APIM_SEM: Estimating the APIM in a Free Online Shiny App

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In collaboration with:
Prof. Tom Loeys and Prof. Axel Mayer

Outline

Apps for standard (and complex) APIMs

APIM_SEM: Demo

Two apps for standard (and complex) APIMs

- Different underlying statistical model
  - APIM_SEM: Structural Equation Modeling
  - APIM_MM: Multilevel Modeling
- Identical results
- Minor differences:
  - APIM_SEM:
    - FIML in case of missingness
    - Correction for unreliability
  - APIM_MM
    - Test of Actor-Partner interaction
    - More in depth test of distinguishability

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Two apps for standard (and complex) APIMs:

- APIM_SEM (Stas, Kenny, Mayer & Loeys, 2017)

  http://datapp.ugent.be/shiny/apim_sem/

- APIM_MM (Kenny, 2017)

  https://davidakenny.shinyapps.io/APIM_MM/

Outline

Apps for standard (and complex) APIMs
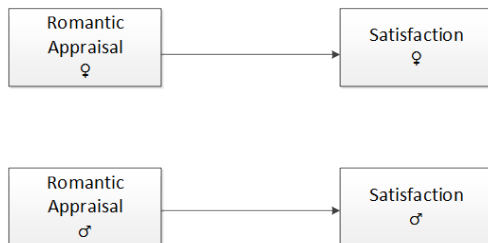
APIM_SEM: Demo

Data of study of Acitelli (1997, 2013) as illustration

- Longitudinal couple data
- Effect of romantic appraisal on satisfaction?

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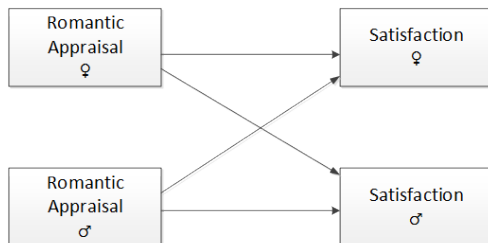
http://datapp.ugent.be/shiny/apim_sem/

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Actor Partner Interdependence Model
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Data (*)
Load Example Data

Select Data

Variables

Additional

[choose example data ▼]

Run
Analysis

Use Your Own Data File (**)
Select file extension:

Download
Output

○ Text file (.txt)
○ CSV file (.csv)
○ SPSS file (.sav)
○ SAS XPORT file (*.xpt)

Reset
If you want to delete all input and output
please click this button:

[Reset]
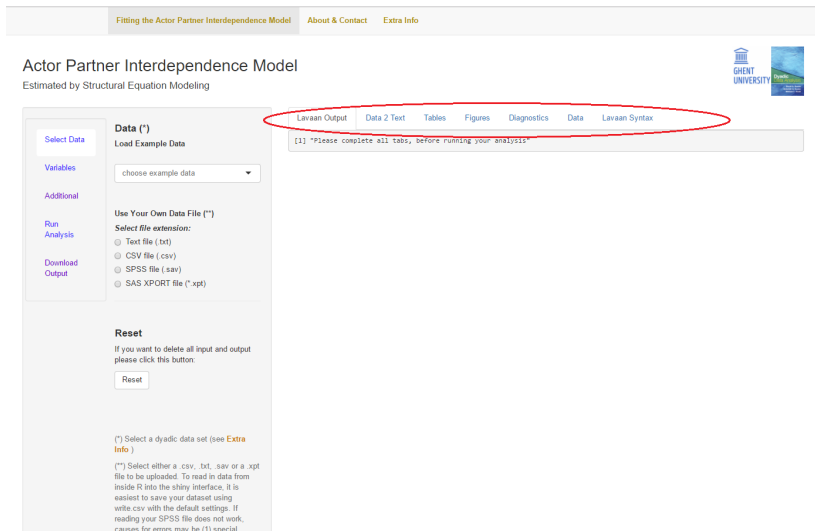
(*) Select a dyadic data set (see **Extra
Info**)

(**) Select either a .csv, .txt, .sav or a .xpt
file to be uploaded. To read in data from
inside R into the shiny interface, it is
easiest to save your dataset using
write.csv with the default settings. If
reading your SPSS file does not work,
causes for errors may be (1) special

