SEMINR

ANALYSE FACTORIELLE MULTI-GROUPE

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❝ (…) the first thing a psychologist, who has proposed a measure for a theoretical attribute, would do is to spell out the nature and form of the relationship between the attribute and its measures. The researcher would, for instance, posit a hypothesis on the structure (e.g., continuous or categorical) of the attribute, on its dimensionality, on the link between that structure and scores on the proposed measurement instruments (e.g., parametric or nonparametric), and offer an explanation of the actual workings of the instrument.❞ — Borsboom (2006)

RAPPELS SUR LA cFA

LAVAAN:CFA

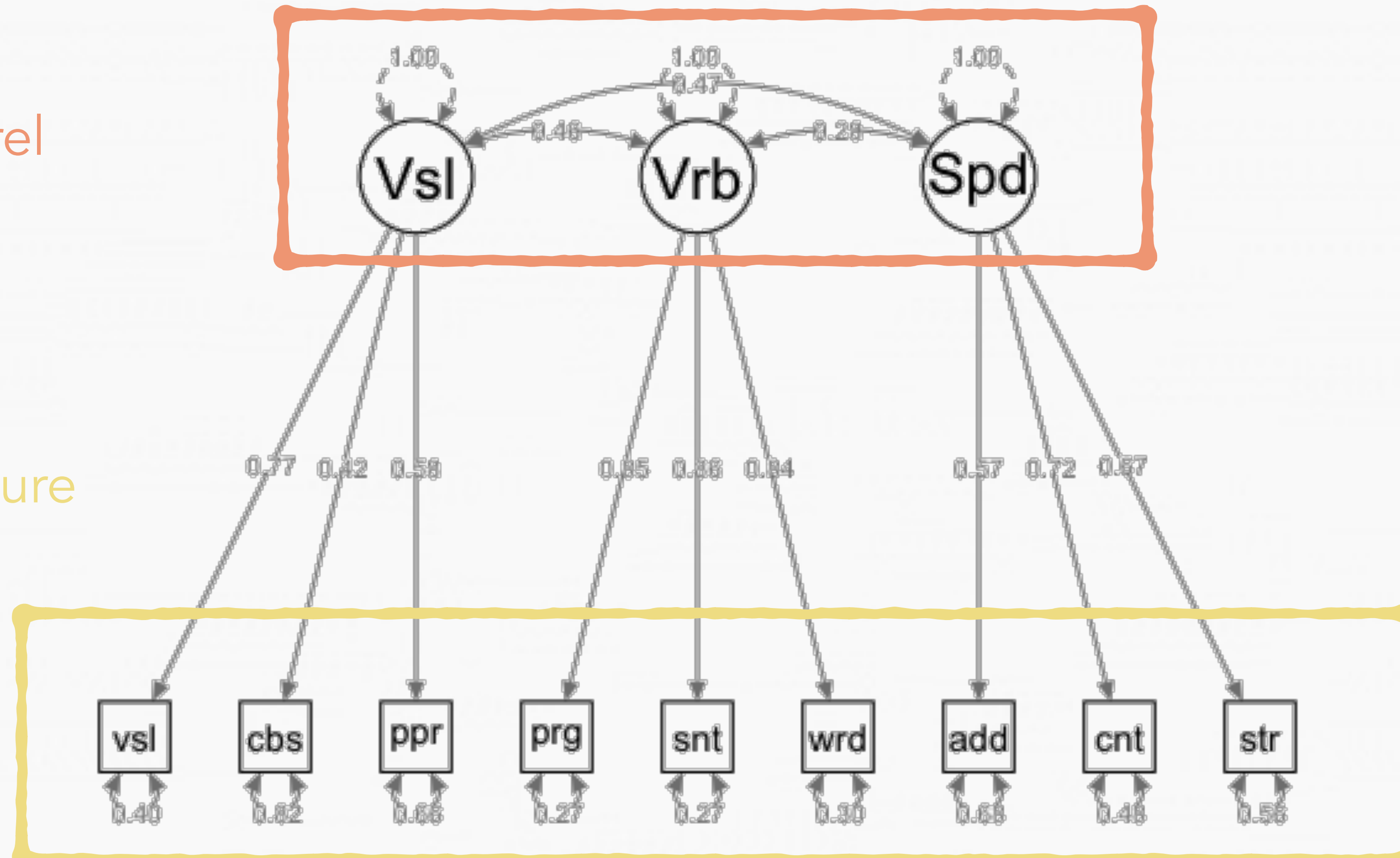
- Spécification d'un modèle réflexif :
  =~ régression MV - LV
  ~~ covariance LV-LV
  ~ régression LV-LV
  == contraintes (identification ou autre)
  := construction d'un nouveau terme de modèle
- Saisie des données : données individuelles ou matrice de covariance (corrélation) + nombre d'observations (`sample.cov=` et `sample.obs=`)
- Méthode de standardisation (MV (1ère variable) ou LV (variance unité))
- Estimation du modèle : `cfa()` ou `sem()` (basé sur `lavaan()`)
- Affichage des résultats : `summary()`, `parameterEstimates()`
- Diagnostic du modèle : `fitMeasures()`, `residuals()`, `anova()` (comparaison de modèles)

