

Code of data analysis_ ACE & OA

2025-10-01

Code of data analysis for

How are Adverse Childhood Experiences Associated with Online Aggression in Adolescents? Serial Mediation from a Longitudinal Perspective

```
### CFA test for interpersonal alienation, parental warmth, cyberbullying
### and online trolling (without the 6th item)
library(lavaan)
library(foreign)

## import data
OAB <- read.spss("ACE & OA - MI.sav", to.data.frame=TRUE, use.value.labels=FALSE)
head(OAB)

## Specify the Models

modelIA <- '
  # first-order factor
  Lone1 =~ IA1.1 + IA1.5 + IA1.6R + IA1.8 + IA1.10 + IA1.11R + IA1.12
  FA1 =~ IA1.7R + IA1.13 + IA1.14 + IA1.15
  SA1 =~ IA1.2 + IA1.3 + IA1.4 + IA1.9

  # general factor
  IA1 =~ Lone1 + FA1 + SA1

  IA1.6R ~~ IA1.7R
'

modelEW <- 'EW1 =~ EW1.1 + EW1.2 + EW1.3 + EW1.4 + EW1.5 + EW1.6 + EW1.7 + EW1.8 +
  EW1.9 + EW1.10 + EW1.11 + EW1.12 + EW1.13 + EW1.14 + EW1.15 +
  EW1.16 + EW1.17'

modelCB <- 'CB1 =~ CB1.1 + CB1.2 + CB1.3 + CB1.4 + CB1.5 + CB1.6 + CB1.7 + CB1.8 + CB1.9'

modelOT <- 'OT1 =~ OT1.1 + OT1.2 + OT1.3 + OT1.4 + OT1.5 + OT1.7 + OT1.8'

## Fit the CFA Models
fitIA <- cfa(modelIA, data = OAB, estimator = "MLR", std.lv = TRUE)
summary(fitIA, fit.measures = TRUE, standardized = TRUE)
modindices(fitIA, sort = TRUE, minimum.value = 20)

fitEW <- cfa(modelEW, data = OAB, estimator = "MLR", std.lv = TRUE)
```

```

summary(fitEW, fit.measures = TRUE, standardized = TRUE)

## use ordinal data process for CB and OT (skewed variables)

fitCBor <- cfa(modelCB,
  data = OAB,
  ordered = c("CB1.1", "CB1.2", "CB1.3", "CB1.4", "CB1.5", "CB1.6", "CB1.7",
    "CB1.8", "CB1.9"),
  estimator = "WLSMV",
  std.lv = TRUE)
summary(fitCBor, fit.measures = TRUE, standardized = TRUE)

fitOTor <- cfa(modelOT,
  data = OAB,
  ordered = c("OT1.1", "OT1.2", "OT1.3", "OT1.4", "OT1.5", "OT1.7", "OT1.8"),
  estimator = "WLSMV",
  std.lv = TRUE)
summary(fitOTor, fit.measures = TRUE, standardized = TRUE)

#### Measurement Invariance Tests ####

## Defining Configural Model IA

config.IA <- '

# first-order factor

  Lone1 =~ IA1.1 + IA1.5 + IA1.6R + IA1.8 + IA1.10 + IA1.11R + IA1.12
  FA1 =~ IA1.7R + IA1.13 + IA1.14 + IA1.15
  SA1 =~ IA1.2 + IA1.3 + IA1.4 + IA1.9

  Lone2 =~ IA2.1 + IA2.5 + IA2.6R + IA2.8 + IA2.10 + IA2.11R + IA2.12
  FA2 =~ IA2.7R + IA2.13 + IA2.14 + IA2.15
  SA2 =~ IA2.2 + IA2.3 + IA2.4 + IA2.9

  Lone3 =~ IA3.1 + IA3.5 + IA3.6R + IA3.8 + IA3.10 + IA3.11R + IA3.12
  FA3 =~ IA3.7R + IA3.13 + IA3.14 + IA3.15
  SA3 =~ IA3.2 + IA3.3 + IA3.4 + IA3.9

# general factor

  IA1 =~ Lone1 + FA1 + SA1
  IA2 =~ Lone2 + FA2 + SA2
  IA3 =~ Lone3 + FA3 + SA3

# IA covariance between waves

  Lone1 ~~ Lone2 + Lone3
  Lone2 ~~ Lone3

  FA1 ~~ FA2 + FA3
  FA2 ~~ FA3