Lavaan Output | Data 2 Text | Tables | Figures | Diagnostics | Data | Lavaan Syntax

[1] "Please complete all tabs, before running your analysis"

Layout: Three main pages

Layout: Three main pages

Layout: Three main pages

Layout: Three main pages

Layout: Input tabs

Layout: Output tabs

Fit Basic APIM: Input

Fit Basic APIM: Input

Fit Basic APIM: Input

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Select Data

Variables

Additional

Run Analysis

Download Output

Please select the correct variable
You can view your data in the tab Data

Independent variable

First role:

RA1_F

Second role:

RA1_M

☐ Include 2nd independent variable

Dependent variable

First role:

Sat2_F

Second role:

Sat2_M

Do you want to include covariates?
☐ Yes

For text output, please provide the label of ..

Distinguishable Variable (*)

Gender

| Lavaan Output | Data 2 Text | Tables | Figures | Diagnostics | Data | Lavaan Syntax |

[1] "Please complete all tabs, before running your analysis"

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Fit Basic APIM: Input

Roles:

label first role singular

Woman

label first role plural

Women

label second role singular

Man

label second role plural

Men

Independent Variable

Romantic Appraisal

Dependent Variable

Satisfaction Wave 2

(*) This is only applicable for analyses with distinguishable dyads. If you want an indistinguishable run, please leave this box empty.

Fit Basic APIM: Input

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Select Data

Variables

Additional

Run
Analysis

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Start a New Analysis

Run!

Note: When you requested regular
bootstraps, it may take a few minutes
before the output appears.

Lavaan Output   Data 2 Text   Tables   Figures   Diagnostics   Data   Lavaan Syntax

[1] "Please complete all tabs, before running your analysis"

Output: lavaan output

Actor Partner Interdependence Model
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Start a New Analysis

Run!

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Select Data

Variables

Additional

Run
Analysis

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Output

```
                APIM: Distinguishable Dyads Using lavaan
                ***************************************

Note: xv1 = RA1_F, xv2 = RA1_M, yv1 = Sat2_F and yv2 = Sat2_M


Standard Model
**************

lavaan (0.5-20) converged normally after  32 iterations

  Number of observations                           158

  Number of missing patterns                         5

  Estimator                                         ML
  Minimum Function Test Statistic                0.000
  Degrees of freedom                                 0

Parameter Estimates:

  Information                                 Observed
  Standard Errors                             Standard

Regressions:
                   Estimate  Std.Err  Z-value  P(>|z|)
  yv1 ~
    xv1      (a1)     0.236    0.079    2.986    0.003
  yv2 ~
    xv2      (a2)     0.152    0.059    2.580    0.010
  yv1 ~
    xv2     (p12)     0.047    0.076    0.620    0.535
  yv2 ~
    xv1     (p21)     0.155    0.064    2.416    0.016


Covariances:
                   Estimate  Std.Err  Z-value  P(>|z|)
  xv1 ~~
    xv2      (cx)    -0.027    0.028   -0.971    0.332
  yv1 ~~
    yv2      (cy)     0.109    0.024    4.561    0.000

Intercepts:
                   Estimate  Std.Err  Z-value  P(>|z|)
```

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Output: lavaan output

		Estimate	Std.Err	Z-value	P(>|z|)
xv1	(mx1)	-0.040	0.046	-0.868	0.385
xv2	(mx2)	0.158	0.049	3.251	0.001
yv1	(my1)	3.624	0.047	76.377	0.000
yv2	(my2)	3.695	0.037	100.070	0.000

Variances:

		Estimate	Std.Err	Z-value	P(>|z|)
xv1	(vx1)	0.335	0.038	8.862	0.000
xv2	(vx2)	0.368	0.042	8.835	0.000
yv1	(vy1)	0.329	0.038	8.605	0.000
yv2	(vy2)	0.193	0.022	8.661	0.000

Defined Parameters:

	Estimate	Std.Err	Z-value	P(>|z|)
a_diff	0.085	0.097	0.872	0.383
p_diff	-0.108	0.098	-1.098	0.272
k1	0.200	0.324	0.616	0.538
k2	1.020	0.560	1.821	0.069
k_diff	-0.820	0.733	-1.119	0.263
i_diff	-0.071	0.046	-1.547	0.122
a_ave	0.194	0.050	3.875	0.000
p_ave	0.101	0.051	1.998	0.046
i_ave	3.659	0.036	102.514	0.000
sum1	0.142	0.057	2.489	0.013
sum2	0.153	0.045	3.420	0.001
cont1	0.189	0.106	1.791	0.073
cont2	-0.003	0.084	-0.036	0.971

Output: Text output

Actor Partner Interdependence Model
Estimated by Structural Equation Modeling

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Lavaan Output | **Data 2 Text** | Tables | Figures | Diagnostics | Data | Lavaan Syntax

Start a New Analysis

Run!

Note: When you requested regular bootstraps, it may take a few minutes before the output appears.

Select Data
Variables
Additional
Run Analysis
Download Output

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                    APIM: Distinguishable Dyads Using lavaan

Standard Model
==============

Introduction

        The focus of this study is the investigation of the effect of Romantic Appraisal on Satisfaction wave 2. The dyad members are treated as if they are distinguishable by the variable Gender. The two roles used are: Women and Men. Both the effect of own Romantic Appraisal (actor) and the effect of partner's Romantic Appraisal (partner) on Satisfaction wave 2 are studied. The total number of dyads (N) is 158. There are missing data for one or more of the variables: The number of cases for Women on Romantic Appraisal is 157 and on Satisfaction wave 2 156. For Men the number of cases on Romantic Appraisal is 156 and on Satisfaction wave 2 152. Residuals of the fitted model that are more extreme than 4 standard deviations (absolute value) are called outliers. Based on this data set it can be concluded that the observations of the following row(s) are more extreme than 4 standard deviations: 51, 97. These outliers can be removed from the data set in the Additional tab under the header 'Remove observations'.

Analyses

        The analyses use structural equation modeling with maximum likelihood estimation using the program lavaan. The tests of coefficients are Z tests. Effect sizes for actor and partner effects are partial correlations. Betas are given twice, one using the overall standard deviation across all persons (o) for standardization and a second using the standard deviation for Women and Men separately (s). If betas are to be compared across members, the beta (o) value should be examined. For all these analyses, alpha is set at 0.05. The descriptive statistics of the raw variables are contained in Table 1 and the FIML estimated means and standard deviations in Table 2 in the output tab "Tables". If there are no missing data, the raw and the FIML means should be the same: the FIML standard deviations differ from the raw ones by the square root of N - 1 divided by N.

Output: Text output

Results

        The lavaan model converged after 32 iterations. A summary of results of the APIM
analyses is contained in Table 3 and the overall effects in Table 4 in the output tab
'Tables'. The variance of the errors for the Women and Men are 0.329 and 0.193,
respectively. The R squared for the women is .054, for the Men it is .073. The partial
intraclass correlation for Satisfaction Wave 2 controlling for the other variables is
equal to .109 and is statistically significant (p < .001, 95% CI [0.06, 0.16]). Thus,
when one member of the dyad scores high (low) on the variable Satisfaction Wave 2, the
other member also tends to have a high (low) score.

        The intercept (the predicted score on Satisfaction Wave 2 when the variables of
Romantic Appraisal equal zero) for women is equal to 3.624 and is statistically
significant (p < .001, 95% CI [3.53, 3.72]). The intercept for Men is equal to 3.695 and
is statistically significant (p < .001, 95% CI [3.62, 3.77]). The difference in
intercepts is equal to -0.071. This difference is not statistically significant (p =
.122, 95% CI [-0.16, 0.02]), which means that there is no main effect of Gender.

