

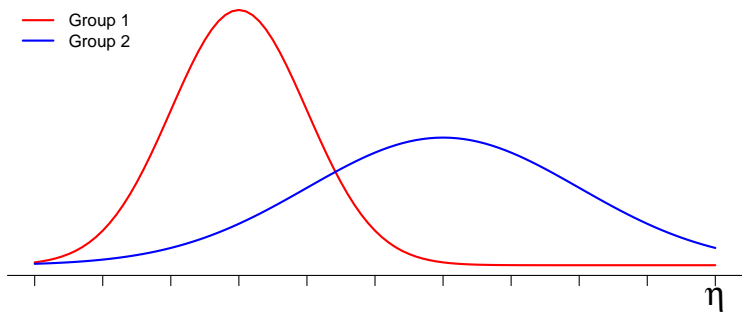
SEM 1: Confirmatory Factor Analysis

Week 3 - Homogeneity testing

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2020

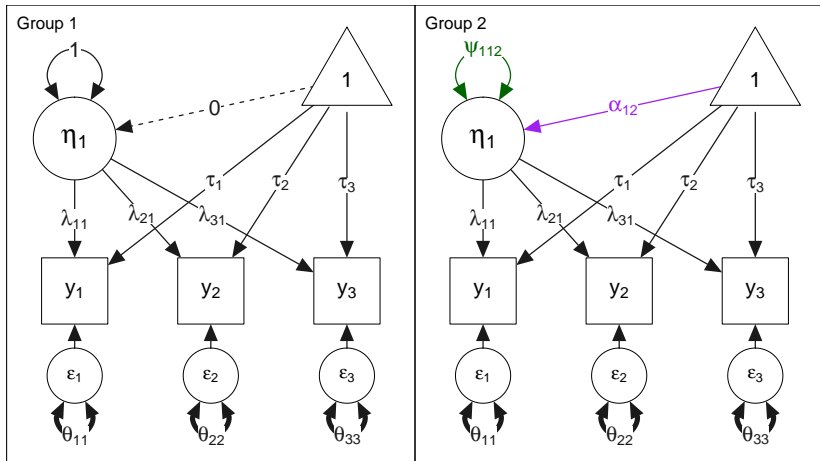
The goal of multi-group CFA is to measure differences in means and (co)variances (networks) between groups:



That is, we wish to perform tests for *homogeneity*:

- ▶ $\alpha_1 = \alpha_2 = \alpha_3 = \dots = \alpha$
- ▶ $\psi_1 = \psi_2 = \psi_3 = \dots = \psi$

Without measurement error, that would be similar MANOVA, Box's test, Levene's test, etcetera.



Homogeneity tests: are latent means ($\alpha_{12} = 0$) and variances ($\psi_{112} = 1$) the same?

At least partial invariance is required to test these hypotheses!

Name	Additional constrains	Allows to test
Configural invariance	Same zeroes in $\mathbf{\Lambda}_1, \mathbf{\Lambda}_2, \dots$	
Weak invariance	$\mathbf{\Lambda}_1 = \mathbf{\Lambda}_2 = \dots = \mathbf{\Lambda}$	$\mathbf{\Psi}_1 = \mathbf{\Psi}_2 = \dots = \mathbf{\Psi}$
Strong invariance	$\tau_1 = \tau_2 = \dots = \tau$	$\alpha_1 = \alpha_2 = \dots = \mathbf{0}$
Strict invariance	$\Theta_1 = \Theta_2 = \dots = \Theta$	Full homogeneity

Note: $\alpha_2, \alpha_3, \dots$ are identified if strong invariance holds.

Do the variances differ?

```
eqvars <- cfa(Model, Data, group = "school",
  group.equal = c("loadings", "intercepts", "residuals",
    "residual.covariances", "lv.variances"),
  group.partial = c("x3 ~ 1", "x7 ~ 1"))
anova(strict, eqvars)

## Chi-Squared Difference Test
##
##           Df      AIC      BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## strict  65 7441.9 7601.3 107.40
## eqvars  68 7437.5 7585.8 108.95      1.5561      3      0.6694
```

And the means?

```
eqmeans <- cfa(Model, Data, group = "school",
  group.equal = c("loadings", "intercepts", "residuals",
    "residual.covariances", "lv.variances",
    "means"),
  group.partial = c("x3 ~ 1", "x7 ~ 1"))
anova(eqvars, eqmeans)

## Chi-Squared Difference Test
##
##           Df      AIC      BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## eqvars    68 7437.5 7585.8 108.95
## eqmeans   71 7460.6 7597.8 138.10      29.141      3 2.092e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Does the model fit still?

```
fitMeasures(eqvars,  
            c("rmsea", "cfi", "tli", "rni", "rfi", "ifi", "srmr", "gfi"))  
  
## rmsea   cfi   tli   rni   rfi   ifi   srmr   gfi  
## 0.063 0.954 0.951 0.954 0.880 0.954 0.067 0.995
```

Adequately, we may now substantively interpret these group differences between the schools:

```
lavInspect(eqvars, "est")[[2]]$alpha  
  
##          intrcp  
## visual    0.035  
## textual  0.574  
## speed   -0.082
```