UNIVERSITEIT GENT
FACULTEIT PSYCHOLOGIE EN PEDAGOGISCHE WETENSCHAPPEN

SRM: Implementation in lavaan

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I. Background information

1. Sample descriptives

- 57 families (consisting of two parents and two children)
- Inclusion criteria:
  - Two adults that live together & in the parent role
  - Two children going to school and living with these parents
    - One in the adolescence (between 11 and 18)
    - The other minimum 11 and maximum 25 years old
- Parents
  - 82% two biological parents, 18% reconstituted families
- Children
  - Between 11 and 25 years old (youngest child: M = 14.26, SD=0.24; oldest child: M = 16.25, SD = 0.32), 60% male

2. Effectance measured with SRM

- Interpersonal Sense of Control (ISOC; Cook, 1993)
  - Effectance scale
- Possible sources of dysfunctional interpersonal influence
  - Family effect
  - Actor effect (perceiver effect)
  - Partner effect (target effect)
  - Relationship effect

! Not unidirectional

Cook (1994): A SEM of dyadic relationships within the family system

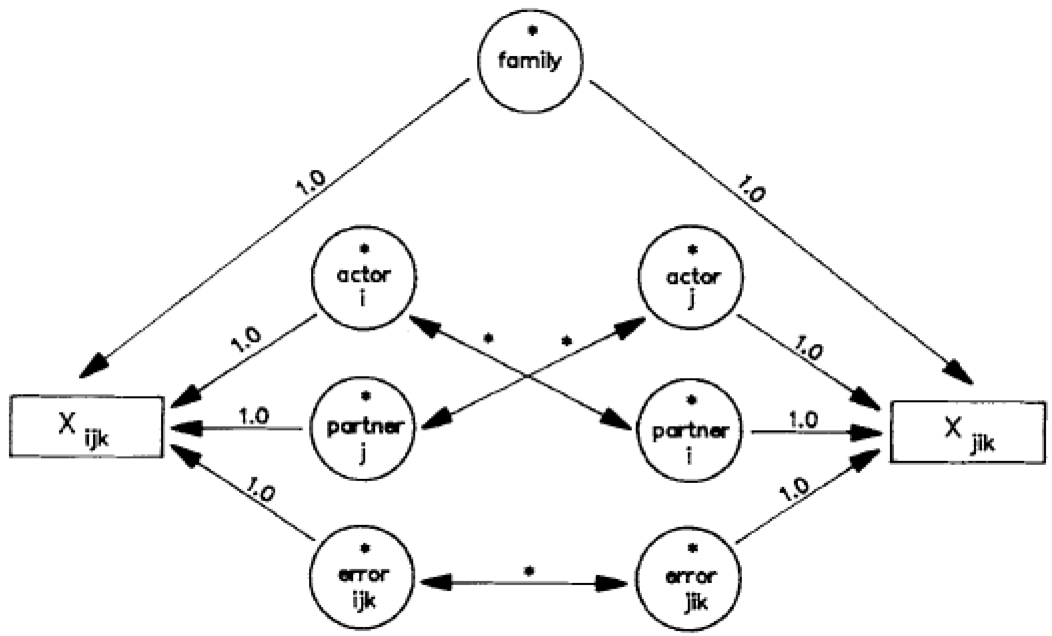


Figure 1. Components of the Social Relations Model. Parameters to be estimated are indicated by an asterisk. Fixed parameters are indicated by a 1.0. Boxes indicate the observed relationship measures, X_{ijk} (a measure of person *i*'s behavior in relation to person *j* on occasion *k*) and X_{jik} (a measure of person *j*'s behavior in relation to person *i* on occasion *k*). Circles indicate latent variables (i.e., factors). Single-headed arrows indicate the observed variable predicted by the source of variance. Double-headed arrows indicate reciprocity correlations.