        The actor effect for the Women is equal to 0.236 (p = .003, 95% CI [0.08, 0.39]).
The overall standardized effect for the women is 0.266 (partial r = .167 and a small
effect size). The actor effect for the Men is equal to 0.152 (p = .010, 95% CI [0.04,
0.27]) and the overall standardized actor effect for the Men is 0.171 (partial r = .258
and a small effect size). When tested if the two actor effects are equal, the difference
was found not statistically significant,p = .383, 95% CI [-0.11, 0.28]. The overall
actor effect is equal to 0.194 and is statistically significant (p < .001, 95% CI [0.1,
0.29]).
        The partner effect from Men to Women is equal to 0.047, which is not statistically
significant (p = .535, 95% CI [-0.1, 0.2]), and its overall standardized effect is 0.053
(partial r = .065 less than small). The partner effect from Women to Men is equal to
0.155 and is statistically significant (p = .016, 95% CI [0.03, 0.28]) and its overall
standardized partner effect is 0.174 (partial r = .167 and a small effect size). When
tested if the two partner effects are equal, the difference was found not statistically
significant (p = .272, 95% CI [-0.3, 0.08]). The overall partner effect is equal to
0.101 is statistically significant (p = .046, 95% CI [0, 0.2]).
        Next, the relative sizes of the actor and partner effects are considered. If the
standardized actor effects of both women and Men are greater than .1 in absolute value
and they are statistically significant, k (i.e. the ratio of the partner effect to the
actor effect) can be interpreted in the output. This is the case for this data set. The
value of k for the women equals 0.2, the k of the Men is equal to 1.02. No further
conclusions can be drawn for k, because a bootstrap analysis was not chosen to calculate
the confidence intervals. By allowing the program to calculate the confidence intervals
by means of bootstrap sampling, dyadic patterns in the Actor-Partner Interdependence
Model can be detected. In particular, the program can check whether the couple model (k =
1), actor-only (k = 0) model or the contrast model (k = -1) is most plausible. This by
checking which value of k (-1, 0 1) situates in the bootstrapped confidence interval of
k. If a more complete output were desired, please specify so in the input tab
'Additional Options'. Please note that the Monte Carlo Sampling technique will be really
fast, this is the parametric bootstrapping method. The non-parametric bootstrapping
method (i.e., regular bootstraps), may take a while to calculate.

Test of Distinguishability:
        In order to test if Gender makes a statistically meaningfull difference, a model
comparison is performed between a model with distinguishable members and a model with
indistinguishabel members. This overall test of distinguishability yields a chi square
statistic with 6 degrees of freedom which equals 24.57 (p < .001). Because this test of
distinguishability is statistically significant, we conclude that members can be
statistically distinguished based on the variable Gender.

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Output: Tables and figures

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Start a New Analysis

Run!

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Lavaan Output Data 2 Text Tables Figures Diagnostics Data Lavaan Syntax

```
Table 1: Descriptive Statistics of the Raw Data
-------------------------------------------------
                   Variable  Role   Mean    SD Minimum Maximum   n
Romantic Appraisal Women  -0.041 0.581  -2.000   1.200 157
                   Men     0.159 0.609  -3.200   1.400 156
Satisfaction Wave 2 Women  3.631 0.584   1.500   4.000 156
                   Men     3.719 0.453   1.750   4.000 152


Table 2: FIML means and standard deviations
-------------------------------------------------
                   Variable  Role   Mean    SD
Romantic Appraisal Women  -0.040 0.579
                   Men     0.158 0.607
Satisfaction Wave 2 Women  3.622 0.590
                   Men     3.713 0.456


Table 3: APIM Results Assuming Different Actor and Partner effects for both roles
-------------------------------------------------------------------------------------
Effect  Role Estimate  Lower 95% CI Upper p value Beta (α) Beta (s)    r
Intercept Women 3.624 3.531   to  3.717 <.001
Actor         0.236 0.081   to  0.392  .003  0.187  0.232 0.167
Partner       0.047 -0.102  to  0.197  .535  0.053  0.049 0.065
Intercept Men  3.695 3.623   to  3.767 <.001
Actor         0.152 0.037   to  0.267  .010  0.171  0.202 0.258
Partner       0.155 0.029   to  0.280  .016  0.174  0.196 0.167


Table 4: APIM Results Assuming Same Actor and Partner effects for both roles
-------------------------------------------------------------------------------------
Effect  Estimate  Lower 95% CI Upper p value
Intercept 3.650 3.582   to  3.718 <.001
Actor     0.202 0.105   to  0.300 <.001
Partner   0.092 -0.007  to  0.191  .070
```

Output: Tables and figures

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Graphical Presentation of the Fitted Model

Reactive Figures

The two figures presented below reflect all variables included in the model, also all covariates. If not all estimates are presented clearly, please try to diminish (or enlarge) the size of your browser. The figure will automatically adapt.