```

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SA1 ~~ SA2 + SA3
SA2 ~~ SA3

IA1 ~~ IA2 + IA3
IA2 ~~ IA3

IA1.6R ~~ IA1.7R
IA2.6R ~~ IA2.7R
IA3.6R ~~ IA3.7R

# IA covariances between items

IA1.1 ~~ IA2.1 + IA3.1
IA2.1 ~~ IA3.1

IA1.2 ~~ IA2.2 + IA3.2
IA2.2 ~~ IA3.2

IA1.3 ~~ IA2.3 + IA3.3
IA2.3 ~~ IA3.3

IA1.4 ~~ IA2.4 + IA3.4
IA2.4 ~~ IA3.4

IA1.5 ~~ IA2.5 + IA3.5
IA2.5 ~~ IA3.5

IA1.6R ~~ IA2.6R + IA3.6R
IA2.6R ~~ IA3.6R

IA1.7R ~~ IA2.7R + IA3.7R
IA2.7R ~~ IA3.7R

IA1.8 ~~ IA2.8 + IA3.8
IA2.8 ~~ IA3.8

IA1.9 ~~ IA2.9 + IA3.9
IA2.9 ~~ IA3.9

IA1.10 ~~ IA2.10 + IA3.10
IA2.10 ~~ IA3.10

IA1.11R ~~ IA2.11R + IA3.11R
IA2.11R ~~ IA3.11R

IA1.12 ~~ IA2.12 + IA3.12
IA2.12 ~~ IA3.12

IA1.13 ~~ IA2.13 + IA3.13
IA2.13 ~~ IA3.13

IA1.14 ~~ IA2.14 + IA3.14
IA2.14 ~~ IA3.14

```

```

IA1.15 ~~ IA2.15 + IA3.15
IA2.15 ~~ IA3.15

'
fit_configIA <- cfa(config.IA, data = OAB, estimator = "MLR", se = "robust",
                    missing = "FIML", std.lv = TRUE)
summary(fit_configIA, fit.measures = TRUE, standardized = TRUE)

## Defining Metric Model IA (constrain factor loading to be equal)

metric.IA <- '

# first-order factor

Lone1 =~ a1*IA1.1 + a5*IA1.5 + a6*IA1.6R + a8*IA1.8 + a10*IA1.10 + a11*IA1.11R +
        a12*IA1.12
FA1 =~ a7*IA1.7R + a13*IA1.13 + a14*IA1.14 + a15*IA1.15
SA1 =~ a2*IA1.2 + a3*IA1.3 + a4*IA1.4 + a9*IA1.9

Lone2 =~ a1*IA2.1 + a5*IA2.5 + a6*IA2.6R + a8*IA2.8 + a10*IA2.10 + a11*IA2.11R +
        a12*IA2.12
FA2 =~ a7*IA2.7R + a13*IA2.13 + a14*IA2.14 + a15*IA2.15
SA2 =~ a2*IA2.2 + a3*IA2.3 + a4*IA2.4 + a9*IA2.9

Lone3 =~ a1*IA3.1 + a5*IA3.5 + a6*IA3.6R + a8*IA3.8 + a10*IA3.10 + a11*IA3.11R +
        a12*IA3.12
FA3 =~ a7*IA3.7R + a13*IA3.13 + a14*IA3.14 + a15*IA3.15
SA3 =~ a2*IA3.2 + a3*IA3.3 + a4*IA3.4 + a9*IA3.9

# general factor

IA1 =~ b1*Lone1 + b2*FA1 + b3*SA1
IA2 =~ b1*Lone2 + b2*FA2 + b3*SA2
IA3 =~ b1*Lone3 + b2*FA3 + b3*SA3

# IA covariance between waves

Lone1 ~~ Lone2 + Lone3
Lone2 ~~ Lone3

FA1 ~~ FA2 + FA3
FA2 ~~ FA3

SA1 ~~ SA2 + SA3
SA2 ~~ SA3

IA1 ~~ IA2 + IA3
IA2 ~~ IA3

IA1.6R ~~ IA1.7R
IA2.6R ~~ IA2.7R
IA3.6R ~~ IA3.7R

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# IA covariances between items

IA1.1 ~~ IA2.1 + IA3.1
IA2.1 ~~ IA3.1

IA1.2 ~~ IA2.2 + IA3.2
IA2.2 ~~ IA3.2

IA1.3 ~~ IA2.3 + IA3.3
IA2.3 ~~ IA3.3

IA1.4 ~~ IA2.4 + IA3.4
IA2.4 ~~ IA3.4

IA1.5 ~~ IA2.5 + IA3.5
IA2.5 ~~ IA3.5

IA1.6R ~~ IA2.6R + IA3.6R
IA2.6R ~~ IA3.6R

IA1.7R ~~ IA2.7R + IA3.7R
IA2.7R ~~ IA3.7R

IA1.8 ~~ IA2.8 + IA3.8
IA2.8 ~~ IA3.8

IA1.9 ~~ IA2.9 + IA3.9
IA2.9 ~~ IA3.9

IA1.10 ~~ IA2.10 + IA3.10
IA2.10 ~~ IA3.10

IA1.11R ~~ IA2.11R + IA3.11R
IA2.11R ~~ IA3.11R

IA1.12 ~~ IA2.12 + IA3.12
IA2.12 ~~ IA3.12

IA1.13 ~~ IA2.13 + IA3.13
IA2.13 ~~ IA3.13

IA1.14 ~~ IA2.14 + IA3.14
IA2.14 ~~ IA3.14

IA1.15 ~~ IA2.15 + IA3.15
IA2.15 ~~ IA3.15

'
fit_metricIA <- cfa(metric.IA, data = OAB, estimator = "MLR", se = "robust",
                    missing = "FIML", std.lv = TRUE)
summary(fit_metricIA, fit.measures = TRUE, standardized = TRUE)