One measure of the observed variable → relationship effect is part of the error-variance

Cook (1994): A SEM of dyadic relationships within the family system

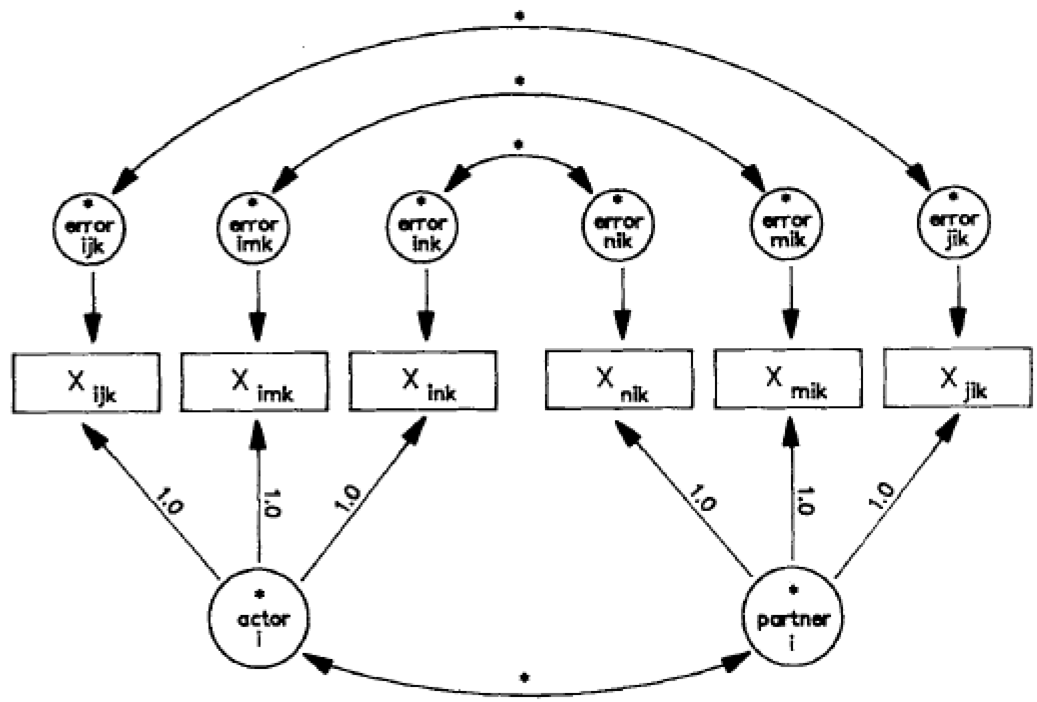


Figure 2. Measurement model for actor and partner effects. Parameters to be estimated are indicated by an asterisk. Fixed parameters are indicated by a 1.0. Boxes indicate observed relationship measures. Circles indicate latent variables (i.e., factors). The three boxes on the left represent the relationships of person *i* (as actor) with persons *j*, *m*, and *n* (as partners), respectively, on occasion *k*. The three boxes on the right represent the relationships of persons *n*, *m*, and *j* (as actors) with person *i* (as partner) on occasion *k*. Single-headed arrows indicate the observed variable predicted by the source of variance. Double-headed arrow at the bottom of the diagram indicates actor–partner reciprocity correlation for person *i*, and double-headed arrows at the top indicate dyadic reciprocity correlations.

II. SRM implementation in lavaan

A. Model specification

- **Step 1**: Open R (or R-studio) and install lavaan
- **Step 2**: Read in your data
  - **Preferable**: a logic order of DV's:
    - E.g. Primary sorted by actor effects (with corresponding partners)

      MF, MC1, MC2, FM, FC1, FC2, C1M, C1F, C1C2, C2M, C2F, C2C1

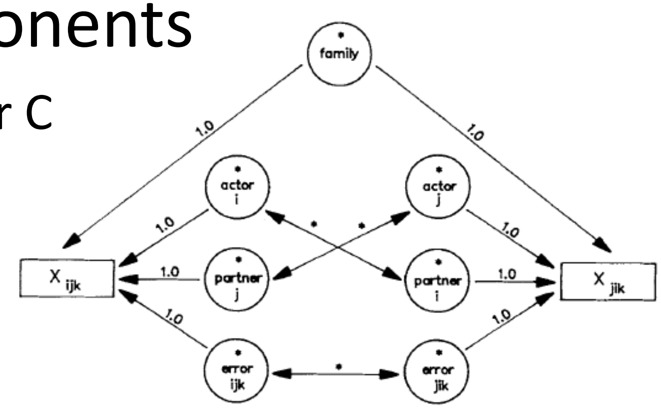
```r
# Step 1: install Lavaan
  install.packages("lavaan", dependencies=TRUE)
  library("lavaan")

# Step 2: read in the data
  setwd("H:/home/Doctoraat/Databestanden")
  Eff <- read.csv("workshop.csv")

