth_depression.R"))
```

## Lavaan syntax for the config models

```
library(semTools)
```

#####

This is semTools 0.5-6

All users of R (or SEM) are invited to submit functions or ideas for functions.

#####

Attaching package: 'semTools'

The following object is masked from 'package:readr':

clipboard

```
config_model_smt <- '  
  eta1 =~  
    l1_w1 * i1_w1 +  
    l2_w1 * i2_w1 +  
    l3_w1 * i3_w1 +  
    l4_w1 * i4_w1 +  
    l5_w1 * i5_w1 +  
    l6_w1 * i6_w1 +  
    l7_w1 * i7_w1 +  
    l8_w1 * i8_w1  
  
  eta2 =~  
    l1_w2 * i1_w2 +  
    l2_w2 * i2_w2 +  
    l3_w2 * i3_w2 +  
    l4_w2 * i4_w2 +  
    l5_w2 * i5_w2 +  
    l6_w2 * i6_w2 +  
    l7_w2 * i7_w2 +  
    l8_w2 * i8_w2  
  eta3 =~  
    l1_w3 * i1_w3 +  
    l2_w3 * i2_w3 +  
    l3_w3 * i3_w3 +  
    l4_w3 * i4_w3 +  
    l5_w3 * i5_w3 +  
    l6_w3 * i6_w3 +  
    l7_w3 * i7_w3 +  
    l8_w3 * i8_w3  
  eta4 =~  
    l1_w4 * i1_w4 +  
    l2_w4 * i2_w4 +  
    l3_w4 * i3_w4 +  
    l4_w4 * i4_w4 +  
    l5_w4 * i5_w4 +  
    l6_w4 * i6_w4 +  
    l7_w4 * i7_w4 +
```

```

        l8_w4 * i8_w4
    ,

config_model_smt_covs <- '
    eta1 =~
        l1_w1 * i1_w1 +
        l2_w1 * i2_w1 +
        l3_w1 * i3_w1 +
        l4_w1 * i4_w1 +
        l5_w1 * i5_w1 +
        l6_w1 * i6_w1 +
        l7_w1 * i7_w1 +
        l8_w1 * i8_w1

    eta2 =~
        l1_w2 * i1_w2 +
        l2_w2 * i2_w2 +
        l3_w2 * i3_w2 +
        l4_w2 * i4_w2 +
        l5_w2 * i5_w2 +
        l6_w2 * i6_w2 +
        l7_w2 * i7_w2 +
        l8_w2 * i8_w2

    eta3 =~
        l1_w3 * i1_w3 +
        l2_w3 * i2_w3 +
        l3_w3 * i3_w3 +
        l4_w3 * i4_w3 +
        l5_w3 * i5_w3 +
        l6_w3 * i6_w3 +
        l7_w3 * i7_w3 +
        l8_w3 * i8_w3

    eta4 =~
        l1_w4 * i1_w4 +
        l2_w4 * i2_w4 +
        l3_w4 * i3_w4 +
        l4_w4 * i4_w4 +
        l5_w4 * i5_w4 +
        l6_w4 * i6_w4 +
        l7_w4 * i7_w4 +
        l8_w4 * i8_w4

```

```

i5_w1 ~~ i7_w1
i5_w2 ~~ i7_w2
i5_w3 ~~ i7_w3
i5_w4 ~~ i7_w4

# Item 4 and Item 6, respectively:
# "You had trouble keeping your mind on what you were doing."
# "You felt that you were too tired to do things."

i4_w1 ~~ i6_w1
i4_w2 ~~ i6_w2
i4_w3 ~~ i6_w3
i4_w4 ~~ i6_w4

# Item 2 and Item 5, respectively:
# "You felt that you could not shake off the blues, even with help from your family and yo
# "You felt depressed."
i2_w1 ~~ i5_w1
i2_w2 ~~ i5_w2
i2_w3 ~~ i5_w3
i2_w4 ~~ i5_w4

# Item 2 and Item 7, respectively:
# "You felt that you could not shake off the blues, even with help from your family and yo
# "You felt sad."
i2_w1 ~~ i7_w1
i2_w2 ~~ i7_w2
i2_w3 ~~ i7_w3
i2_w4 ~~ i7_w4

'

```

## Config Models

```

longitudinal_factor_names <- list(
  comp = c("eta1", "eta2", "eta3", "eta4")
)

longitudinal_ind <- list(

```

```

i1 = c("i1_w1", "i1_w2", "i1_w3", "i1_w4"),
i2 = c("i2_w1", "i2_w2", "i2_w3", "i2_w4"),
i3 = c("i3_w1", "i3_w2", "i3_w3", "i3_w4"),
i4 = c("i4_w1", "i4_w2", "i4_w3", "i4_w4"),
i5 = c("i5_w1", "i5_w2", "i5_w3", "i5_w4"),
i6 = c("i6_w1", "i6_w2", "i6_w3", "i6_w4"),
i7 = c("i7_w1", "i7_w2", "i7_w3", "i7_w4"),
i8 = c("i8_w1", "i8_w2", "i8_w3", "i8_w4")
)

config_model_smt <- semTools::measEq.syntax(
  configural.model = config_model_smt,
  longFacNames = longitudinal_factor_names,
  ID.fac = "fixed.factor",
  ID.cat = "Wu.Estabrook.2016",
  data = dat
)
config_model_smt <- as.character(config_model_smt)

config_model_smt_covs <- semTools::measEq.syntax(
  configural.model = config_model_smt_covs,
  longFacNames = longitudinal_factor_names,
  ID.fac = "fixed.factor",
  ID.cat = "Wu.Estabrook.2016",
  data = dat
)
config_model_smt_covs <- as.character(config_model_smt_covs)

```

## Weak Model