## Defining Configural Model EW

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```

config.EW <- '

# EW factor loadings defined

EW1 =~ EW1.1 + EW1.2 + EW1.3 + EW1.4 + EW1.5 + EW1.6 + EW1.7 + EW1.8 + EW1.9 +
      EW1.10 + EW1.11 + EW1.12 + EW1.13 + EW1.14 + EW1.15 + EW1.16 + EW1.17

EW2 =~ EW2.1 + EW2.2 + EW2.3 + EW2.4 + EW2.5 + EW2.6 + EW2.7 + EW2.8 + EW2.9 +
      EW2.10 + EW2.11 + EW2.12 + EW2.13 + EW2.14 + EW2.15 + EW2.16 + EW2.17

EW3 =~ EW3.1 + EW3.2 + EW3.3 + EW3.4 + EW3.5 + EW3.6 + EW3.7 + EW3.8 + EW3.9 +
      EW3.10 + EW3.11 + EW3.12 + EW3.13 + EW3.14 + EW3.15 + EW3.16 + EW3.17

# EW covariance between waves

EW1 ~~ EW2 + EW3
EW2 ~~ EW3

# EW covariances between items

EW1.1 ~~ EW2.1 + EW3.1
EW2.1 ~~ EW3.1

EW1.2 ~~ EW2.2 + EW3.2
EW2.2 ~~ EW3.2

EW1.3 ~~ EW2.3 + EW3.3
EW2.3 ~~ EW3.3

EW1.4 ~~ EW2.4 + EW3.4
EW2.4 ~~ EW3.4

EW1.5 ~~ EW2.5 + EW3.5
EW2.5 ~~ EW3.5

EW1.6 ~~ EW2.6 + EW3.6
EW2.6 ~~ EW3.6

EW1.7 ~~ EW2.7 + EW3.7
EW2.7 ~~ EW3.7

EW1.8 ~~ EW2.8 + EW3.8
EW2.8 ~~ EW3.8

EW1.9 ~~ EW2.9 + EW3.9
EW2.9 ~~ EW3.9

EW1.10 ~~ EW2.10 + EW3.10
EW2.10 ~~ EW3.10

EW1.11 ~~ EW2.11 + EW3.11
EW2.11 ~~ EW3.11

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EW1.12 ~~ EW2.12 + EW3.12
EW2.12 ~~ EW3.12

EW1.13 ~~ EW2.13 + EW3.13
EW2.13 ~~ EW3.13

EW1.14 ~~ EW2.14 + EW3.14
EW2.14 ~~ EW3.14

EW1.15 ~~ EW2.15 + EW3.15
EW2.15 ~~ EW3.15

EW1.16 ~~ EW2.16 + EW3.16
EW2.16 ~~ EW3.16

EW1.17 ~~ EW2.17 + EW3.17
EW2.17 ~~ EW3.17

'
fit_configEW <- cfa(config.EW, data = OAB, estimator = "MLR", se = "robust",
                    missing = "FIML", std.lv = TRUE)
summary(fit_configEW, fit.measures = TRUE, standardized = TRUE)

## Defining Metric Model EW

metric.EW <- '

# EW factor loadings defined

EW1 =~ c1*EW1.1 + c2*EW1.2 + c3*EW1.3 + c4*EW1.4 + c5*EW1.5 + c6*EW1.6 + c7*EW1.7 +
      c8*EW1.8 + c9*EW1.9 + c10*EW1.10 + c11*EW1.11 + c12*EW1.12 + c13*EW1.13 +
      c14*EW1.14 + c15*EW1.15 + c16*EW1.16 + c17*EW1.17

EW2 =~ c1*EW2.1 + c2*EW2.2 + c3*EW2.3 + c4*EW2.4 + c5*EW2.5 + c6*EW2.6 + c7*EW2.7 +
      c8*EW2.8 + c9*EW2.9 + c10*EW2.10 + c11*EW2.11 + c12*EW2.12 + c13*EW2.13 +
      c14*EW2.14 + c15*EW2.15 + c16*EW2.16 + c17*EW2.17