```

- **Step 3:** Specify the SRM model
  - SRM components are independent latent variables in a CFA (Cook, 1994)

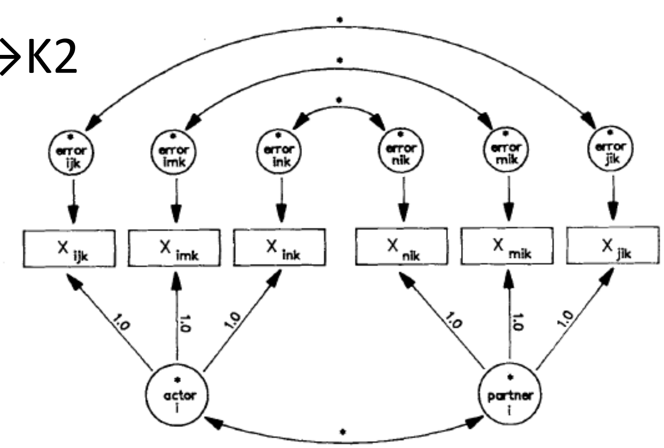
➔ ***Step 3a***: The observed measures are forced to load on corresponding SRM components (factorloadings usually fixed to 1)

Goal: how many variance in DV is explained by each of the components?

- **<u>Difference EQS and lavaan</u>**
  - <u>EQS</u> : Variance of observed measure is partitioned into corresponding SRM components
    - E.g.: M→C = family + actor M + partner C + M-C relationship



  - <u>lavaan</u>: specify latent variable with all corresponding observed measures
    - E.g.: Actor Mother = M→V + M→K1 + M→K2



Specification of SRM components
depends on sequence of variables

Legend:
M = mother
V = father
K1 = oldest child
K2 = youngest child
Eff = effectance

Our sequence of variables:
- EffMV
- EffMK1
- EffMK2
- EffVM
- EffVK1
- EffVK2
- EffK1M
- EffK1V
- EffK1K2
- EffK2M
- EffK2V
- EffK2K1

Our sequence of SRM components:
- Factor 1 = family effect
- Factor 2 = actor mother
- Factor 3 = actor father
- Factor 4 = actor oldest child
- Factor 5 = actor youngest child
- Factor 6 = partner father
- Factor 7 = partner oldest child
- Factor 8 = partner youngest child
- Factor 9 = partner mother

Specification of the **model** in lavaan

```
# Step 3: specify the SRM model
  SRM <- '
  family.effect =~ 1*effMV  + 1*effMK1 + 1*effMK2  +
                   1*effVM  + 1*effVK1 + 1*effVK2  +
                   1*effK1M + 1*effK1V + 1*effK1K2 +
                   1*effK2M + 1*effK2V + 1*effK2K1
  actor.M     =~   1*effMV  + 1*effMK1 + 1*effMK2
  actor.V     =~   1*effVM  + 1*effVK1 + 1*effVK2
  actor.K1    =~   1*effK1M + 1*effK1V + 1*effK1K2
  actor.K2    =~   1*effK2M + 1*effK2V + 1*effK2K1
  partner.V   =~   1*effMV  + 1*effK1V + 1*effK2V
  partner.K1 =~    1*effMK1 + 1*effVK1 + 1*effK2K1
  partner.K2 =~    1*effMK2 + 1*effVK2 + 1*effK1K2
  partner.M   =~   1*effVM  + 1*effK1M + 1*effK2M
```

Legend:

M = mother
F = father
K1 = oldest child
K2 = youngest child

Step 3b: Reciprocities

Specify covariances:

At the individual level of analysis

- actor.M ~~ partner.M
- actor.V ~~ partner.V
- actor.K1 ~~ partner.K1
- actor.K2 ~~ partner.K2

At the dyadic level of analysis

- effMV ~~ effVM
- effMK1 ~~ effK1M
- effMK2 ~~ effK2M
- effVK1 ~~ effK1V
- effVK2 ~~ effK2V
- effK1K2 ~~ effK2K1

