Exercises session 5 - Multigroup analyses

Exercise 4.1: Measurement invariance between the WAIS and WAIS-IV

In this exercise, we will compare the measurement models underlying two different versions of the Wechsler Adult Intelligence Scale (WAIS): the original WAIS and the WAIS-IV. In fact, the data come from the same sample of participants, who completed both the WAIS and the WAIS-IV, but we are ignoring this repeated measures structure here, which may not be completely appropriate. We will evaluate measurement invariance of the 8 subtests that are included in both the WAIS and the WAIS-IV.

First, we read in the data:

```
WAIS.cor <- lav_matrix_lower2full(c(
  1.00,
  0.31, 1.00,
  0.36, 0.40, 1.00,
  0.51, 0.46, 0.45, 1.00,
  0.29, 0.40, 0.33, 0.43, 1.00,
  0.39, 0.29, 0.27, 0.36, 0.33, 1.00,
  0.32, 0.27, 0.29, 0.33, 0.24, 0.28, 1.00,
  0.22, 0.32, 0.15, 0.22, 0.27, 0.12, 0.26, 1.00
))
WAIS.means <- c(7.83, 5.50, 5.67, 21.50, 7.67, 8.00, 6.50, 34.83)
WAIS.sds <- c(2.69, 1.50, 2.36, 6.06, 1.85, 2.18, 5.97, 9.94)
WAIS.cov <- cor2cov(WAIS.cor, sds=WAIS.sds)

WAISIV.cor <- lav_matrix_lower2full(c(
  1.00,
  0.46, 1.00,
  0.58, 0.55, 1.00,
  0.63, 0.43, 0.73, 1.00,
  0.27, 0.51, 0.37, 0.33, 1.00,
  0.45, 0.38, 0.37, 0.43, 0.13, 1.00,
  0.33, 0.52, 0.49, 0.41, 0.29, 0.43, 1.00,
  0.15, 0.27, 0.16, 0.09, 0.12, 0.25, 0.23, 1.00
))
WAISIV.means <- c(15.17, 15.00, 11.83, 21.67, 12.17, 17.83, 18.67, 45.83)
WAISIV.sds <- c(4.93, 4.10, 5.20, 6.54, 2.72, 5.35, 9.36, 10.44)
WAISIV.cov <- cor2cov(WAISIV.cor, sds=WAISIV.sds)

WAIS.names <- c("Compr", "Arith", "Simil", "Vocab", "DigSpan", "PictCompl",
                "BlockDes", "Cod")

names(WAIS.means) <- names(WAIS.sds) <- colnames(WAIS.cov) <-
  rownames(WAIS.cov) <- names(WAISIV.means) <- names(WAISIV.sds) <-
  rownames(WAISIV.cov) <- colnames(WAISIV.cov) <- WAIS.names
```

```
WAIS.cov.list <- list(WAIS.cov, WAISIV.cov)
WAIS.mean.list <- list(WAIS.means, WAISIV.means)
WAIS.n.list <- list(WAIS.n = 200, WAISIV.n = 200)
```

We fit a three-dimensional model, with Verbal Comprehension (Similarities, Vocabulary and Comprehension), Working Memory (Artihmetic, Digit Span and Coding) and Perceptual Reasoning (Picture Completion and Block Design) as latent factors:

```
WAIS.mod <- '
  ## verbal comprehension
  VC =~ Simil + Vocab + Compr

  ## Perceptual reasoning
  PR =~ PictCompl + BlockDes

  ## Working memory
  WM =~ Arith + DigSpan + Cod
'
```

a) Given that the the datasets come from the same participants, and that the two tests measure the same latent factors, think about which identification approach would be more appropriate: the standardized-LV approach or the marker-variable approach?

Perform a multigroup analysis on these data, using the identification approach you chose for question a):

b) Assess whether configural invariance between the WAIS and WAIS-IV is tenable.

c) Assess whether loadings, intercepts and residual variances are equal between the two WAIS versions. Note: If the majority of equality restrictions in a given step of (metric, scalar, uniqueness invariance) are not tenable, you need not do a step-by-step search of which restrictions to lift. Just remove the equality restriction for every parameter of the same type, and continue with the next step.

Additional exercise: Gender and age differences in anxiety as measured by the HADS

Download the file 'HADS.sav' from the github repository and read it into `R`:

```
library("foreign")
hads <- read.spss("HADS.sav", to.data.frame = TRUE)
```

The file contains scores on seven items of the Anxiety subscale of the Hospital Anxiety and Depression Scale. Barth and Martin (2005) a two-dimensional model, consisting of Psychomotor Agitation (PAG; items 1, 4 and 6) and a Psychic Anxiety (ANX; items 2, 3, 5 and 7) factor:

1. I feel tense or wound up.
2. I get a sort of frightened feeling as if something bad is about to happen.
3. Worrying thoughts go through my mind.
4. I can sit at ease and feel relaxed.
5. I get a sort of frightened feeling like butterflies in the stomach.
6. I feel restless and have to be on the move.

7. I get sudden feelings of panic.

Use the following model:

```
HADS_mod <- '
  PAG =~ HADS1 + HADS4 + HADS6
  ANX =~ HADS2 + HADS3 + HADS5 + HADS7
'
```

Factor PAG reflects physical agitation, ANX reflect anxiety symptoms.

a) Assess measurement invariance of the HADS Anxiety items with respect to gender (i.e., specify `group = "geslacht"`). Describe and interpret any differences you found.

b) Assess structural invariance of the HADS Anxiety factor with respect to gender. Describe and interpret any differences you found.

c) Fit one single model (i.e., do not specify the `group` argument), in which you assess the main and interaction effects of gender ('geslacht') and age ('leeftijd') on the levels of the latent factors Psychomotor Agitation and Psychic Anxiety.