EW3 =~ c1*EW3.1 + c2*EW3.2 + c3*EW3.3 + c4*EW3.4 + c5*EW3.5 + c6*EW3.6 + c7*EW3.7 +
      c8*EW3.8 + c9*EW3.9 + c10*EW3.10 + c11*EW3.11 + c12*EW3.12 + c13*EW3.13 +
      c14*EW3.14 + c15*EW3.15 + c16*EW3.16 + c17*EW3.17

# EW covariance between waves

EW1 ~~ EW2 + EW3
EW2 ~~ EW3

# EW covariances between items

EW1.1 ~~ EW2.1 + EW3.1
EW2.1 ~~ EW3.1

EW1.2 ~~ EW2.2 + EW3.2
EW2.2 ~~ EW3.2

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```

EW1.3 ~~ EW2.3 + EW3.3
EW2.3 ~~ EW3.3

EW1.4 ~~ EW2.4 + EW3.4
EW2.4 ~~ EW3.4

EW1.5 ~~ EW2.5 + EW3.5
EW2.5 ~~ EW3.5

EW1.6 ~~ EW2.6 + EW3.6
EW2.6 ~~ EW3.6

EW1.7 ~~ EW2.7 + EW3.7
EW2.7 ~~ EW3.7

EW1.8 ~~ EW2.8 + EW3.8
EW2.8 ~~ EW3.8

EW1.9 ~~ EW2.9 + EW3.9
EW2.9 ~~ EW3.9

EW1.10 ~~ EW2.10 + EW3.10
EW2.10 ~~ EW3.10

EW1.11 ~~ EW2.11 + EW3.11
EW2.11 ~~ EW3.11

EW1.12 ~~ EW2.12 + EW3.12
EW2.12 ~~ EW3.12

EW1.13 ~~ EW2.13 + EW3.13
EW2.13 ~~ EW3.13

EW1.14 ~~ EW2.14 + EW3.14
EW2.14 ~~ EW3.14

EW1.15 ~~ EW2.15 + EW3.15
EW2.15 ~~ EW3.15

EW1.16 ~~ EW2.16 + EW3.16
EW2.16 ~~ EW3.16

EW1.17 ~~ EW2.17 + EW3.17
EW2.17 ~~ EW3.17

EW2.16 ~~ EW2.17
EW2.15 ~~ EW2.16

'
fit_metricEW <- cfa(metric.EW, data = OAB, estimator = "MLR", se = "robust",
                    missing = "FIML", std.lv = TRUE)
summary(fit_metricEW, fit.measures = TRUE, standardized = TRUE)

```

```

## Defining Configural Model CB

config.CB <- '

# CB factor loadings defined

CB1 =~ CB1.1 + CB1.2 + CB1.3 + CB1.4 + CB1.5 + CB1.6 + CB1.7 + CB1.8 + CB1.9

CB2 =~ CB2.1 + CB2.2 + CB2.3 + CB2.4 + CB2.5 + CB2.6 + CB2.7 + CB2.8 + CB2.9

CB3 =~ CB3.1 + CB3.2 + CB3.3 + CB3.4 + CB3.5 + CB3.6 + CB3.7 + CB3.8 + CB3.9

# CB covariance between waves

CB1 ~~ CB2 + CB3
CB2 ~~ CB3

# CB covariances between items

CB1.1 ~~ CB2.1 + CB3.1
CB2.1 ~~ CB3.1

CB1.2 ~~ CB2.2 + CB3.2
CB2.2 ~~ CB3.2

CB1.3 ~~ CB2.3 + CB3.3
CB2.3 ~~ CB3.3

CB1.4 ~~ CB2.4 + CB3.4
CB2.4 ~~ CB3.4

CB1.5 ~~ CB2.5 + CB3.5
CB2.5 ~~ CB3.5

CB1.6 ~~ CB2.6 + CB3.6
CB2.6 ~~ CB3.6

CB1.7 ~~ CB2.7 + CB3.7
CB2.7 ~~ CB3.7

CB1.8 ~~ CB2.8 + CB3.8
CB2.8 ~~ CB3.8

CB1.9 ~~ CB2.9 + CB3.9
CB2.9 ~~ CB3.9

'

fit_configCB <- cfa(config.CB, data = OAB, estimator = "WLSMV",
                    ordered = names(OAB), std.lv = TRUE)
summary(fit_configCB, fit.measures = TRUE, standardized = TRUE)

## Defining Metric Model CB

```

```

metric.CB <- '

# CB factor loadings defined

CB1 =~ d1*CB1.1 + d2*CB1.2 + d3*CB1.3 + d4*CB1.4 + d5*CB1.5 + d6*CB1.6 +
      d7*CB1.7 + d8*CB1.8 + d9*CB1.9