Positive estimates are indicated with green arrows, negative estimates with red arrows. The stronger the effect, the thicker the line of the arrow will be. The double headed arrow between "Romantic Appraisal Man" and "Romantic Appraisal Woman" represents its covariance. The double headed arrow between "Satisfaction Wave 2 Woman" and "Satisfaction Wave 2 Man" is the residual nonindependence in these outcome scores, which is represented by the covariance between their corresponding two errorterms.

Standard model:

Start a New Analysis	
Run!	

Note: When you requested regular bootstraps, it may take a few minutes before the output appears.

Select Data

Variables

Additional

Run Analysis

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Romantic Appraisal Man — 0.15 → Satisfaction Wave 2 Man

-0.03

0.05

0.15

0.11

Romantic Appraisal Woman — 0.24 → Satisfaction Wave 2 Woman

Model with standardized parameter estimates:

Romantic Appraisal Man — 0.20 → Satisfaction Wave 2 Man

Output: Tables and figures

The two plots below are identical to the ones above, but only show the basic APIM. Covariates and other requested parameters are still estimated, but for simplicity only the estimates of the actor and partner effects are presented, together with the residual nonindependence in the outcome scores. In particular, the estimates, standard error and level of significance are shown.

Standard model:

* p < .05; ** p < .01; *** p < .001

Model with standardized parameter estimates:

* p < .05; ** p < .01; *** p < .001

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Output: Diagnostics

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Start a New Analysis

Run!

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Check Normality and Outliers

In order to check the normality of the residuals, one can consult the following three plots.

Guidelines for interpretation:

- The density function of the residuals ideally looks bell-shaped.

- The boxplot should look symmetric around zero with limited number of outliers (or none at all).

- For the QQ-Plot, the dots should be situated on or close to the straight line.

Density function of residuals
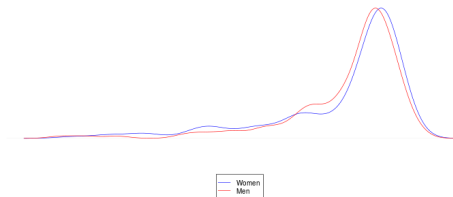
Women
Men

Boxplot Women

Boxplot Men

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Output: Diagnostics

QQ plot Women — **QQ plot Men**
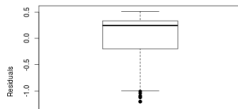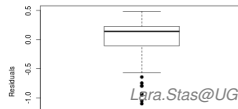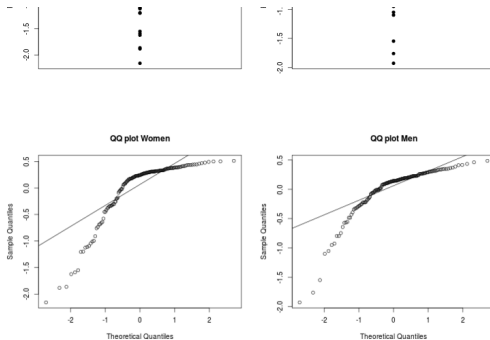
Effects in Raw Data

The following plots are an exploration of actor (partner) effects, ignoring partner (actor) effects and the effects of plausible covariates. Stricto sensu, these effects are no real actor (partner) effects since they do not take into account partner (actor) effects. These plots are solely meant for data exploration.

When one is interested in the estimated actor and partner effects of the fitted model, please consult the tab *Figures* .

Semi-actor effects — **Semi-partner effects**
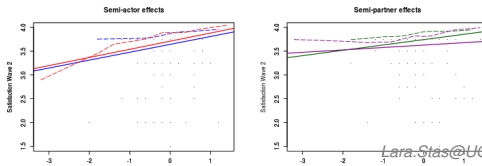
Download complete output

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Select Data	**Download the complete output**
Variables	After running your analysis you can download the complete output to your own computer.
Additional	Please note this may take a few minutes
Run Analysis	Please select the desired output format:
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Download the complete output

After running your analysis you can download the complete output to your own computer.