MODELE STRUCTUREL

Holzinger & Swinburne (1939)

Modèle structurel

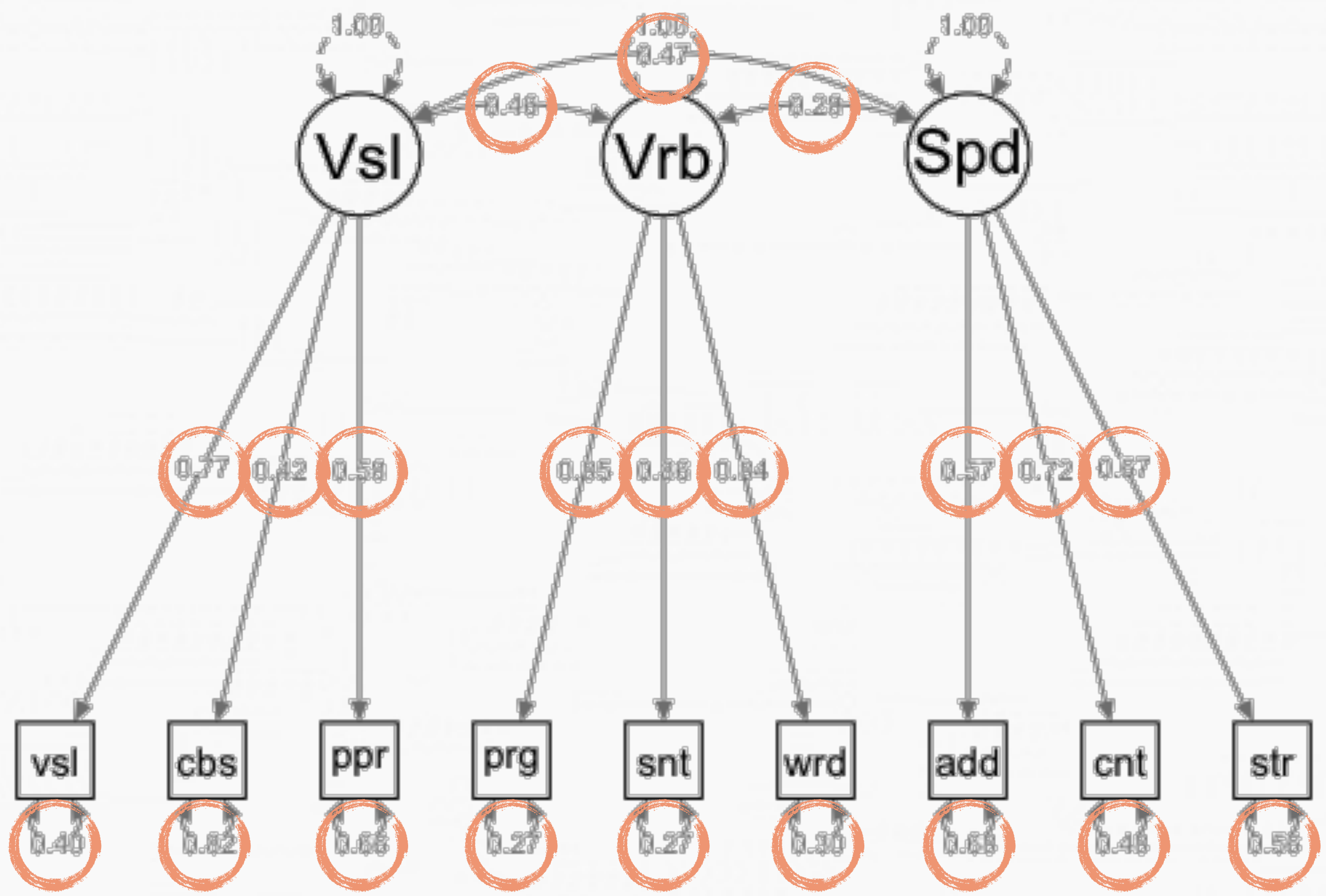
Modèle de mesure



IDENTIFICATION

Holzinger & Swinburne (1939)