CB2 =~ d1*CB2.1 + d2*CB2.2 + d3*CB2.3 + d4*CB2.4 + d5*CB2.5 + d6*CB2.6 +
      d7*CB2.7 + d8*CB2.8 + d9*CB2.9

CB3 =~ d1*CB3.1 + d2*CB3.2 + d3*CB3.3 + d4*CB3.4 + d5*CB3.5 + d6*CB3.6 +
      d7*CB3.7 + d8*CB3.8 + d9*CB3.9

# CB covariance between waves

CB1 ~~ CB2 + CB3
CB2 ~~ CB3

# CB covariances between items

CB1.1 ~~ CB2.1 + CB3.1
CB2.1 ~~ CB3.1

CB1.2 ~~ CB2.2 + CB3.2
CB2.2 ~~ CB3.2

CB1.3 ~~ CB2.3 + CB3.3
CB2.3 ~~ CB3.3

CB1.4 ~~ CB2.4 + CB3.4
CB2.4 ~~ CB3.4

CB1.5 ~~ CB2.5 + CB3.5
CB2.5 ~~ CB3.5

CB1.6 ~~ CB2.6 + CB3.6
CB2.6 ~~ CB3.6

CB1.7 ~~ CB2.7 + CB3.7
CB2.7 ~~ CB3.7

CB1.8 ~~ CB2.8 + CB3.8
CB2.8 ~~ CB3.8

CB1.9 ~~ CB2.9 + CB3.9
CB2.9 ~~ CB3.9

'

fit_metricCB <- cfa(metric.CB, data = OAB, estimator = "WLSMV",
                   ordered = names(OAB), std.lv = TRUE)
summary(fit_metricCB, fit.measures = TRUE, standardized = TRUE)

## Defining Configural Model OT

```

```

config.OT <- '

# OT factor loadings defined

OT1 =~ OT1.1 + OT1.2 + OT1.3 + OT1.4 + OT1.5 + OT1.7 + OT1.8

OT2 =~ OT2.1 + OT2.2 + OT2.3 + OT2.4 + OT2.5 + OT2.7 + OT2.8

OT3 =~ OT3.1 + OT3.2 + OT3.3 + OT3.4 + OT3.5 + OT3.7 + OT3.8

# OT covariance between waves

OT1 ~~ OT2 + OT3
OT2 ~~ OT3

# OT covariances between items

OT1.1 ~~ OT2.1 + OT3.1
OT2.1 ~~ OT3.1

OT1.2 ~~ OT2.2 + OT3.2
OT2.2 ~~ OT3.2

OT1.3 ~~ OT2.3 + OT3.3
OT2.3 ~~ OT3.3

OT1.4 ~~ OT2.4 + OT3.4
OT2.4 ~~ OT3.4

OT1.5 ~~ OT2.5 + OT3.5
OT2.5 ~~ OT3.5

OT1.7 ~~ OT2.7 + OT3.7
OT2.7 ~~ OT3.7

OT1.8 ~~ OT2.8 + OT3.8
OT2.8 ~~ OT3.8

'

fit_configOT <- cfa(config.OT, data = OAB, estimator = "WLSMV",
                    ordered = names(OAB), std.lv = TRUE)
summary(fit_configOT, fit.measures = TRUE, standardized = TRUE)

## Defining Metric Model OT

metric.OT <- '

# OT factor loadings defined

OT1 =~ e1*OT1.1 + e2*OT1.2 + e3*OT1.3 + e4*OT1.4 + e5*OT1.5 + e6*OT1.7 + e7*OT1.8

OT2 =~ e1*OT2.1 + e2*OT2.2 + e3*OT2.3 + e4*OT2.4 + e5*OT2.5 + e6*OT2.7 + e7*OT2.8

```

```

OT3 =~ e1*OT3.1 + e2*OT3.2 + e3*OT3.3 + e4*OT3.4 + e5*OT3.5 + e6*OT3.7 + e7*OT3.8

# OT covariance between waves

OT1 ~~ OT2 + OT3
OT2 ~~ OT3

# OT covariances between items

OT1.1 ~~ OT2.1 + OT3.1
OT2.1 ~~ OT3.1

OT1.2 ~~ OT2.2 + OT3.2
OT2.2 ~~ OT3.2

OT1.3 ~~ OT2.3 + OT3.3
OT2.3 ~~ OT3.3

OT1.4 ~~ OT2.4 + OT3.4
OT2.4 ~~ OT3.4

OT1.5 ~~ OT2.5 + OT3.5
OT2.5 ~~ OT3.5

OT1.7 ~~ OT2.7 + OT3.7
OT2.7 ~~ OT3.7

OT1.8 ~~ OT2.8 + OT3.8
OT2.8 ~~ OT3.8

'
fit_metricOT <- cfa(metric.OT, data = OAB, estimator = "WLSMV",
                    ordered = names(OAB), std.lv = TRUE)
summary(fit_metricOT, fit.measures = TRUE, standardized = TRUE)
modificationIndices(fit_metricOT, sort.=TRUE, minimum.value = 20)