Please note this may take a few minutes

Please select the desired output format:
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⬇ Download

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Additional options

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Select Data

Variables

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Significance level
The level of alpha is set to ...

0,05

Center Variables
Do you want to center the predictor(s) on the mean?
☐ Yes

Do you want to center the covariates, if present?
☐ Yes

Missing data
How do you want to treat missing data?

◉ Full Information Maximum Likelihood (FIML)
○ Listwise deletion

Correct for Unreliability
Do you want to run a model correcting for unreliability?
☐ Yes

Lavaan Output　　Data 2 Text　　Tables　　Figures　　Diagnostics　　Data　　Lavaan Syntax

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APIM: Distinguishable Dyads Using lavaan

Standard Model
===============

Introduction

The focus of this study is the investigation of the effect of Romantic Appraisal on Satisfaction wave 2. The dyad members are treated as if they are distinguishable by the variable gender. The two roles used are: women and Men. Both the effect of own Romantic Appraisal (actor) and the effect of partner's Romantic Appraisal (partner) on Satisfaction wave 2 are studied. The total number of dyads (y) is 158. There are missing data for one or more of the variables: The number of cases for Women on Romantic Appraisal is 157 and on Satisfaction wave 2 156. For Men the number of cases on Romantic Appraisal is 156 and on Satisfaction wave 2 152. Residuals of the fitted model that are more extreme than 4 standard deviations (absolute value) are called outliers. Based on this data set it can be concluded that the observations of the following row(s) are more extreme than 4 standard deviations: 51, 97. These outliers can be removed from the data set in the Additional tab under the header 'Remove observations'.

Analyses

The analyses use structural equation modeling with maximum likelihood estimation using the program lavaan. The tests of coefficients are Z tests. Effect sizes for actor and partner effects are partial correlations. Betas are given twice, one using the overall standard deviation across all persons (o) for standardization and a second using the standard deviation for women and men separately (s). If betas are to be compared across members, the beta (o) value should be examined. For all these analyses, alpha is set at 0.06. The descriptive statistics of the raw variables are contained in Table 1 and the FIML estimated means and standard deviations in Table 2 in the output tab 'Tables'. If there are no missing data, the raw and the FIML means should be the same: The FIML standard deviations differ from the raw ones by the square root of N - 1 divided by N.

Additional options

Calculating k (*)

Do you want to bootstrap the CI('s) of the k('s)? (**)

☐ Yes

Outliers

Observations more extreme than ... standard deviations are called outliers

```
4
```

Remove observations

Enter the observations (i.e. rows) that you want to delete from the dataset (separated by a comma)

```

```

(*) For more info on k, please consult the tab **Extra info**

(**) If no bootstrap trials are allowed, no conclusion can be drawn which model suits this dataset the best (actor-only, couple or contrast model).

Results

        The lavaan model converged after 32 iterations. A summary of results of the APIM
analyses is contained in Table 3 and the overall effects in Table 4 in the output tab
'Tables'. The variance of the errors for the Women and Men are 0.329 and 0.193,
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equal to .109 and is statistically significant (p < .001, 95% CI [0.06, 0.16]). Thus,
when one member of the dyad scores high (low) on the variable Satisfaction wave 2, the
other member also tends to have a high (low) score.

        The intercept (the predicted score on Satisfaction wave 2 when the variables of
Romantic Appraisal equal zero) for women is equal to 3.624 and is statistically
significant (p < .001, 95% CI [3.53, 3.72]). The intercept for Men is equal to 3.695 and
is statistically significant (p < .001, 95% CI [3.62, 3.77]). The difference in
intercepts is equal to -0.071. This difference is not statistically significant (p =
.122, 95% CI [-0.16, 0.02]), which means that there is no main effect of Gender.