21 paramètres estimés



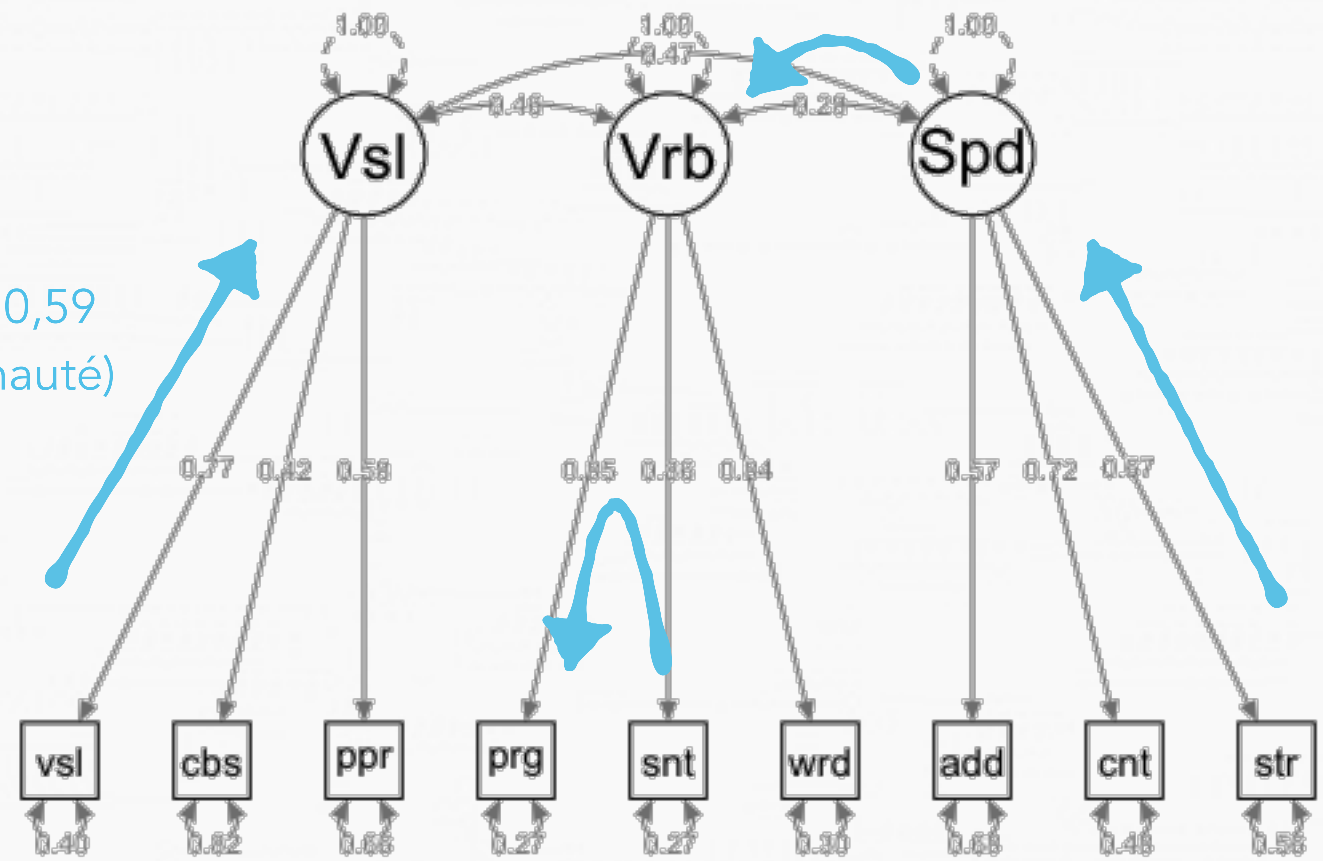
p(p+1)/2 (+m)
termes
non redondants

INTERPRETATION

« tracing rules »

straight → Verbal
0,67 x 0,28 = 0,19

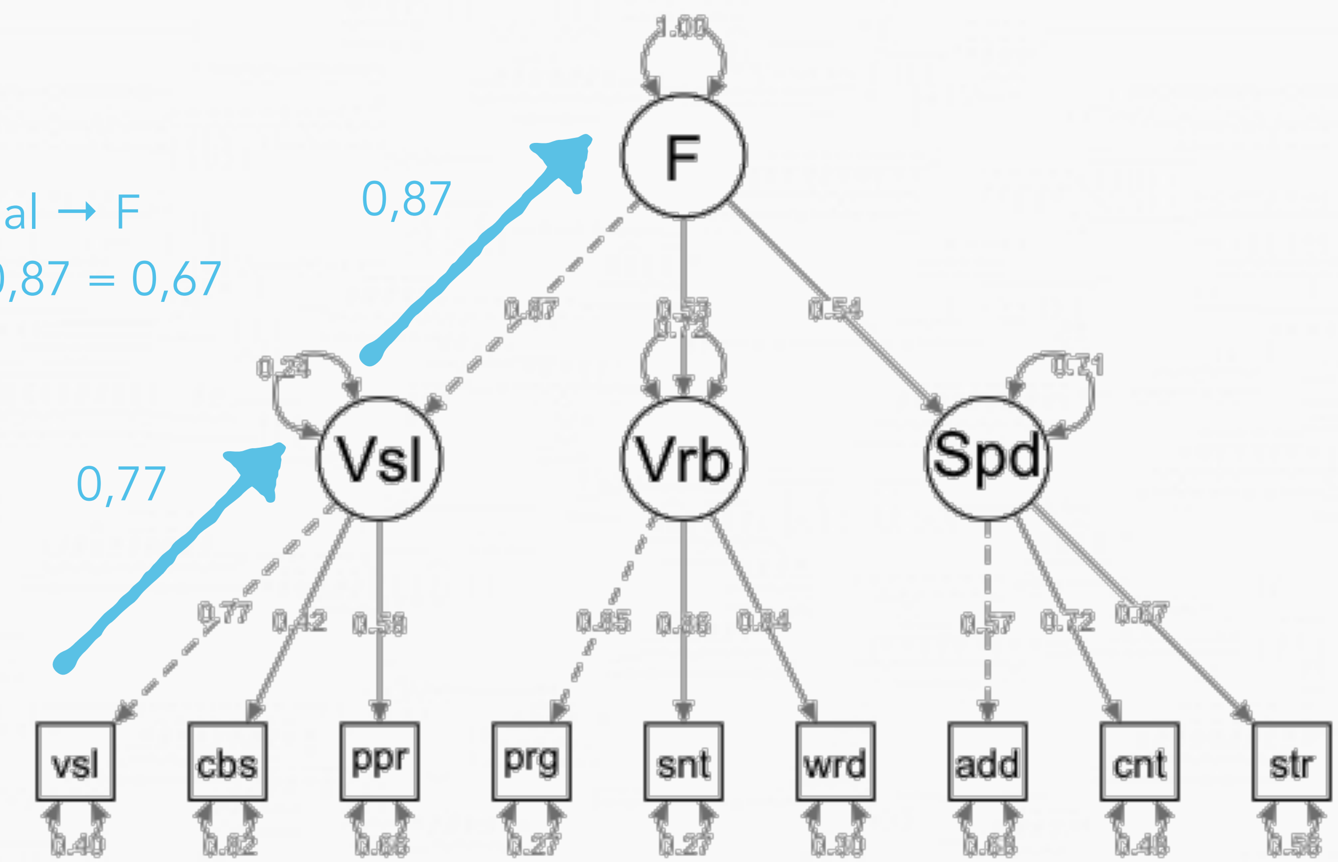
0,77^2 = 0,59
(communauté)