## Defining Partial Metric Model OT (free item 5 loading)

pmetric.OT <- '

# OT factor loadings defined

OT1 =~ e1*OT1.1 + e2*OT1.2 + e3*OT1.3 + e4*OT1.4 + OT1.5 + e6*OT1.7 + e7*OT1.8

OT2 =~ e1*OT2.1 + e2*OT2.2 + e3*OT2.3 + e4*OT2.4 + OT2.5 + e6*OT2.7 + e7*OT2.8

OT3 =~ e1*OT3.1 + e2*OT3.2 + e3*OT3.3 + e4*OT3.4 + OT3.5 + e6*OT3.7 + e7*OT3.8

# OT covariance between waves

OT1 ~~ OT2 + OT3
OT2 ~~ OT3

```

```

# OT covariances between items

OT1.1 ~~ OT2.1 + OT3.1
OT2.1 ~~ OT3.1

OT1.2 ~~ OT2.2 + OT3.2
OT2.2 ~~ OT3.2

OT1.3 ~~ OT2.3 + OT3.3
OT2.3 ~~ OT3.3

OT1.4 ~~ OT2.4 + OT3.4
OT2.4 ~~ OT3.4

OT1.5 ~~ OT2.5 + OT3.5
OT2.5 ~~ OT3.5

OT1.7 ~~ OT2.7 + OT3.7
OT2.7 ~~ OT3.7

OT1.8 ~~ OT2.8 + OT3.8
OT2.8 ~~ OT3.8

'
fit_pmetricOT <- cfa(pmetric.OT, data = OAB, estimator = "WLSMV",
                     ordered = names(OAB), std.lv = TRUE)
summary(fit_pmetricOT, fit.measures = TRUE, standardized = TRUE)

#### Longitudinal Mediation Models ACE & OA ####

mydata <- read.spss("ACE & OA.sav", to.data.frame = TRUE, use.value.labels = FALSE)

### Longitudinal mediation model ACE & CB

model1_CB <- '

# Autoregressive paths (include second order autoregressive path)

ACE2 ~ ACE1
ACE3 ~ ACE2 + ACE1

PW2M ~ PW1M
PW3M ~ PW2M + PW1M

IA2M ~ IA1M
IA3M ~ IA2M + IA1M

CB2M ~ CB1M
CB3M ~ CB2M + CB1M

# Covariance paths

ACE1 ~~ PW1M + IA1M + CB1M

```

```

PW1M ~~ IA1M + CB1M
IA1M ~~ CB1M

ACE2 ~~ PW2M + IA2M + CB2M
PW2M ~~ IA2M + CB2M
IA2M ~~ CB2M

ACE3 ~~ PW3M + IA3M + CB3M
PW3M ~~ IA3M + CB3M
IA3M ~~ CB3M

# Cross-lagged paths

PW2M ~ ACE1 + GenderA + AgeA + SES
PW3M ~ ACE2 + GenderA + AgeA + SES

IA2M ~ ACE1 + PW1M + GenderA + AgeA + SES
IA3M ~ ACE2 + PW2M + GenderA + AgeA + SES

CB2M ~ ACE1 + PW1M + IA1M + GenderA + AgeA + SES
CB3M ~ ACE2 + PW2M + IA2M + GenderA + AgeA + SES

# Reverse cross-lagged paths

ACE2 ~ PW1M + IA1M + CB1M + GenderA + AgeA + SES
ACE3 ~ PW2M + IA2M + CB2M + GenderA + AgeA + SES

PW2M ~ IA1M + CB1M + GenderA + AgeA + SES
PW3M ~ IA2M + CB2M + GenderA + AgeA + SES

IA2M ~ CB1M + GenderA + AgeA + SES
IA3M ~ CB2M + GenderA + AgeA + SES

## Mediation paths  ## test H2, H3, H4

PW2M ~ a1*ACE1 + GenderA + AgeA + SES
IA2M ~ a2*ACE1 + GenderA + AgeA + SES
IA3M ~ d*PW2M + GenderA + AgeA + SES
CB3M ~ b1*PW2M + b2*IA2M + c*ACE1 + GenderA + AgeA + SES

# Indirect effects
ind1 := a1*b1
ind2 := a2*b2
ind3 := a1*d*b2
total := c + ind1 + ind2 + ind3

# modification indices
PW1M ~ GenderA
IA1M ~ GenderA

'
fit_model1_CB <- sem(model1_CB, data = mydata, estimator = "MLR", se = "robust",
                     missing = "FIML", fixed.x = FALSE)

```

```

summary(fit_model1_CB, fit.measures = TRUE, standardized = TRUE)