```

weak_model_smt_covs <- semTools::measEq.syntax(
  configural.model = config_model_smt_covs,
  longFacNames = longitudinal_factor_names,
  ID.fac = "std.lv",
  ID.cat = "Wu.Estabrook.2016",
  long.equal = c("loadings"),

```

```

    data = dat
  )

  weak_model_smt_covs <- as.character(weak_model_smt_covs)

```

## Strong Model

```

strong_model_smt_covs <- semTools::measEq.syntax(
  configural.model = config_model_smt_covs,
  longFacNames = longitudinal_factor_names,
  ID.fac = "std.lv",
  ID.cat = "Wu.Estabrook.2016",
  long.equal = c("loadings", "intercepts"),
  data = dat
)
strong_model_smt_covs <- as.character(strong_model_smt_covs)

```

## Strict Model

```

# Covs
strict_model_smt_covs <- measEq.syntax(
  configural.model = config_model_smt_covs,
  longFacNames = longitudinal_factor_names,
  ID.fac = "std.lv",
  ID.cat = "Wu.Estabrook.2016",
  long.equal = c("loadings", "intercepts", "residuals"),
  data = dat
)

strict_model_smt_covs <- as.character(strict_model_smt_covs)

```

## Multithreading to fit the models

```
config_model_smt <- as.character(config_model_smt)

list_all_fit_files_semt <- list(
  config_model_smt      = config_model_smt,
  config_model_smt_covs = config_model_smt_covs,
  weak_model_smt_covs   = weak_model_smt_covs,
  strong_model_smt_covs = strong_model_smt_covs,
  strict_model_smt_covs = strict_model_smt_covs
)

RunCFA_semt <- function(model, test = FALSE) {
  if (test) {
    res <- lavaan::cfa(model, data = dat)
  } else {
    res <- lavaan::cfa(model, data = dat,
                      estimator = "MLR",
                      meanstructure = TRUE,
                      fixed.x = FALSE,
                      missing = "FIML",
                      se = "robust.mlr")
  }
}

n_cores <- (parallel::detectCores() / 2)

cl <- makeCluster(n_cores)
doParallel::registerDoParallel(cl)

snow::clusterExport(cl, c("list_all_fit_files_semt", "RunCFA_semt", "dat"))

system.time({
  list_all_res_semt <- snow::clusterApply(
    cl,
    seq_along(list_all_fit_files_semt),
    function(fit_model_num) {
      print(names(list_all_fit_files_semt)[fit_model_num])
    }
  )
})
```

```

fit_cfa_semt <- RunCFA_semt(
  list_all_fit_files_semt[[fit_model_num]],
  # do test = TRUE to test with ML, much faster
  test = FALSE
)
return(fit_cfa_semt)
})
names(list_all_res_semt) <- names(list_all_fit_files_semt)
})

```

```

user  system elapsed
0.02   0.00   52.51

```

```

#list_all_res_semt

```

```

#cat(list_all_fit_files_semt$strong_model_smt_covs)

```

**TODO: Partial Invariance!** Using the same syntax as it would for `group.partial`, though that doesn't free the intercepts.

**TODO: `lavPredict`, factor scores for bartlett, get descriptives for each based on partial invariance model (or if doesn't work, then `strong`)**

```

partial_strong_model_smt_covs <- measEq.syntax(
  configural.model = config_model_smt_covs,
  longFacNames = longitudinal_factor_names,
  longIndNames = longitudinal_ind,
  ID.fac = "std.lv",
  ID.cat = "Wu.Estabrook.2016",
  long.equal = c("loadings", "intercepts"),
  data = dat
)

cat(as.character(partial_strong_model_smt_covs))

```



## LOADINGS:

```
eta1 =~ NA*i1_w1 + lambda.1_1*i1_w1
eta1 =~ NA*i2_w1 + lambda.2_1*i2_w1
eta1 =~ NA*i3_w1 + lambda.3_1*i3_w1
eta1 =~ NA*i4_w1 + lambda.4_1*i4_w1
eta1 =~ NA*i5_w1 + lambda.5_1*i5_w1
eta1 =~ NA*i6_w1 + lambda.6_1*i6_w1
eta1 =~ NA*i7_w1 + lambda.7_1*i7_w1
eta1 =~ NA*i8_w1 + lambda.8_1*i8_w1
eta2 =~ NA*i1_w2 + lambda.1_1*i1_w2
eta2 =~ NA*i2_w2 + lambda.2_1*i2_w2
eta2 =~ NA*i3_w2 + lambda.3_1*i3_w2
eta2 =~ NA*i4_w2 + lambda.4_1*i4_w2
eta2 =~ NA*i5_w2 + lambda.5_1*i5_w2
eta2 =~ NA*i6_w2 + lambda.6_1*i6_w2
eta2 =~ NA*i7_w2 + lambda.7_1*i7_w2
eta2 =~ NA*i8_w2 + lambda.8_1*i8_w2
eta3 =~ NA*i1_w3 + lambda.1_1*i1_w3
eta3 =~ NA*i2_w3 + lambda.2_1*i2_w3
eta3 =~ NA*i3_w3 + lambda.3_1*i3_w3
eta3 =~ NA*i4_w3 + lambda.4_1*i4_w3
eta3 =~ NA*i5_w3 + lambda.5_1*i5_w3
eta3 =~ NA*i6_w3 + lambda.6_1*i6_w3
eta3 =~ NA*i7_w3 + lambda.7_1*i7_w3
eta3 =~ NA*i8_w3 + lambda.8_1*i8_w3
eta4 =~ NA*i1_w4 + lambda.1_1*i1_w4
eta4 =~ NA*i2_w4 + lambda.2_1*i2_w4
eta4 =~ NA*i3_w4 + lambda.3_1*i3_w4
eta4 =~ NA*i4_w4 + lambda.4_1*i4_w4
eta4 =~ NA*i5_w4 + lambda.5_1*i5_w4
eta4 =~ NA*i6_w4 + lambda.6_1*i6_w4
eta4 =~ NA*i7_w4 + lambda.7_1*i7_w4
eta4 =~ NA*i8_w4 + lambda.8_1*i8_w4
```

## INTERCEPTS:

```
i1_w1 ~ NA*1 + nu.1*1
i2_w1 ~ NA*1 + nu.2*1
i3_w1 ~ NA*1 + nu.3*1
i4_w1 ~ NA*1 + nu.4*1
i5_w1 ~ NA*1 + nu.5*1
i6_w1 ~ NA*1 + nu.6*1
```

```

i7_w1 ~ NA*1 + nu.7*1
i8_w1 ~ NA*1 + nu.8*1
i1_w2 ~ NA*1 + nu.1*1
i2_w2 ~ NA*1 + nu.2*1
i3_w2 ~ NA*1 + nu.3*1
i4_w2 ~ NA*1 + nu.4*1
i5_w2 ~ NA*1 + nu.5*1
i6_w2 ~ NA*1 + nu.6*1
i7_w2 ~ NA*1 + nu.7*1
i8_w2 ~ NA*1 + nu.8*1
i1_w3 ~ NA*1 + nu.1*1
i2_w3 ~ NA*1 + nu.2*1
i3_w3 ~ NA*1 + nu.3*1
i4_w3 ~ NA*1 + nu.4*1
i5_w3 ~ NA*1 + nu.5*1
i6_w3 ~ NA*1 + nu.6*1
i7_w3 ~ NA*1 + nu.7*1
i8_w3 ~ NA*1 + nu.8*1
i1_w4 ~ NA*1 + nu.1*1
i2_w4 ~ NA*1 + nu.2*1
i3_w4 ~ NA*1 + nu.3*1
i4_w4 ~ NA*1 + nu.4*1
i5_w4 ~ NA*1 + nu.5*1
i6_w4 ~ NA*1 + nu.6*1
i7_w4 ~ NA*1 + nu.7*1
i8_w4 ~ NA*1 + nu.8*1

```

## UNIQUE-FACTOR VARIANCES:

```

i1_w1 ~~ NA*i1_w1 + theta.1_1*i1_w1
i2_w1 ~~ NA*i2_w1 + theta.2_2*i2_w1
i3_w1 ~~ NA*i3_w1 + theta.3_3*i3_w1
i4_w1 ~~ NA*i4_w1 + theta.4_4*i4_w1
i5_w1 ~~ NA*i5_w1 + theta.5_5*i5_w1
i6_w1 ~~ NA*i6_w1 + theta.6_6*i6_w1
i7_w1 ~~ NA*i7_w1 + theta.7_7*i7_w1
i8_w1 ~~ NA*i8_w1 + theta.8_8*i8_w1
i1_w2 ~~ NA*i1_w2 + theta.9_9*i1_w2
i2_w2 ~~ NA*i2_w2 + theta.10_10*i2_w2
i3_w2 ~~ NA*i3_w2 + theta.11_11*i3_w2
i4_w2 ~~ NA*i4_w2 + theta.12_12*i4_w2
i5_w2 ~~ NA*i5_w2 + theta.13_13*i5_w2
i6_w2 ~~ NA*i6_w2 + theta.14_14*i6_w2

```

```

i7_w2 ~~ NA*i7_w2 + theta.15_15*i7_w2
i8_w2 ~~ NA*i8_w2 + theta.16_16*i8_w2
i1_w3 ~~ NA*i1_w3 + theta.17_17*i1_w3
i2_w3 ~~ NA*i2_w3 + theta.18_18*i2_w3
i3_w3 ~~ NA*i3_w3 + theta.19_19*i3_w3
i4_w3 ~~ NA*i4_w3 + theta.20_20*i4_w3
i5_w3 ~~ NA*i5_w3 + theta.21_21*i5_w3
i6_w3 ~~ NA*i6_w3 + theta.22_22*i6_w3
i7_w3 ~~ NA*i7_w3 + theta.23_23*i7_w3
i8_w3 ~~ NA*i8_w3 + theta.24_24*i8_w3
i1_w4 ~~ NA*i1_w4 + theta.25_25*i1_w4
i2_w4 ~~ NA*i2_w4 + theta.26_26*i2_w4
i3_w4 ~~ NA*i3_w4 + theta.27_27*i3_w4
i4_w4 ~~ NA*i4_w4 + theta.28_28*i4_w4
i5_w4 ~~ NA*i5_w4 + theta.29_29*i5_w4
i6_w4 ~~ NA*i6_w4 + theta.30_30*i6_w4
i7_w4 ~~ NA*i7_w4 + theta.31_31*i7_w4
i8_w4 ~~ NA*i8_w4 + theta.32_32*i8_w4

```

## UNIQUE-FACTOR COVARIANCES:

```

i1_w1 ~~ NA*i1_w2 + theta.9_1*i1_w2
i1_w1 ~~ NA*i1_w3 + theta.17_1*i1_w3
i1_w1 ~~ NA*i1_w4 + theta.25_1*i1_w4
i2_w1 ~~ NA*i5_w1 + theta.5_2*i5_w1
i2_w1 ~~ NA*i7_w1 + theta.7_2*i7_w1
i2_w1 ~~ NA*i2_w2 + theta.10_2*i2_w2
i2_w1 ~~ NA*i2_w3 + theta.18_2*i2_w3
i2_w1 ~~ NA*i2_w4 + theta.26_2*i2_w4
i3_w1 ~~ NA*i3_w2 + theta.11_3*i3_w2
i3_w1 ~~ NA*i3_w3 + theta.19_3*i3_w3
i3_w1 ~~ NA*i3_w4 + theta.27_3*i3_w4
i4_w1 ~~ NA*i6_w1 + theta.6_4*i6_w1
i4_w1 ~~ NA*i4_w2 + theta.12_4*i4_w2
i4_w1 ~~ NA*i4_w3 + theta.20_4*i4_w3
i4_w1 ~~ NA*i4_w4 + theta.28_4*i4_w4
i5_w1 ~~ NA*i7_w1 + theta.7_5*i7_w1
i5_w1 ~~ NA*i5_w2 + theta.13_5*i5_w2
i5_w1 ~~ NA*i5_w3 + theta.21_5*i5_w3
i5_w1 ~~ NA*i5_w4 + theta.29_5*i5_w4
i6_w1 ~~ NA*i6_w2 + theta.14_6*i6_w2
i6_w1 ~~ NA*i6_w3 + theta.22_6*i6_w3
i6_w1 ~~ NA*i6_w4 + theta.30_6*i6_w4

```

```

i7_w1 ~~ NA*i7_w2 + theta.15_7*i7_w2
i7_w1 ~~ NA*i7_w3 + theta.23_7*i7_w3
i7_w1 ~~ NA*i7_w4 + theta.31_7*i7_w4
i8_w1 ~~ NA*i8_w2 + theta.16_8*i8_w2
i8_w1 ~~ NA*i8_w3 + theta.24_8*i8_w3
i8_w1 ~~ NA*i8_w4 + theta.32_8*i8_w4
i1_w2 ~~ NA*i1_w3 + theta.17_9*i1_w3
i1_w2 ~~ NA*i1_w4 + theta.25_9*i1_w4
i2_w2 ~~ NA*i5_w2 + theta.13_10*i5_w2
i2_w2 ~~ NA*i7_w2 + theta.15_10*i7_w2
i2_w2 ~~ NA*i2_w3 + theta.18_10*i2_w3
i2_w2 ~~ NA*i2_w4 + theta.26_10*i2_w4
i3_w2 ~~ NA*i3_w3 + theta.19_11*i3_w3
i3_w2 ~~ NA*i3_w4 + theta.27_11*i3_w4
i4_w2 ~~ NA*i6_w2 + theta.14_12*i6_w2
i4_w2 ~~ NA*i4_w3 + theta.20_12*i4_w3
i4_w2 ~~ NA*i4_w4 + theta.28_12*i4_w4
i5_w2 ~~ NA*i7_w2 + theta.15_13*i7_w2
i5_w2 ~~ NA*i5_w3 + theta.21_13*i5_w3
i5_w2 ~~ NA*i5_w4 + theta.29_13*i5_w4
i6_w2 ~~ NA*i6_w3 + theta.22_14*i6_w3
i6_w2 ~~ NA*i6_w4 + theta.30_14*i6_w4
i7_w2 ~~ NA*i7_w3 + theta.23_15*i7_w3
i7_w2 ~~ NA*i7_w4 + theta.31_15*i7_w4
i8_w2 ~~ NA*i8_w3 + theta.24_16*i8_w3
i8_w2 ~~ NA*i8_w4 + theta.32_16*i8_w4
i1_w3 ~~ NA*i1_w4 + theta.25_17*i1_w4
i2_w3 ~~ NA*i5_w3 + theta.21_18*i5_w3
i2_w3 ~~ NA*i7_w3 + theta.23_18*i7_w3
i2_w3 ~~ NA*i2_w4 + theta.26_18*i2_w4
i3_w3 ~~ NA*i3_w4 + theta.27_19*i3_w4
i4_w3 ~~ NA*i6_w3 + theta.22_20*i6_w3
i4_w3 ~~ NA*i4_w4 + theta.28_20*i4_w4
i5_w3 ~~ NA*i7_w3 + theta.23_21*i7_w3
i5_w3 ~~ NA*i5_w4 + theta.29_21*i5_w4
i6_w3 ~~ NA*i6_w4 + theta.30_22*i6_w4
i7_w3 ~~ NA*i7_w4 + theta.31_23*i7_w4
i8_w3 ~~ NA*i8_w4 + theta.32_24*i8_w4
i2_w4 ~~ NA*i5_w4 + theta.29_26*i5_w4
i2_w4 ~~ NA*i7_w4 + theta.31_26*i7_w4
i4_w4 ~~ NA*i6_w4 + theta.30_28*i6_w4
i5_w4 ~~ NA*i7_w4 + theta.31_29*i7_w4

```

```
## LATENT MEANS/INTERCEPTS:
```

```
eta1 ~ 0*1 + alpha.1*1  
eta2 ~ NA*1 + alpha.2*1  
eta3 ~ NA*1 + alpha.3*1  
eta4 ~ NA*1 + alpha.4*1
```