Corr(prg,snt)
0,85 x 0,86 = 0,73

MODELE DE 2ND ORDRE

visual → F
0,77 x 0,87 = 0,67



COVARIANCE-BASED MODELS

cfa2.R

données

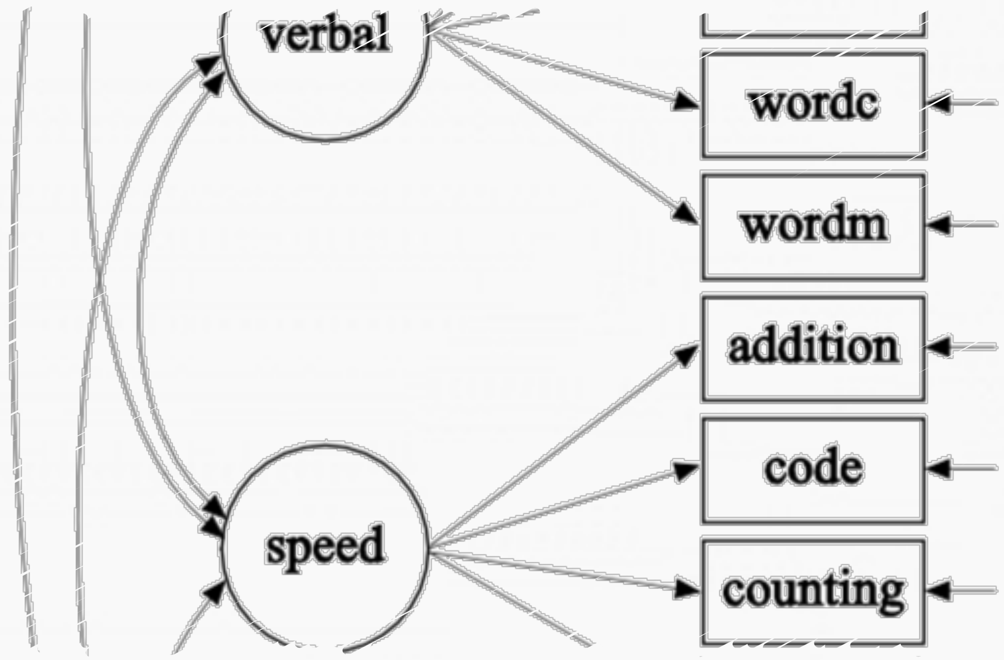
```
Console ~/Desktop/SEMinR/
> cov(d)
          visual  cubes  paper paragrap sentence wordm addition counting straight
visual     1.363 0.4087 0.5818    0.507    0.442 0.456   0.0850    0.265    0.460
cubes      0.409 1.3864 0.4526    0.210    0.212 0.248  -0.0971    0.110    0.245
paper      0.582 0.4526 1.2791    0.209    0.113 0.245   0.0886    0.213    0.375
paragrap   0.507 0.2096 0.2089    1.355    1.101 0.899   0.2205    0.126    0.244
sentence   0.442 0.2118 0.1127    1.101    1.665 1.018   0.1435    0.181    0.296
wordm      0.456 0.2484 0.2449    0.899    1.018 1.200   0.1446    0.166    0.237
addition   0.085 -0.0971 0.0886   0.220    0.143 0.145   1.1871    0.537    0.375
counting   0.265 0.1100 0.2130    0.126    0.181 0.166   0.5370    1.025    0.459
straight   0.460 0.2448 0.3751    0.244    0.296 0.237   0.3745    0.459    1.018
> resid(r)
$type
[1] "raw"

$cov
         visual cubes  paper  pargrp sentnc wordm  additn contng strght
visual    0.000
cubes     0.275  0.000
paper     0.452  0.386  0.000
paragrap  0.002 -0.046 -0.040  0.000
sentence -0.112 -0.070 -0.160  0.030  0.000
wordm    -0.013  0.010  0.014 -0.008  0.021  0.000
addition -0.015 -0.148  0.039  0.026 -0.070 -0.036  0.000
counting  0.160  0.057  0.161 -0.075 -0.040 -0.021  0.495  0.000
straight  0.301  0.164  0.296 -0.061 -0.040 -0.047  0.313  0.394  0.000
```