Optional: Intragenerational similarity correlations

- actor.M ~~ actor.V
- actor.K1 ~~ actor.K2
- partner.M ~~ partner.V
- partner.K1 ~~ partner.K2

Legend:
M = mother
V = father
K1 = oldest child
K2 = youngest child
Eff = effectance

F1 = family effect
F2 = actor M
F3 = actor V
F4 = actor K1
F5 = actor K2
F6 = partner V
F7 = partner K1
F8 = partner K2
F9 = partner M

Step 4: fit the model with the data

```
SRM <- '
family.effect =~ 1*effMV  + 1*effMK1 + 1*effMK2  +
                 1*effVM  + 1*effVK1 + 1*effVK2  +
                 1*effK1M + 1*effK1V + 1*effK1K2 +
                 1*effK2M + 1*effK2V + 1*effK2K1
actor.M    =~    1*effMV  + 1*effMK1 + 1*effMK2
actor.V    =~    1*effVM  + 1*effVK1 + 1*effVK2
actor.K1   =~    1*effK1M + 1*effK1V + 1*effK1K2
actor.K2   =~    1*effK2M + 1*effK2V + 1*effK2K1
partner.V  =~    1*effMV  + 1*effK1V + 1*effK2V
partner.K1 =~    1*effMK1 + 1*effVK1 + 1*effK2K1
partner.K2 =~    1*effMK2 + 1*effVK2 + 1*effK1K2
partner.M  =~    1*effVM  + 1*effK1M + 1*effK2M

# RECIPROCITIES #
 # At the individual level of analysis
 actor.M  ~~ partner.M
 actor.V  ~~ partner.V
 actor.K1 ~~ partner.K1
 actor.K2 ~~ partner.K2

 # At the dyadic level of analysis
 effMV   ~~ effVM
 effMK1  ~~ effK1M
 effMK2  ~~ effK2M
 effVK1  ~~ effK1V
 effVK2  ~~ effK2V
 effK1K2 ~~ effK2K1  '
```

fit <- lavaan(SRM, data=Eff, mimic="EQS", auto.var=TRUE) *=> fit model with data*

summary(fit,fit.measures=T) *=> summary about the f*

B. Output

Step 1:

Does your model fit the data?

lavaan (0.5-10) converged normally after 45 iterations	
Number of observations	57
Estimator	ML
Minimum Function Chi-square	44.790
Degrees of freedom	47
P-value	**0.565**
Chi-square test baseline model:	
Minimum Function Chi-square	281.560
Degrees of freedom	66
P-value	0.000
Full model versus baseline model:	
Comparative Fit Index (CFI)	1.000
Tucker-Lewis Index (TLI)	1.014
Loglikelihood and Information Criteria:	
Loglikelihood user model (H0)	-801.824
Loglikelihood unrestricted model (H1)	-779/029
Number of free parameters	31
Akaike (AIC)	1665.647
Bayesian (BIC)	1728.982
Sample-size adjusted Bayesian (BIC)	1631.531
Root Mean Square Error of Approximation:	
RMSEA	0.000
90 Percent Confidence Interval	0.000 0.080
P-value RMSEA <= 0.05	0.786
Standardized Root Mean Square Residual:	
SRMR	0.096
Parameter estimates:	
Information	Expected
Standard Errors	Standard

χ^2:

Does the model differ significantly from the data?

- P-value needs to be > .05
- (influenced by the samplesize)

CFI:

- Sufficiently if >.90, though recommended for SRM >.95 (Cook,1994)

RMSEA:

- The closer to zero the better
- Kenny (2011):
  - 0.01 = excellent fit
  - 0.04 = good fit
  - 0.08 = moderate fit

A bad fit?

- Modification indices

```
MI <- modindices(fit)
sortedModInd <- MI[order(-MI$mi),] ; sortedModInd[1:10,]
```

	lhs	op	rhs	mi	epc	sepc.lv	sepc.all	sepc.nox
1	effMK2	~~	effK1K2	6.126	-0.179	-0.179	-0.190	-0.190
2	partner.K2	=~	effVK2	5.983	1.282	0.477	0.604	0.604
3	actor.V	~~	partner.M	5.800	-0.117	-1.071	-1.071	-1.071
4	family.effect	=~	effVK2	5.294	2.839	0.477	0.604	0.604
5	effK2V	~~	effK2K1	4.809	-0.222	-0.222	-0.220	-0.220
6	actor.K2	=~	effK2M	4.295	0.362	0.277	0.265	0.265
7	partner.M	=~	effVK1	4.158	-2.501	-0.437	-0.552	-0.552
8	effK2M	~~	effK2V	3.882	0.208	0.208	0.219	0.219
9	actor.K2	=~	effK2K1	3.742	-0.347	-0.265	-0.239	-0.239
10	family.effect	~~	partner.K2	3.701	0.069	1.101	1.101	1.101

Which modifications?

