Assignment 3

SEM 1: Confirmatory Factor Analysis

Please hand in a `.pdf` file containing your report and a `.R` containing your codes or screenshots of every Jasp analysis. The deadline of this assignment is Wednesday April 26 11:00.

Assignment

While still working at the University of Amsterdam, Wicherts and Dolan (2010) performed measurement invariance tests on data used by te Nijenhuis, Tolboom, Resing, and Bleichrodt (2004) that aimed to measure intelligence differences between ethnic majority and minority groups in the Netherlands. In particular, the following factor model was used:
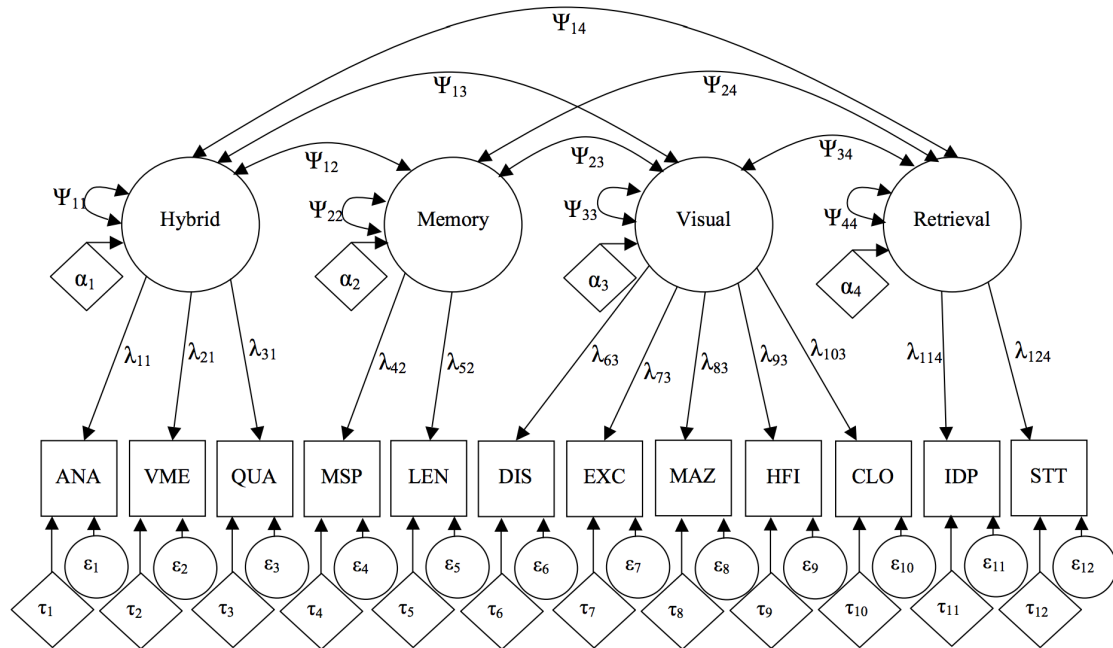

Table 2 of Wicherts and Dolan (2010) report the main results of the measurement invariance tests (note that the order of restrictions is slightly different than in the lecture):

Table 2

Fit measures of steps towards strict factorial invariance

Step	Restrictions	df	χ^2	Δdf	$\Delta\chi^2$	p	RMSEA	CFI	AIC
1	-	96	152.52**				.059	.962	318
2	**Factor loadings**	104	157.13**	8	4.61	.798	.055	.964	306
3	Factor loadings, **residual variances**	116	179.96**	12	22.83*	.029	.059	.957	310
3a	Factor loadings, residual variances[1]	115	170.93**	-1	9.03**	.003	.054	.962	299
4	Factor loadings, residual variances[1], **intercepts**	123	240.80**	8	69.87**	.000	.077	.920	356
4c	Factor loadings, residual variances[1], intercepts[2,3,4]	120	174.37**	-1	4.14*	.042	.052	.963	292

Note: Restrictions in bold are tested by loglikelihood test $\Delta\chi^2$. *p < 0.05; **p < 0.01; (-1): Parameter freely estimated;