## Bootstrap CI

set.seed(111)

fit_model1_CBboot <- sem(model1_CB, data = mydata, estimator = "ML", se = "bootstrap",
                        bootstrap = 5000, missing = "FIML", fixed.x = FALSE)
summary(fit_model1_CBboot, ci = TRUE)

### Longitudinal mediation model ACE & OT

model1_OT <- '

# Autoregressive paths (include second order autoregressive path)

ACE2 ~ ACE1
ACE3 ~ ACE2 + ACE1

PW2M ~ PW1M
PW3M ~ PW2M + PW1M

IA2M ~ IA1M
IA3M ~ IA2M + IA1M

OT2M ~ OT1M
OT3M ~ OT2M + OT1M

# Covariance paths

ACE1 ~~ PW1M + IA1M + OT1M
PW1M ~~ IA1M + OT1M
IA1M ~~ OT1M

ACE2 ~~ PW2M + IA2M + OT2M
PW2M ~~ IA2M + OT2M
IA2M ~~ OT2M

ACE3 ~~ PW3M + IA3M + OT3M
PW3M ~~ IA3M + OT3M
IA3M ~~ OT3M

# Cross-lagged paths

PW2M ~ ACE1 + GenderA + AgeA + SES
PW3M ~ ACE2 + GenderA + AgeA + SES

IA2M ~ ACE1 + PW1M + GenderA + AgeA + SES
IA3M ~ ACE2 + PW2M + GenderA + AgeA + SES

OT2M ~ ACE1 + PW1M + IA1M + GenderA + AgeA + SES
OT3M ~ ACE2 + PW2M + IA2M + GenderA + AgeA + SES

```

```

# Reverse cross-lagged paths

ACE2 ~ PW1M + IA1M + OT1M + GenderA + AgeA + SES
ACE3 ~ PW2M + IA2M + OT2M + GenderA + AgeA + SES

PW2M ~ IA1M + OT1M + GenderA + AgeA + SES
PW3M ~ IA2M + OT2M + GenderA + AgeA + SES

IA2M ~ OT1M + GenderA + AgeA + SES
IA3M ~ OT2M + GenderA + AgeA + SES

## Mediation paths  ## test H2, H3, H4

PW2M ~ a1*ACE1 + GenderA + AgeA + SES
IA2M ~ a2*ACE1 + GenderA + AgeA + SES
IA3M ~ d*PW2M + GenderA + AgeA + SES
OT3M ~ b1*PW2M + b2*IA2M + c*ACE1 + GenderA + AgeA + SES

# Indirect effects
ind1 := a1*b1
ind2 := a2*b2
ind3 := a1*d*b2
total := c + ind1 + ind2 + ind3

# modification indices
PW1M ~ GenderA
IA1M ~ GenderA

'
fit_model1_OT <- sem(model1_OT, data = mydata, estimator = "MLR", se = "robust",
                    missing = "FIML", fixed.x = FALSE)
summary(fit_model1_OT, fit.measures = TRUE, standardized = TRUE)

## Bootstrap CI

set.seed(222)

fit_model1_OTboot <- sem(model1_OT, data = mydata, estimator = "ML", se = "bootstrap",
                        bootstrap = 5000, missing = "FIML", fixed.x = FALSE)
summary(fit_model1_OTboot, ci = TRUE)

### Sensitivity test (before winsorization)

mydata_st <- read.spss("ACE & OA - with outliers.sav", to.data.frame = TRUE,
                      use.value.labels = FALSE)

### Longitudinal mediation model ACE & CB

model2_CB <- '

# Autoregressive paths (include second order autoregressive path)

```

```

ACE2 ~ ACE1
ACE3 ~ ACE2 + ACE1

PW2M ~ PW1M
PW3M ~ PW2M + PW1M

IA2M ~ IA1M
IA3M ~ IA2M + IA1M

CB2M ~ CB1M
CB3M ~ CB2M + CB1M

# Covariance paths

ACE1 ~~ PW1M + IA1M + CB1M
PW1M ~~ IA1M + CB1M
IA1M ~~ CB1M

ACE2 ~~ PW2M + IA2M + CB2M
PW2M ~~ IA2M + CB2M
IA2M ~~ CB2M

ACE3 ~~ PW3M + IA3M + CB3M
PW3M ~~ IA3M + CB3M
IA3M ~~ CB3M

# Cross-lagged paths

PW2M ~ ACE1 + GenderA + AgeA + SES
PW3M ~ ACE2 + GenderA + AgeA + SES

IA2M ~ ACE1 + PW1M + GenderA + AgeA + SES
IA3M ~ ACE2 + PW2M + GenderA + AgeA + SES

CB2M ~ ACE1 + PW1M + IA1M + GenderA + AgeA + SES
CB3M ~ ACE2 + PW2M + IA2M + GenderA + AgeA + SES

