Example 6a: Path Analysis for Mediation among Conditionally Multivariate Normal Outcomes

(complete syntax and output available for STATA, Mplus, R, and SAS electronically)

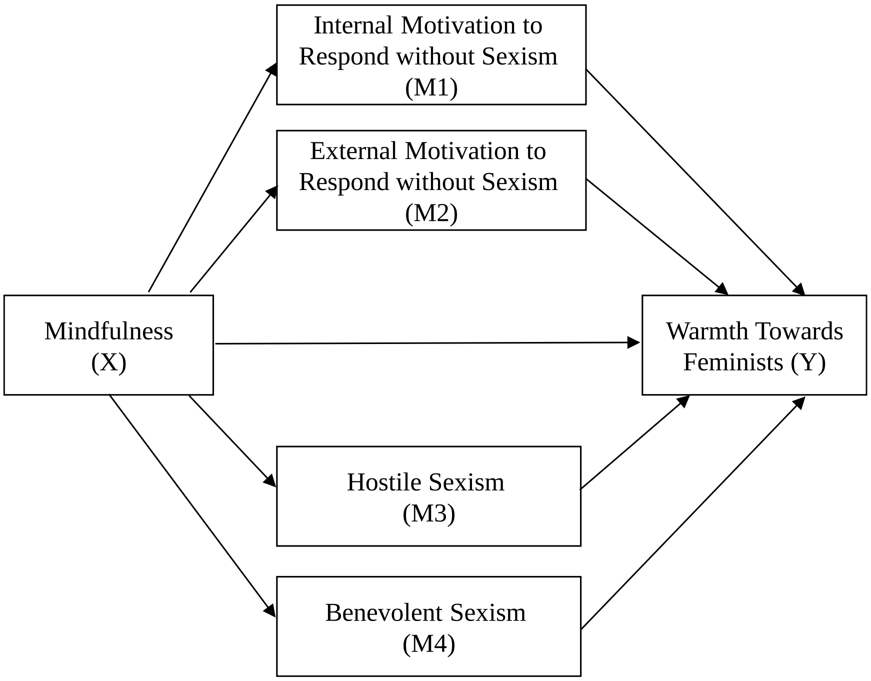

Figure 1 from: Gervais, S. J. & Hoffman, L. (2013). Just think about it: Mindfulness, sexism, and prejudice towards feminists. *Sex Roles*, *68*(5), 283–295.

A sample of 653 undergraduates completed the six measures depicted in Figure 1 (residual covariances among the four mediators are not shown for diagram clarity). Table 3 shows the correlations of the six variables by gender. (The published article is also included in the online materials for this example.)

The research questions were as follows:
(1) To what extent do these four mediators account for the relationship between mindfulness and warmth towards feminists?
(2) How do these direct and indirect effects differ by binary gender?

Table 3 Inter-correlations of all factors by participant gender for main study

	1.	2.	3.	4.	5.	6.
1. Mindfulness	–	**.20**	.10	**−.17**	−.08	**.15**
2. Internal motivation	.04	–	**.39**	.06	**−.40**	**.45**
3. External motivation	−.04	**.38**	–	**.14**	.05	.11
4. Benevolent sexism	.08	−.01	**.17**	–	.07	−.06
5. Hostile sexism	**−.11**	**−.21**	.03	**.20**	–	**−.44**
6. Warmth toward feminists	−.00	**.30**	**.14**	−.08	**−.24**	–

Bold font denotes significant correlation coefficients. Correlations for men (*N*=272–273) are reported above the diagonal and correlations for women (*N*=378–380) are reported below the diagonal. Mindfulness (1 = *rarely*, 4 = *almost always*), Warmth Toward Feminists (0° = *very coolly*, 100° = *very warmly*), and Internal Motivation, External Motivation, Hostile Sexism, Benevolent Sexism (1 = *disagree strongly*, 7 = *agree strongly*)

This example demonstrates how to bring predictors into the likelihood by estimating their mean and variance in any empty model—this turns them into endogenous variables instead of exogenous variables, even if they aren't being predicted by anything. This strategy then allows those predictors to have missing data (assuming missing at random, just like for the outcomes already in the likelihood), but doing so also assumes a multivariate normal distribution (for the marginal distribution for any variables not predicted in the model). The choice of whether to bring predictors into the likelihood is available in Mplus and in R lavaan (0.6-10 used here), but not in SAS PROC CALIS or STATA SEM, which forces all variables into the likelihood when full-information maximum likelihood is selected for any missing outcomes. Likewise, a robust version of full-information maximum likelihood (MLR) is available in Mplus and R lavaan that corrects fit statistics and parameter standard errors for multivariate normality. Robust standard errors are also available in STATA SEM, but not in SAS PROC CALIS in the presence of missing data (so the SAS standard errors differ slightly).