1: Memory Span; 2: Verbal Meaning; 3: Learning Names; 4: Storytelling

Jelte Wichers, a strong proponent of open science and editor of the Journal of Open Psychological Data, has made papers and summary statistics needed to replicate the analyses available on his website.[1] A free version of the paper can be found here (journal version is on blackboard) and the summary statistics needed for the

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[1]There are many more papers here, some of which could be useful for individual projects.

analysis can be found here. We can read these into R by using the `WichertsData.R` file on blackboard. The sample size of the majority group was 196 and the sample size of the minority group was 131. These variance–covariance matrices and means can directly be used in a SEM analysis. To estimate a model using summary statistics, you can use the `sample.cov`, `sample.mean` and `sample.nobs` arguments. Note, multi-group analysis using summary statistics have not yet been implemented in Jasp. To this end, I have simulated the data `WichertsSimData_forJasp.csv` on blackboard that can be used in Jasp and should give about the same results. *Only* use this data if you use Jasp!

Question 1 (8 points)   Replicate Table 2 of Wicherts and Dolan (2010) (disregarding steps 4a and 4b which are blanked out above). To obtain the right values, use the `mimic = "EQS"` option in lavaan (also available in Jasp). In Onyx, it is ok if you approximately get the same values. In Jasp, use the data file from blackboard, otherwise compute the model using summary statistics. For every step, write down the model matrices for both groups, including subscripts denoting group for parameters that are free in both groups. Also list all parameters that are freely estimated (e.g., $\lambda_{12}, \lambda_{13}, \ldots$), and manually recompute the degrees of freedom (take restrictions into account!). ∎

Question 2 (1 points)   Group membership could also be included in a CFA model as an ordinal variable by using a threshold model. Does it make sense to model group membership via a threshold model? And what would multi-group CFA allow us to analyze that including the variable in a single CFA model wouldn't? ∎

Question 3 (1 points)   If intercepts and residual variances are equal across groups, but factor loadings are not, can the test score still be considered fair? Why (not)? ∎

Question 4 (1 points)   Compute the required sample size to reject H_0:

$$H_0 : \text{RMSEA} < 0.05$$

given that we assume RMSEA $= 0.08$ with 50 degrees of freedom. Do the same for the hypothesis:

$$H_0 : \text{RMSEA} > 0.08$$

assuming RMSEA $= 0.01$ with 50 degrees of freedom. How are these hypotheses called? ∎

Question 5 (1 points)
Describe variables that can be assumed binary or ordinally distributed (2-4 answering categories), but on which it might not make plausibly sense to compute polychoric correlations. ∎

Suppose we measured two binary variables, *A* and *B*, with the following counts:

```
table(Data$A)

##
##   0   1
## 187 813

table(Data$B)

##
##   0   1
## 683 317
```

When computing thresholds, we need to choose the thresholds such that the area left and right of the normal

distribution correspond to the proportion of people that scored 0 and 1 respectively.

> **Question 6 (1 points)**
> Estimate the thresholds for *A* and *B*. Assume the latent items are standard normally distributed (mean of 0 and SD of 1). You can use R, but you can also approximate these using tables in general statistics textbooks. ∎

Suppose the data has the following frequency table:

```
table(Data)

##     B
## A     0    1
##   0 148   39
##   1 535  278
```

> **Bonus question 7 (1 bonus point)**
> Use `optimize` or `optim` to estimate the polychoric correlation given your computed thresholds. To do this, you need to create a function of the correlation (variances of latent items are 1) that computes the expected frequency table given your computed thresholds. Next, you need to minimize the distance between the observed and expected frequency tables (e.g., by minimizing the sum of squared differences). The true polychoric correlation was 0.25, so your answer must be roughly near that value. Tip, see `pmvnorm` in the *mvtnorm* package. ∎

References

te Nijenhuis, J., Tolboom, E., Resing, W., & Bleichrodt, N. (2004). Does cultural background influence the intellectual performance of children from immigrant groups? *European Journal of Psychological Assessment*, *20*(1), 10–26.

Wicherts, J. M., & Dolan, C. V. (2010). Measurement invariance in confirmatory factor analysis: An illustration using iq test performance of minorities. *Educational Measurement: Issues and Practice*, *29*(3), 39–47.