# Reverse cross-lagged paths

ACE2 ~ PW1M + IA1M + CB1M + GenderA + AgeA + SES
ACE3 ~ PW2M + IA2M + CB2M + GenderA + AgeA + SES

PW2M ~ IA1M + CB1M + GenderA + AgeA + SES
PW3M ~ IA2M + CB2M + GenderA + AgeA + SES

IA2M ~ CB1M + GenderA + AgeA + SES
IA3M ~ CB2M + GenderA + AgeA + SES

## Mediation paths  ## test H2, H3, H4

PW2M ~ a1*ACE1 + GenderA + AgeA + SES
IA2M ~ a2*ACE1 + GenderA + AgeA + SES
IA3M ~ d*PW2M + GenderA + AgeA + SES

```

```

CB3M ~ b1*PW2M + b2*IA2M + c*ACE1 + GenderA + AgeA + SES

# Indirect effects
ind1 := a1*b1
ind2 := a2*b2
ind3 := a1*d*b2
total := c + ind1 + ind2 + ind3

# modification indices
PW1M ~ GenderA
IA1M ~ GenderA

'
fit_model2_CB <- sem(model2_CB, data = mydata_st, estimator = "MLR", se = "robust",
                     missing = "FIML", fixed.x = FALSE)
summary(fit_model2_CB, fit.measures = TRUE, standardized = TRUE)

## Bootstrap CI

set.seed(333)

fit_model2_CBboot <- sem(model2_CB, data = mydata_st, estimator = "ML", se = "bootstrap",
                        bootstrap = 5000, missing = "FIML", fixed.x = FALSE)
summary(fit_model2_CBboot, ci = TRUE)

### Longitudinal mediation model ACEs & OT

model2_OT <- '

## Structural model

# Autoregressive paths (include second order autoregressive path)

ACE2 ~ ACE1
ACE3 ~ ACE2 + ACE1

PW2M ~ PW1M
PW3M ~ PW2M + PW1M

IA2M ~ IA1M
IA3M ~ IA2M + IA1M

OT2M ~ OT1M
OT3M ~ OT2M + OT1M

# Covariance paths

ACE1 ~~ PW1M + IA1M + OT1M
PW1M ~~ IA1M + OT1M
IA1M ~~ OT1M

ACE2 ~~ PW2M + IA2M + OT2M
PW2M ~~ IA2M + OT2M

```

```

IA2M ~~ OT2M

ACE3 ~~ PW3M + IA3M + OT3M
PW3M ~~ IA3M + OT3M
IA3M ~~ OT3M

# Cross-lagged paths

PW2M ~ ACE1 + GenderA + AgeA + SES
PW3M ~ ACE2 + GenderA + AgeA + SES

IA2M ~ ACE1 + PW1M + GenderA + AgeA + SES
IA3M ~ ACE2 + PW2M + GenderA + AgeA + SES

OT2M ~ ACE1 + PW1M + IA1M + GenderA + AgeA + SES
OT3M ~ ACE2 + PW2M + IA2M + GenderA + AgeA + SES

# Reverse cross-lagged paths

ACE2 ~ PW1M + IA1M + OT1M + GenderA + AgeA + SES
ACE3 ~ PW2M + IA2M + OT2M + GenderA + AgeA + SES

PW2M ~ IA1M + OT1M + GenderA + AgeA + SES
PW3M ~ IA2M + OT2M + GenderA + AgeA + SES

IA2M ~ OT1M + GenderA + AgeA + SES
IA3M ~ OT2M + GenderA + AgeA + SES

## Mediation paths  ## test H2, H3, H4

PW2M ~ a1*ACE1 + GenderA + AgeA + SES
IA2M ~ a2*ACE1 + GenderA + AgeA + SES
IA3M ~ d*PW2M + GenderA + AgeA + SES
OT3M ~ b1*PW2M + b2*IA2M + c*ACE1 + GenderA + AgeA + SES

# Indirect effects
ind1 := a1*b1
ind2 := a2*b2
ind3 := a1*d*b2
total := c + ind1 + ind2 + ind3

# modification indices
PW1M ~ GenderA
IA1M ~ GenderA

'
fit_model2_OT <- sem(model2_OT, data = mydata_st, estimator = "MLR", se = "robust",
                     missing = "FIML", fixed.x = FALSE)
summary(fit_model2_OT, fit.measures = TRUE, standardized = TRUE)

## Bootstrap CI

set.seed(444)

```

```
fit_model2_OTboot <- sem(model2_OT, data = mydata_st, estimator = "ML", se = "bootstrap",  
                          bootstrap = 5000, missing = "FIML", fixed.x = FALSE)  
summary(fit_model2_OTboot, ci = TRUE)
```