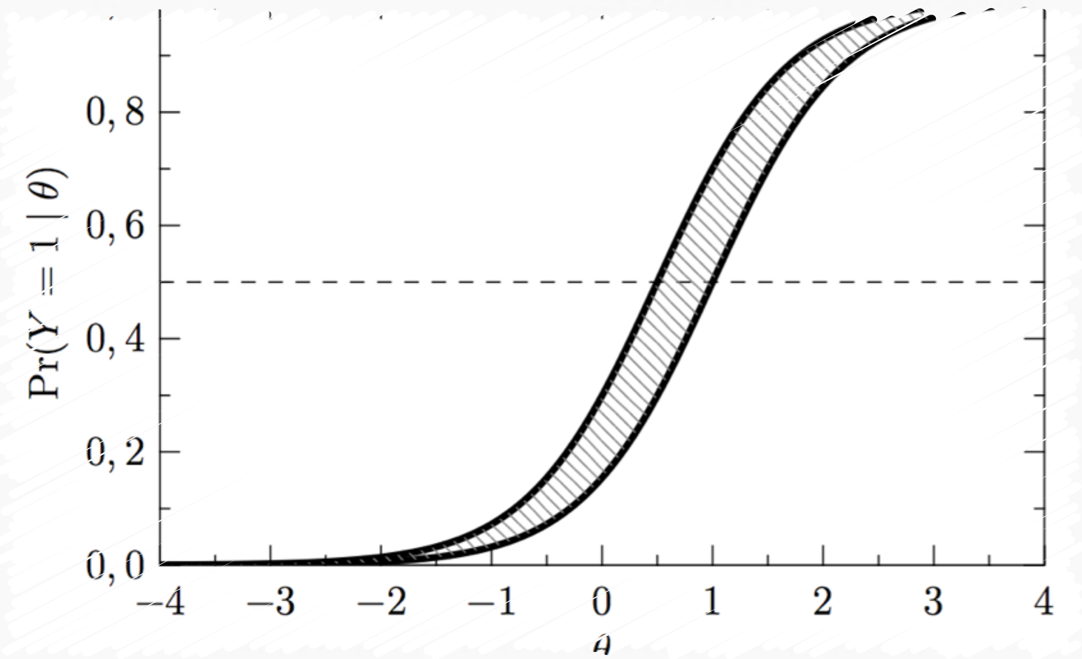
erreurs (écarts au modèle)

Modèle = données + erreurs

(matrice de covariance avec dénominateur à N, méthode ML)

QUALITE DU MODELE





SPECIFICATION

- comparaison de modèles (RMSEA, CFI, R^2, etc.)
- indices de modification (erreurs corrélées, EPC)
- interprétation, modèle structurel

INVARIANCE DE MESURE

- équivalence du modèle de mesure dans des sous-populations
- biais de fonctionnement différentiel des items