        The actor effect for the Women is equal to 0.236 (p = .003, 95% CI [0.08, 0.39]).
The overall standardized effect for the Women is 0.266 (partial r = .167 and a small
effect size). The actor effect for the Men is equal to 0.152 (p = .010, 95% CI [0.04,
0.27]) and the overall standardized actor effect for the Men is 0.171 (partial r = .258
and a small effect size). When tested if the two actor effects are equal, the difference
was found not statistically significant,p = .383, 95% CI [-0.11, 0.28]. The overall
actor effect is equal to 0.194 and is statistically significant (p < .001, 95% CI [0.1,
0.29]).

        The partner effect for Men to Women is equal to 0.047, which is not statistically
significant (p = .535, 95% CI [-0.1, 0.2]), and its overall standardized effect is 0.053
(partial r = .065 less than small). The partner effect from women to Men is equal to
0.155 and is statistically significant (p = .016, 95% CI [0.03, 0.28]) and its overall
standardized partner effect is 0.174 (partial r = .167 and a small effect size). When
tested if the two partner effects are equal, the difference was found not statistically
significant (p = .272, 95% CI [-0.3, 0.08]). The overall partner effect is equal to
0.101 is statistically significant (p = .046, 95% CI [0, 0.2]).

        Next, the relative sizes of the actor and partner effects are considered. If the
standardized actor effects of both women and Men are greater than .1 in absolute value
and they are statistically significant, k (i.e. the ratio of the partner effect to the
actor effect) can be interpreted in the output. This is the case for this data set. The
value of k for the women equals 0.2, the k of the Men is equal to 1.02. No further
conclusions can be drawn for k, because a bootstrap analysis was not chosen to calculate
the confidence intervals. By allowing the program to calculate the confidence intervals
by means of bootstrap sampling, dyadic patterns in the Actor-Partner Interdependence
Model can be detected. In particular, the program can check whether the couple model (k =
1), actor-only (k = 0) model or the contrast model (k = -1) is most plausible. This by
checking which value of k (-1, 0, 1) situates in the bootstrapped confidence interval of
k. If a more complete output were desired, please specify so in the input tab
'Additional Options'. Please note that the Monte Carlo Sampling technique will be really
fast, this is the non parametric bootstrapping method. The non-parametric bootstrapping
method (i.e., regular bootstraps), may take a while to calculate.

Fitting more complex models

Fitting more complex models

Actor Partner Interdependence Model
Estimated by Structural Equation Modeling

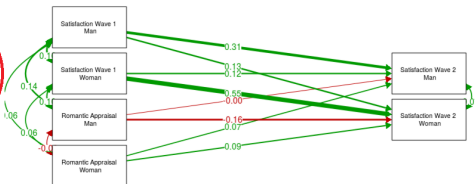Lavaan Output   Data 2 Text   Tables   Figures   Diagnostics   Data   Lavaan Syntax
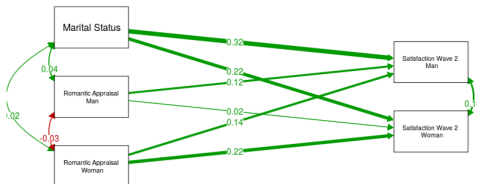
Graphical Presentation of the Fitted Model

Reactive Figures

The two figures presented below reflect all variables included in the model, also all covariates. If not all estimates are presented clearly, please try to diminish (or enlarge) the size of your browser. The figure will automatically adapt.

Positive estimates are indicated with green arrows, negative estimates with red arrows. The stronger the effect, the thicker the line of the arrow will be. The double headed arrow between "Romantic Appraisal Man" and "Romantic Appraisal Woman" represents its covariance. The double headed arrow between "Satisfaction Wave 2 Woman" and "Satisfaction Wave 2 Man" is the residual nonindependence in these outcome scores, which is represented by the covariance between their corresponding two errorterms.

Standard model:

Please select the correct variable

You can view your data in the tab Data

Independent variable

First role:

RA1_F

Second role:

RA1_M

☐ Include 2nd independent variable

Dependent variable

First role:

Sat2_F

Second role:

Sat2_M

Do you want to include covariates?

☑ Yes

☑ Between dyad covariate(s)

1st covariate:

Married

This covariate is:

○ continuous

● binary

Select reference category:

-1

Select Data
Variables
Additional
Run Analysis
Download Output

Lara.Stas@UGent.be

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