```
## COMMON-FACTOR VARIANCES:
```

```
eta1 ~~ 1*eta1 + psi.1_1*eta1  
eta2 ~~ NA*eta2 + psi.2_2*eta2  
eta3 ~~ NA*eta3 + psi.3_3*eta3  
eta4 ~~ NA*eta4 + psi.4_4*eta4
```

```
## COMMON-FACTOR COVARIANCES:
```

```
eta1 ~~ NA*eta2 + psi.2_1*eta2  
eta1 ~~ NA*eta3 + psi.3_1*eta3  
eta1 ~~ NA*eta4 + psi.4_1*eta4  
eta2 ~~ NA*eta3 + psi.3_2*eta3  
eta2 ~~ NA*eta4 + psi.4_2*eta4  
eta3 ~~ NA*eta4 + psi.4_3*eta4
```

```
partial_strong_model_smt_covs_free_64 <-  
  update(partial_strong_model_smt_covs, change.syntax =  
    "i6_w4 ~ NA*1 + nu.6_4*1")  
  
partial_strong_model_smt_covs_free_64_33 <-  
  update(partial_strong_model_smt_covs_free_64, change.syntax =  
    "i3_w3 ~ NA*1 + nu.3_3*1")  
  
partial_strong_model_smt_covs_free_64_33_34 <-  
  update(partial_strong_model_smt_covs_free_64_33, change.syntax =  
    "i3_w4 ~ NA*1 + nu.3_4*1")  
  
partial_strong_model_smt_covs_free_64_33_34_43 <-  
  update(partial_strong_model_smt_covs_free_64_33_34, change.syntax =  
    "i4_w3 ~ NA*1 + nu.4_3*1")  
  
partial_strong_model_smt_covs_free_64_33_34_43_81 <-  
  update(partial_strong_model_smt_covs_free_64_33_34_43, change.syntax =
```

```

      "i8_w1 ~ NA*1 + nu.8_1*1")

partial_strong_model_smt_covs_free_64_33_34_43_81_51 <-
  update(partial_strong_model_smt_covs_free_64_33_34_43_81, change.syntax =
    "i5_w1 ~ NA*1 + nu.5_1*1")

partial_strong_model_smt_covs_free_64_33_34_43_81_51_52 <-
  update(partial_strong_model_smt_covs_free_64_33_34_43_81_51, change.syntax =
    "i5_w2 ~ NA*1 + nu.5_2*1")

partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13 <-
  update(partial_strong_model_smt_covs_free_64_33_34_43_81_51_52, change.syntax =
    "i1_w3 ~ NA*1 + nu.1_3*1")

partial_strong_model_smt_covs_free_64 <-
  as.character(partial_strong_model_smt_covs_free_64)

partial_strong_model_smt_covs_free_64_33 <-
  as.character(partial_strong_model_smt_covs_free_64_33)

partial_strong_model_smt_covs_free_64_33_34 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34)

partial_strong_model_smt_covs_free_64_33_34_43 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34_43)

partial_strong_model_smt_covs_free_64_33_34_43_81 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34_43_81)

partial_strong_model_smt_covs_free_64_33_34_43_81_51 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34_43_81_51)

partial_strong_model_smt_covs_free_64_33_34_43_81_51_52 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34_43_81_51_52)

partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13 <-
  as.character(partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13)

cat(partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13)

```

## LOADINGS:

```

eta1 =~ NA*i1_w1 + lambda.1_1*i1_w1
eta1 =~ NA*i2_w1 + lambda.2_1*i2_w1
eta1 =~ NA*i3_w1 + lambda.3_1*i3_w1
eta1 =~ NA*i4_w1 + lambda.4_1*i4_w1
eta1 =~ NA*i5_w1 + lambda.5_1*i5_w1
eta1 =~ NA*i6_w1 + lambda.6_1*i6_w1
eta1 =~ NA*i7_w1 + lambda.7_1*i7_w1
eta1 =~ NA*i8_w1 + lambda.8_1*i8_w1
eta2 =~ NA*i1_w2 + lambda.1_1*i1_w2
eta2 =~ NA*i2_w2 + lambda.2_1*i2_w2
eta2 =~ NA*i3_w2 + lambda.3_1*i3_w2
eta2 =~ NA*i4_w2 + lambda.4_1*i4_w2
eta2 =~ NA*i5_w2 + lambda.5_1*i5_w2
eta2 =~ NA*i6_w2 + lambda.6_1*i6_w2
eta2 =~ NA*i7_w2 + lambda.7_1*i7_w2
eta2 =~ NA*i8_w2 + lambda.8_1*i8_w2
eta3 =~ NA*i1_w3 + lambda.1_1*i1_w3
eta3 =~ NA*i2_w3 + lambda.2_1*i2_w3
eta3 =~ NA*i3_w3 + lambda.3_1*i3_w3
eta3 =~ NA*i4_w3 + lambda.4_1*i4_w3
eta3 =~ NA*i5_w3 + lambda.5_1*i5_w3
eta3 =~ NA*i6_w3 + lambda.6_1*i6_w3
eta3 =~ NA*i7_w3 + lambda.7_1*i7_w3
eta3 =~ NA*i8_w3 + lambda.8_1*i8_w3
eta4 =~ NA*i1_w4 + lambda.1_1*i1_w4
eta4 =~ NA*i2_w4 + lambda.2_1*i2_w4
eta4 =~ NA*i3_w4 + lambda.3_1*i3_w4
eta4 =~ NA*i4_w4 + lambda.4_1*i4_w4
eta4 =~ NA*i5_w4 + lambda.5_1*i5_w4
eta4 =~ NA*i6_w4 + lambda.6_1*i6_w4
eta4 =~ NA*i7_w4 + lambda.7_1*i7_w4
eta4 =~ NA*i8_w4 + lambda.8_1*i8_w4

```

## INTERCEPTS:

```

i1_w1 ~ NA*1 + nu.1*1
i2_w1 ~ NA*1 + nu.2*1
i3_w1 ~ NA*1 + nu.3*1
i4_w1 ~ NA*1 + nu.4*1
i5_w1 ~ NA*1 + nu.5_1*1
i6_w1 ~ NA*1 + nu.6*1
i7_w1 ~ NA*1 + nu.7*1

```

```

i8_w1 ~ NA*1 + nu.8_1*1
i1_w2 ~ NA*1 + nu.1*1
i2_w2 ~ NA*1 + nu.2*1
i3_w2 ~ NA*1 + nu.3*1
i4_w2 ~ NA*1 + nu.4*1
i5_w2 ~ NA*1 + nu.5_2*1
i6_w2 ~ NA*1 + nu.6*1
i7_w2 ~ NA*1 + nu.7*1
i8_w2 ~ NA*1 + nu.8*1
i1_w3 ~ NA*1 + nu.1_3*1
i2_w3 ~ NA*1 + nu.2*1
i3_w3 ~ NA*1 + nu.3_3*1
i4_w3 ~ NA*1 + nu.4_3*1
i5_w3 ~ NA*1 + nu.5*1
i6_w3 ~ NA*1 + nu.6*1
i7_w3 ~ NA*1 + nu.7*1
i8_w3 ~ NA*1 + nu.8*1
i1_w4 ~ NA*1 + nu.1*1
i2_w4 ~ NA*1 + nu.2*1
i3_w4 ~ NA*1 + nu.3_4*1
i4_w4 ~ NA*1 + nu.4*1
i5_w4 ~ NA*1 + nu.5*1
i6_w4 ~ NA*1 + nu.6_4*1
i7_w4 ~ NA*1 + nu.7*1
i8_w4 ~ NA*1 + nu.8*1

```

## UNIQUE-FACTOR VARIANCES:

```

i1_w1 ~~ NA*i1_w1 + theta.1_1*i1_w1
i2_w1 ~~ NA*i2_w1 + theta.2_2*i2_w1
i3_w1 ~~ NA*i3_w1 + theta.3_3*i3_w1
i4_w1 ~~ NA*i4_w1 + theta.4_4*i4_w1
i5_w1 ~~ NA*i5_w1 + theta.5_5*i5_w1
i6_w1 ~~ NA*i6_w1 + theta.6_6*i6_w1
i7_w1 ~~ NA*i7_w1 + theta.7_7*i7_w1
i8_w1 ~~ NA*i8_w1 + theta.8_8*i8_w1
i1_w2 ~~ NA*i1_w2 + theta.9_9*i1_w2
i2_w2 ~~ NA*i2_w2 + theta.10_10*i2_w2
i3_w2 ~~ NA*i3_w2 + theta.11_11*i3_w2
i4_w2 ~~ NA*i4_w2 + theta.12_12*i4_w2
i5_w2 ~~ NA*i5_w2 + theta.13_13*i5_w2
i6_w2 ~~ NA*i6_w2 + theta.14_14*i6_w2
i7_w2 ~~ NA*i7_w2 + theta.15_15*i7_w2

```



```

i8_w2 ~~ NA*i8_w2 + theta.16_16*i8_w2
i1_w3 ~~ NA*i1_w3 + theta.17_17*i1_w3
i2_w3 ~~ NA*i2_w3 + theta.18_18*i2_w3
i3_w3 ~~ NA*i3_w3 + theta.19_19*i3_w3
i4_w3 ~~ NA*i4_w3 + theta.20_20*i4_w3
i5_w3 ~~ NA*i5_w3 + theta.21_21*i5_w3
i6_w3 ~~ NA*i6_w3 + theta.22_22*i6_w3
i7_w3 ~~ NA*i7_w3 + theta.23_23*i7_w3
i8_w3 ~~ NA*i8_w3 + theta.24_24*i8_w3
i1_w4 ~~ NA*i1_w4 + theta.25_25*i1_w4
i2_w4 ~~ NA*i2_w4 + theta.26_26*i2_w4
i3_w4 ~~ NA*i3_w4 + theta.27_27*i3_w4
i4_w4 ~~ NA*i4_w4 + theta.28_28*i4_w4
i5_w4 ~~ NA*i5_w4 + theta.29_29*i5_w4
i6_w4 ~~ NA*i6_w4 + theta.30_30*i6_w4
i7_w4 ~~ NA*i7_w4 + theta.31_31*i7_w4
i8_w4 ~~ NA*i8_w4 + theta.32_32*i8_w4

```

## UNIQUE-FACTOR COVARIANCES:

```

i1_w1 ~~ NA*i1_w2 + theta.9_1*i1_w2
i1_w1 ~~ NA*i1_w3 + theta.17_1*i1_w3
i1_w1 ~~ NA*i1_w4 + theta.25_1*i1_w4
i2_w1 ~~ NA*i5_w1 + theta.5_2*i5_w1
i2_w1 ~~ NA*i7_w1 + theta.7_2*i7_w1
i2_w1 ~~ NA*i2_w2 + theta.10_2*i2_w2
i2_w1 ~~ NA*i2_w3 + theta.18_2*i2_w3
i2_w1 ~~ NA*i2_w4 + theta.26_2*i2_w4
i3_w1 ~~ NA*i3_w2 + theta.11_3*i3_w2
i3_w1 ~~ NA*i3_w3 + theta.19_3*i3_w3
i3_w1 ~~ NA*i3_w4 + theta.27_3*i3_w4
i4_w1 ~~ NA*i6_w1 + theta.6_4*i6_w1
i4_w1 ~~ NA*i4_w2 + theta.12_4*i4_w2
i4_w1 ~~ NA*i4_w3 + theta.20_4*i4_w3
i4_w1 ~~ NA*i4_w4 + theta.28_4*i4_w4
i5_w1 ~~ NA*i7_w1 + theta.7_5*i7_w1
i5_w1 ~~ NA*i5_w2 + theta.13_5*i5_w2
i5_w1 ~~ NA*i5_w3 + theta.21_5*i5_w3
i5_w1 ~~ NA*i5_w4 + theta.29_5*i5_w4
i6_w1 ~~ NA*i6_w2 + theta.14_6*i6_w2
i6_w1 ~~ NA*i6_w3 + theta.22_6*i6_w3
i6_w1 ~~ NA*i6_w4 + theta.30_6*i6_w4
i7_w1 ~~ NA*i7_w2 + theta.15_7*i7_w2

```

```

i7_w1 ~~ NA*i7_w3 + theta.23_7*i7_w3
i7_w1 ~~ NA*i7_w4 + theta.31_7*i7_w4
i8_w1 ~~ NA*i8_w2 + theta.16_8*i8_w2
i8_w1 ~~ NA*i8_w3 + theta.24_8*i8_w3
i8_w1 ~~ NA*i8_w4 + theta.32_8*i8_w4
i1_w2 ~~ NA*i1_w3 + theta.17_9*i1_w3
i1_w2 ~~ NA*i1_w4 + theta.25_9*i1_w4
i2_w2 ~~ NA*i5_w2 + theta.13_10*i5_w2
i2_w2 ~~ NA*i7_w2 + theta.15_10*i7_w2
i2_w2 ~~ NA*i2_w3 + theta.18_10*i2_w3
i2_w2 ~~ NA*i2_w4 + theta.26_10*i2_w4
i3_w2 ~~ NA*i3_w3 + theta.19_11*i3_w3
i3_w2 ~~ NA*i3_w4 + theta.27_11*i3_w4
i4_w2 ~~ NA*i6_w2 + theta.14_12*i6_w2
i4_w2 ~~ NA*i4_w3 + theta.20_12*i4_w3
i4_w2 ~~ NA*i4_w4 + theta.28_12*i4_w4
i5_w2 ~~ NA*i7_w2 + theta.15_13*i7_w2
i5_w2 ~~ NA*i5_w3 + theta.21_13*i5_w3
i5_w2 ~~ NA*i5_w4 + theta.29_13*i5_w4
i6_w2 ~~ NA*i6_w3 + theta.22_14*i6_w3
i6_w2 ~~ NA*i6_w4 + theta.30_14*i6_w4
i7_w2 ~~ NA*i7_w3 + theta.23_15*i7_w3
i7_w2 ~~ NA*i7_w4 + theta.31_15*i7_w4
i8_w2 ~~ NA*i8_w3 + theta.24_16*i8_w3
i8_w2 ~~ NA*i8_w4 + theta.32_16*i8_w4
i1_w3 ~~ NA*i1_w4 + theta.25_17*i1_w4
i2_w3 ~~ NA*i5_w3 + theta.21_18*i5_w3
i2_w3 ~~ NA*i7_w3 + theta.23_18*i7_w3
i2_w3 ~~ NA*i2_w4 + theta.26_18*i2_w4
i3_w3 ~~ NA*i3_w4 + theta.27_19*i3_w4
i4_w3 ~~ NA*i6_w3 + theta.22_20*i6_w3
i4_w3 ~~ NA*i4_w4 + theta.28_20*i4_w4
i5_w3 ~~ NA*i7_w3 + theta.23_21*i7_w3
i5_w3 ~~ NA*i5_w4 + theta.29_21*i5_w4
i6_w3 ~~ NA*i6_w4 + theta.30_22*i6_w4
i7_w3 ~~ NA*i7_w4 + theta.31_23*i7_w4
i8_w3 ~~ NA*i8_w4 + theta.32_24*i8_w4
i2_w4 ~~ NA*i5_w4 + theta.29_26*i5_w4
i2_w4 ~~ NA*i7_w4 + theta.31_26*i7_w4
i4_w4 ~~ NA*i6_w4 + theta.30_28*i6_w4
i5_w4 ~~ NA*i7_w4 + theta.31_29*i7_w4

```

## LATENT MEANS/INTERCEPTS:

```

eta1 ~ 0*1 + alpha.1*1
eta2 ~ NA*1 + alpha.2*1
eta3 ~ NA*1 + alpha.3*1
eta4 ~ NA*1 + alpha.4*1

```

```
## COMMON-FACTOR VARIANCES:
```

```

eta1 ~~ 1*eta1 + psi.1_1*eta1
eta2 ~~ NA*eta2 + psi.2_2*eta2
eta3 ~~ NA*eta3 + psi.3_3*eta3
eta4 ~~ NA*eta4 + psi.4_4*eta4

```