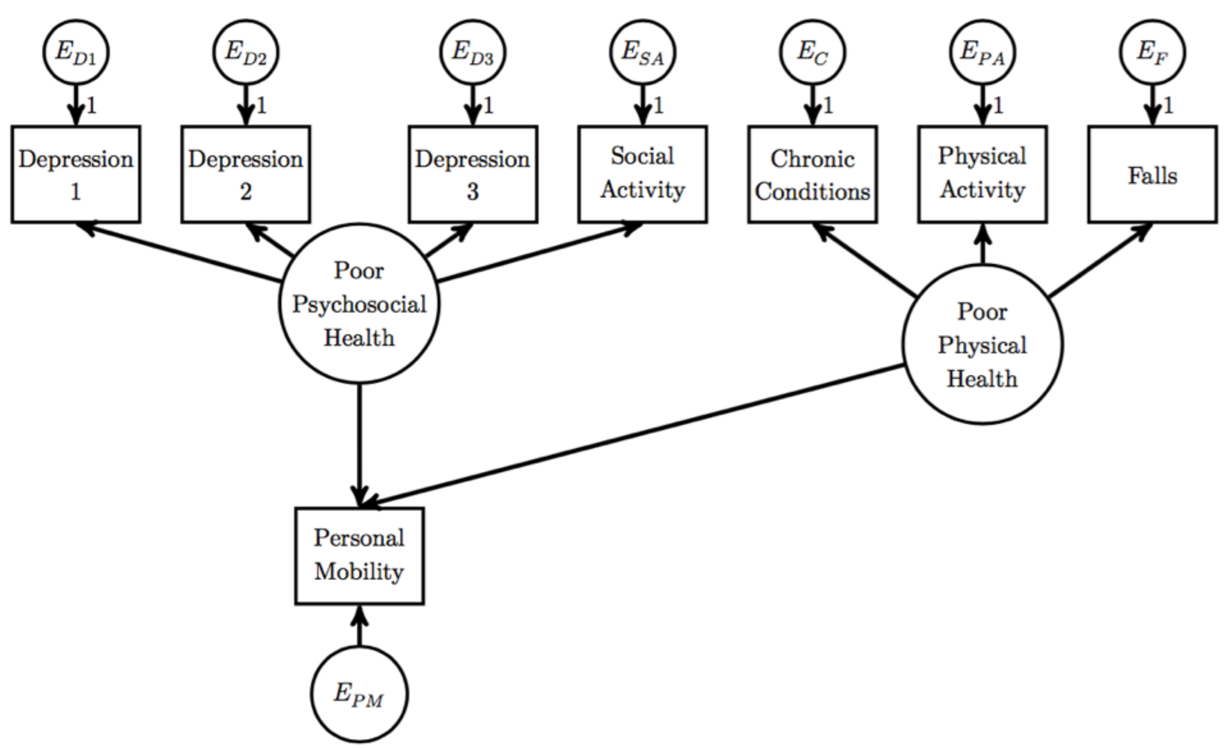
APPLICATION

Beaujean (2014)

	D1	D2	D3	SA	F	CC	PA	PM
Depression 1	0.77	0.38	0.39	−0.25	0.31	0.24	−3.16	−0.92
Depression 2	0.38	0.65	0.39	−0.32	0.29	0.25	−3.56	−0.88
Depression 3	0.39	0.39	0.62	−0.27	0.26	0.19	−2.63	−0.72
Social Activity	−0.25	−0.32	−0.27	6.09	−0.36	−0.18	6.09	0.88
Falls	0.31	0.29	0.26	−0.36	7.67	0.51	−3.12	−1.49
Chronic Conditions	0.24	0.25	0.19	−0.18	0.51	1.69	−4.58	−1.41
Physical Activity	−3.16	−3.56	−2.63	6.09	−3.12	−4.58	204.79	16.53
Personal Mobility	−0.92	−0.88	−0.72	0.88	−1.49	−1.41	16.53	7.24

Data taken from Umstattd-Meyer et al. (2013, pp. 4-5)

Les facteurs psychosociaux et de santé physiques sont-ils prédictifs de la mobilité ?



INVARIANCE DE MESURE

THEORIE DES TESTS

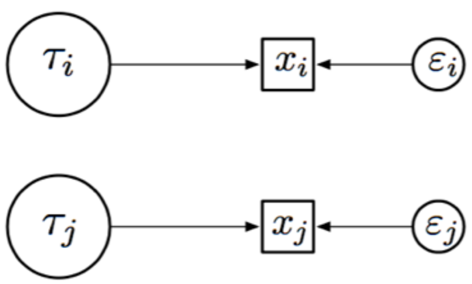
(a_1) τ-equivalence, $\tau_i = \tau_j$

(a_2) essential τ-equivalence, $\tau_i = \tau_j + \lambda_{ij}, \quad \lambda_{ij} \in \mathbb{R}$

(a_3) τ-congenerity, $\tau_i = \lambda_{ij0} + \lambda_{ij1}\tau_j, \quad \lambda_{ij0}, \lambda_{ij1} \in \mathbb{R}, \lambda_{ij1} > 0$

(b) uncorrelated errors, $\mathrm{cov}(\varepsilon_i, \varepsilon_j) = 0, \forall i \neq j$

(c) equal error variances, $\mathbb{V}(\varepsilon_i) = \mathbb{V}(\varepsilon_j)$



A1, B ET C = TESTS PARALLELES

A2 ET B = TESTS TAU-EQUIVALENT

A3 ET B = TESTS CONGENERIQUES

INVARIANCE DE MESURE

MODELE DE MESURE

- Invariance configurale : structure factorielle identique entre groupes
- Invariance faible : égalité des charges factorielles entre groupes
- Invariance forte : égalité des moyennes (ordonnées à l'origine) entre groupes
- Invariance stricte : égalité des erreurs (variances) entre groupes
- Invariance stricte + égalité des variances LV
- Invariance stricte + égalité des variances LV + égalité des moyennes LV
- Invariance partielle : conditions non vérifiées pour l'ensemble des MV

MODELE STRUCTUREL

	Type of Invariance	Constraints	Between-Groups Comparisons Allowed
1	Configural	Same model. No parameter constraints.	None
2	Weak	1 + all loadings constrained to be equal between groups (but can vary within a group). Latent (co)variances allowed to vary between groups.	Latent (co)variances [weak evidence]
3	Strong	2 + all intercepts are constrained to be equal between groups (but can vary within a group). Latent means allowed to vary between groups.	Latent means, latent (co)variances [strong evidence]
4	Strict	3 + error variances are constrained to be the same between groups (but can vary within a group).	

Models with larger numbers are nested within the models with smaller numbers.