Possible hierarchy:

1. Negative variances?

   => fix corresponding correlations to zero

2. Theoretically fundated

   (e.g. intragenerational similarities,…)

3. Set factor free in DV (i.e. not fix to 1)

   - Interpret in the output (i.e. smaller or larger than 1?)

4. Let two factors correlate without theoretical fundation

   - Interpret - with caution - the output

Step 2: Parameter estimation

Variances:

	Estimate	Std.err	Z-value	P(>|z|)
family.effect	0.028	0.043	0.656	0.512
actor.M	0.411	0.105	3.903	0.000
actor.V	0.388	0.096	4.057	0.000
actor.K1	0.451	0.120	3.757	0.000
actor.K2	0.586	0.141	4.167	0.000
partner.V	0.006	0.041	0.143	0.886
partner.K1	0.061	0.038	1.588	0.112
partner.K2	0.138	0.048	2.855	0.004
partner.M	0.030	0.047	0.650	0.516
effMV	0.480	0.119	4.024	0.000
effMK1	0.190	0.071	2.658	0.008
effMK2	0.255	0.083	3.066	0.002
effVM	0.415	0.107	3.897	0.000
effVK1	0.149	0.060	2.506	0.012
effVK2	0.068	0.054	1.259	0.208
effK1M	0.457	0.124	3.692	0.000
effK1V	0.377	0.110	3.428	0.001
effK1K2	0.448	0.128	3.508	0.000
effK2M	0.446	0.120	3.711	0.000
effK2V	0.212	0.086	2.467	0.014
effK2K1	0.555	0.139	3.977	0.000

Variance estimates and corresponding standard errors
=> When variances are negative fix them to zero!

Variance is positive
➔ one-sided testing (lavaan shows two sided p-values)
- significant: $Z > 1.65$, $p < .05$
- marginally significant: $Z > 1.29$, $p < .10$

- Significant variance

  = significant source of variance in <u>each</u> observed measure that loads on this factor.

- parameterEstimates(fit)
  - Gives the estimate of each SRM component

```
> parameterEstimates(fit)
              lhs op             rhs   est    se     z pvalue ci.lower ci.upper
1   family.effect =~          effMV 1.000 0.000    NA     NA    1.000    1.000
2   family.effect =~         effMK1 1.000 0.000    NA     NA    1.000    1.000

59 family.effect ~~ family.effect 0.028 0.043 0.656  0.512   -0.056    0.113
60       actor.M ~~        actor.M 0.411 0.105 3.903  0.000    0.204    0.617
61       actor.V ~~        actor.V 0.388 0.096 4.057  0.000    0.201    0.576
```

Interpretation:

Lecture Prof. Dr. W.L. Cook

Step 3: Reciprocities

Covariances:	Estimate	Std.err	Z-value	P(>|z|)
actor.M ~~				
partner.M	0.017	0.048	0.363	0.717
actor.V ~~				
partner.V	0.034	0.043	0.785	0.432
actor.K1 ~~				
partner.K1	0.030	0.048	0.619	0.536
actor.K2 ~~				
partner.K2	0.033	0.058	0.565	0.572
effMV ~~				
effVM	-0.061	0.076	-0.802	0.423
effMK1 ~~				
effK1M	0.073	0.066	1.110	0.267
effMK2 ~~				
effK2M	-0.078	0.069	-1.129	0.259
effVK1 ~~				
effK1V	-0.064	0.055	-1.167	0.243
effVK2 ~~				
effK2V	-0.041	0.045	-0.897	0.370
effK1K2 ~~				
effK2K1	0.201	0.098	2.051	0.040

In order to interpret: **both** corresponding factors need to be significant (cfr. Step 2)!

Interpretation:
Lecture Prof. Dr. W.L. Cook