```
## COMMON-FACTOR COVARIANCES:
```

```

eta1 ~~ NA*eta2 + psi.2_1*eta2
eta1 ~~ NA*eta3 + psi.3_1*eta3
eta1 ~~ NA*eta4 + psi.4_1*eta4
eta2 ~~ NA*eta3 + psi.3_2*eta3
eta2 ~~ NA*eta4 + psi.4_2*eta4
eta3 ~~ NA*eta4 + psi.4_3*eta4

```

```

list_all_fit_files_semt_partial <- list(
  partial_strong_model_smt_covs_free_64 = partial_strong_model_smt_covs_free_64,
  partial_strong_model_smt_covs_free_64_33 = partial_strong_model_smt_covs_free_64_33,
  partial_strong_model_smt_covs_free_64_33_34 = partial_strong_model_smt_covs_free_64_33_34,
  partial_strong_model_smt_covs_free_64_33_34_43 = partial_strong_model_smt_covs_free_64_33_34_43,
  partial_strong_model_smt_covs_free_64_33_34_43_81 = partial_strong_model_smt_covs_free_64_33_34_43_81,
  partial_strong_model_smt_covs_free_64_33_34_43_81_51 = partial_strong_model_smt_covs_free_64_33_34_43_81_51,
  partial_strong_model_smt_covs_free_64_33_34_43_81_51_52 = partial_strong_model_smt_covs_free_64_33_34_43_81_51_52,
  partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13 = partial_strong_model_smt_covs_free_64_33_34_43_81_51_52_13
)

```

```

RunCFA_semt <- function(model, test = FALSE) {
  if (test) {
    res <- lavaan::cfa(model, data = dat)
  } else {
    res <- lavaan::cfa(model, data = dat,
      estimator = "MLR",
      meanstructure = TRUE,
      fixed.x = FALSE,
    )
  }
}

```

```

        missing = "FIML",
        se = "robust.mlr")
    }
}

n_cores <- (parallel::detectCores() - 2)

cl <- makeCluster(n_cores)
doParallel::registerDoParallel(cl)

snow::clusterExport(cl, c("list_all_fit_files_semt_partial", "RunCFA_semt", "dat"))

system.time({
  list_all_res_semt_partial <- snow::clusterApply(
    cl,
    seq_along(list_all_fit_files_semt_partial),
    function(fit_model_num) {
      print(names(list_all_fit_files_semt_partial)[fit_model_num])
      fit_cfa_semt <- RunCFA_semt(
        list_all_fit_files_semt_partial[[fit_model_num]],
        # do test = TRUE to test with ML, much faster
        test = FALSE
      )
      return(fit_cfa_semt)
    })
  names(list_all_res_semt_partial) <- names(list_all_fit_files_semt_partial)
})

```

```

user  system elapsed
0.05   0.03   64.30

```

```
list_all_res_semt_partial
```

```

$partial_strong_model_smt_covs_free_64
lavaan 0.6-19 ended normally after 94 iterations

```

Estimator	ML
Optimization method	NLMINB
Number of model parameters	172

Number of equality constraints	47		
	Used	Total	
Number of observations	6502	6504	
Number of missing patterns	68		

Model Test User Model:

	Standard	Scaled
Test Statistic	2718.857	2248.922
Degrees of freedom	435	435
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.209
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33  
lavaan 0.6-19 ended normally after 88 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	172
Number of equality constraints	46

	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	2500.834	2068.272
Degrees of freedom	434	434
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.209
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34  
lavaan 0.6-19 ended normally after 97 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	172
Number of equality constraints	45

	Used	Total
--	------	-------

Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	2251.464	1861.028
Degrees of freedom	433	433
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.210
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34\_43  
lavaan 0.6-19 ended normally after 84 iterations

Estimator	ML	
Optimization method	NLMINB	
Number of model parameters	172	
Number of equality constraints	44	

  

	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	2113.940	1746.829
Degrees of freedom	432	432
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.210
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34\_43\_81  
lavaan 0.6-19 ended normally after 90 iterations

Estimator	ML	
Optimization method	NLMINB	
Number of model parameters	172	
Number of equality constraints	43	

  

	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	1994.300	1647.463
Degrees of freedom	431	431
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.211
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34\_43\_81\_51  
lavaan 0.6-19 ended normally after 96 iterations

Estimator	ML	
Optimization method	NLMINB	
Number of model parameters	172	
Number of equality constraints	42	
	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	1874.413	1547.530
Degrees of freedom	430	430
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.211
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34\_43\_81\_51\_52  
lavaan 0.6-19 ended normally after 89 iterations

Estimator	ML	
Optimization method	NLMINB	
Number of model parameters	172	
Number of equality constraints	41	
	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	1776.649	1466.454

Degrees of freedom	429	429
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.212
Yuan-Bentler correction (Mplus variant)		

\$partial\_strong\_model\_smt\_covs\_free\_64\_33\_34\_43\_81\_51\_52\_13  
lavaan 0.6-19 ended normally after 89 iterations

Estimator	ML
Optimization method	NLMINB
Number of model parameters	172
Number of equality constraints	40

	Used	Total
Number of observations	6502	6504
Number of missing patterns	68	

Model Test User Model:

	Standard	Scaled
Test Statistic	1716.107	1415.884
Degrees of freedom	428	428
P-value (Chi-square)	0.000	0.000
Scaling correction factor		1.212
Yuan-Bentler correction (Mplus variant)		