Beaujean (2014)

DONNEES CATEGORIELLES

CATEGORIES ET DIMENSIONS

- Analyse factorielle : MV et LV supposées continues.
- Cas des MV catégorielles ? Deux types : dichotomiques (oui/non) ou polytomiques (type Likert).
- Solution : modèle de type IRT ou CFA sur matrice de corrélation appropriée (IFA ; package R `polycor`, `psych::fa.poly`, `psych::irt.fa`), choix d'un estimateur approprié (WLSM(V)/DWLS et paramétrisation theta ; Muthén, 1993).
- Le package lavaan permet de traiter le cas des variables catégorielles et fournit des modèles à seuils (Beaujean, 2014 ; chap. 6).

ESTIMATEURS WLS

Table A.2 Robust Estimators Available in `lavaan`.

Estimator Variant	Description
	Maximum Likelihood (ML)
`MLM`	Estimation with robust standard errors and Satorra-Bentler scaled test statistic. For complete data only.
`MLMVS`	Estimation with robust standard errors and a mean- and variance-adjusted test statistic (Satterthwaite approach). For complete data only.
`MLMV`	Estimation with robust standard errors and a mean- and variance-adjusted test statistic (scale-shifted approach). For complete data only.
`MLF`	Estimation with standard errors based on the first-order derivatives and a conventional test statistic. For both complete and incomplete data.
`MLR`	Estimation with robust (Huber-White) standard errors and a scaled test statistic that is asymptotically equal to the Yuan-Bentler test statistic. For both complete and incomplete data.
	Least-Squares (DWLS/ULS)
`WLSM`[a,b]	Weighted least squares estimation with robust standard errors and a mean-adjusted test statistic. For complete data only.
`WLSMVS`[a,b]	Weighted least squares estimation with robust standard errors and a mean- and variance-adjusted test statistic (Satterthwaite approach). For complete data only.
`WLSMV`[a,b]	Weighted least squares estimation with robust standard errors and a mean- and variance-adjusted test statistic (scale-shifted approach). For complete data only.
`ULSM`	Unweighted least squares estimation with robust standard errors and a mean-adjusted test statistic. For complete data only.
`ULSMVS`	Unweighted least squares estimation with robust standard errors and a mean- and variance-adjusted test statistic (Satterthwaite approach). For complete data only.
`ULSMV`	Unweighted least squares estimation with robust standard errors and a mean- and variance-adjusted test statistic (scale-shifted approach). For complete data only.

[a] For the robust weighted least squares variants (WLSM, WLSMVS, WLSMV), `lavaan` uses the diagonal of the weight matrix for estimation, but uses the full weight matrix to correct the standard errors and to compute the test statistic.
[b] As of version 05.15 in `lavaan`, categorical data can have missing data using `missing="pairwise"` argument.

Mplus, lavaan
(≠ EQS, Stata)

Beaujean (2014)

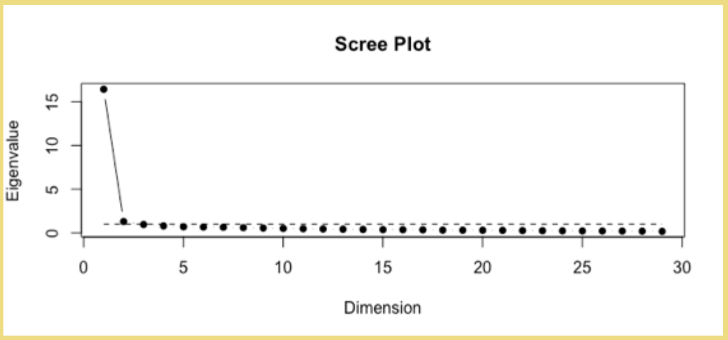
http://lavaan.ugent.be/tutorial/est.html

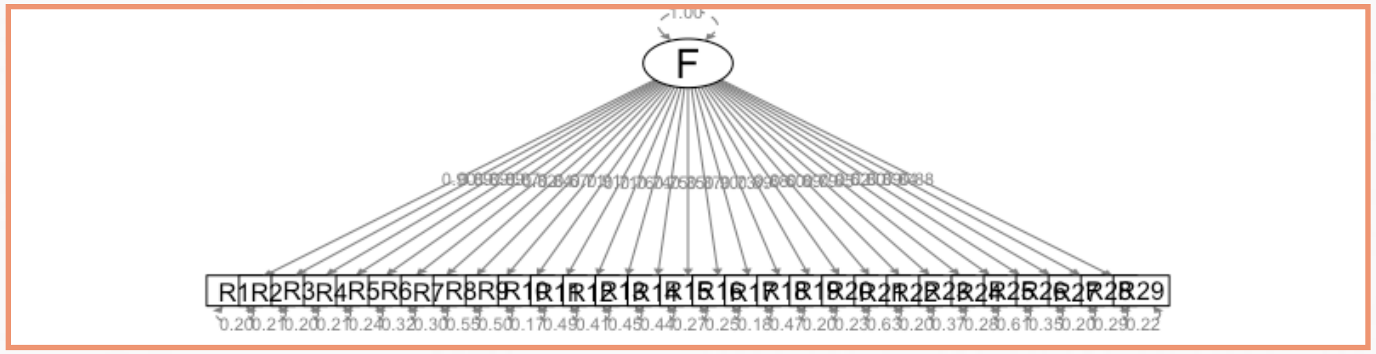
Choi et al. (2011) ; Pilkonis et al. (2011)

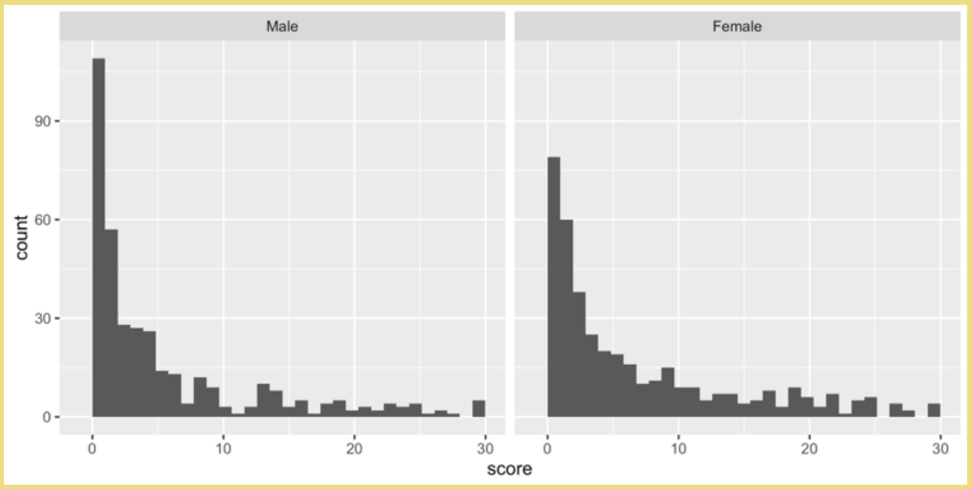
1. I felt fearful
2. I felt frightened
3. It scared me when I felt nervous
4. I felt anxious
5. I felt like I needed help for my anxiety
6. I was concerned about my mental health
7. I felt upset
8. I had a racing or pounding heart
9. I was anxious if my normal routine was disturbed
10. I had sudden feelings of panic
11. I was easily startled
12. I had trouble paying attention
13. I avoided public places or activities
14. I felt fidgety
15. I felt something awful would happen
16. I felt worried
17. I felt terrified
18. I worried about other people's reactions to me
19. I found it hard to focus on anything other than my anxiety
20. My worries overwhelmed me
21. I had twitching or trembling muscles
22. I felt nervous
23. I felt indecisive
24. Many situations made me worry
25. I had difficulty sleeping
26. I had trouble relaxing
27. I felt uneasy
28. I felt tense
29. I had difficulty calming down

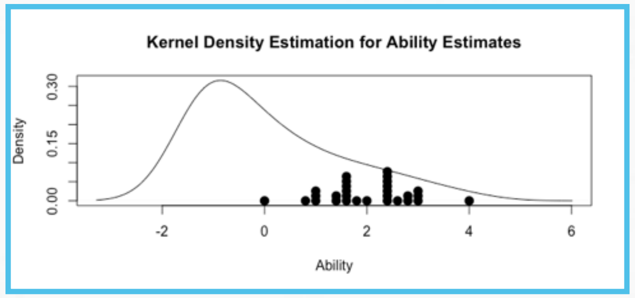
1 ='Never', 2 ='Rarely', 3 ='Sometimes', 4 ='Often', 5 ='Always'

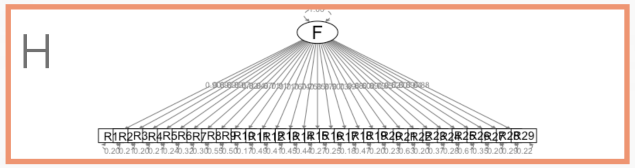
PEUT-ON METTRE EN EVIDENCE UNE DIFFERENCE DE SCORES ENTRE LES HOMMES ET LES FEMMES ?

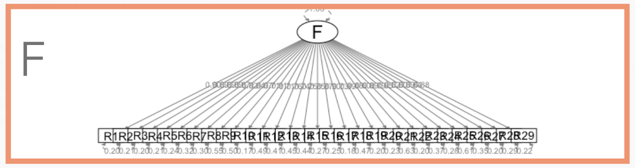












anxiety.R

References

1. Pilkonis, P., Choi, S., Reise, S., Stover, A. and Riley, W. et al. Item banks for mea- suring emotional distress from the patient-reported outcomes measurement information system (PROMIS): Depression, anxiety, and anger. *Assessment*, 18(3): 263–283, 2011.
2. Choi, S., Gibbons, L. and Crane, P. (2011). lordif: An R package for detecting differential item functioning using iterative hybrid ordinal logistic regression/Item Response Theory and monte carlo simulations. *Journal of Statistical Software*, 39(8), 2011.
3. Beaujean, A.A. *Latent Variable Modeling Using R, A Step-by-Step Guide*. New York: Routledge, 2014.
4. Muthén, B.O. Goodness of fit with categorical and other nonnormal variables. In K.A. Bollen, & J.S. Long (eds.), *Testing structural equation Models* (pp. 205-234). Newbury Park, CA: Sage, 1993.