In this example, we will begin with a single-group model, and then examine a multiple-group model in which all parameters are estimated separately for men and women (binary gender). In a multiple-group model, we will request Wald tests for the difference in each direct and indirect effect (which allows for faster, simultaneous testing of all differences). Alternatively, one could constrain specific direct and indirect effects to be equal across gender groups and track the decrease in model fit (best approach in theory, but it's more time-consuming)—this alternative strategy will be demonstrated in the last model.

STATA SEM Syntax for Single-Group Path Model using Regular FIML and Robust Standard Errors:

```
display "STATA Single-Group Path Model with Indirect Effects using Regular FIML and Robust SEs"
sem                                                    ///
    (intern extern hostile benev warmth <- _cons)      /// All intercepts estimated (by default)
    (warmth <- mindc)                                  /// Regression X to Y
    (intern extern hostile benev <- mindc)             /// Regressions X to M1,M2,M3,M4
    (warmth <- intern extern hostile benev),           /// Regressions M1,M2,M3,M4 to Y
     means(mindc) var(mindc)                           /// Print X mean and variance (not default)
     var(e.intern e.extern e.hostile e.benev e.warmth)  /// All residual variances (by default)
     covstruct(e.intern e.extern e.hostile e.benev, unstructured) /// All possible residual covars
     method(mlmv) vce(robust)                     // Full-information ML and robust SEs (fit is same)
     estat teffects                               // Direct, indirect, and total effects (combined)
     nlcom _b[intern:mindc] *_b[warmth:intern]    // Indirect effect XtoM1toY
     nlcom _b[extern:mindc] *_b[warmth:extern]    // Indirect effect XtoM2toY
     nlcom _b[hostile:mindc]*_b[warmth:hostile]   // Indirect effect XtoM3toY
     nlcom _b[benev:mindc]  *_b[warmth:benev]     // Indirect effect XtoM4toY
     nlcom _b[intern:mindc] *_b[warmth:intern]    + _b[extern:mindc]*_b[warmth:extern] + ///
           _b[hostile:mindc]*_b[warmth:hostile]  + _b[benev:mindc]* _b[warmth:benev]   + ///
           _b[warmth:mindc]                       // Total indirect+direct effects
     nlcom _b[intern:mindc]* _b[warmth:intern]    + _b[extern:mindc]*_b[warmth:extern] + ///
           _b[hostile:mindc]*_b[warmth:hostile]  + _b[benev:mindc]*_b[warmth:benev]     ///
                                                   // Total indirect effects
     sem, coeflegend                               // Print parameter labels (to use in lincom)
     sem, standardized                             // Print standardized solution
     estat gof, stats(all)                         // Print model fit statistics
     estat eqgof                                   // Print R2 per variable
```

R Syntax and Output for Single-Group Path Model using Robust FIML and Standard Errors:

```
print("R Single-Group Path Model with Indirect Effects using Robust FIML and Standard Errors")
# Create model syntax as separate text object
SyntaxSingle = "
# Means/Intercepts and Variances/Residual Variances (labels)
  MindC   ~ (Xint)*1;  MindC   ~~ (Xvar)*MindC;
  Intern  ~ (M1int)*1; Intern  ~~ (M1var)*Intern;
  Extern  ~ (M2int)*1; Extern  ~~ (M2var)*Extern;
  Hostile ~ (M3int)*1; Hostile ~~ (M3var)*Hostile;
  Benev   ~ (M4int)*1; Benev   ~~ (M4var)*Benev;
  Warmth  ~ (Yint)*1;  Warmth  ~~ (Yvar)*Warmth;
# Direct MindC --> Warmth
  Warmth ~ (XtoY)*MindC
# Left side of model
  Intern  ~ (XtoM1)*MindC
  Extern  ~ (XtoM2)*MindC
  Hostile ~ (XtoM3)*MindC
  Benev   ~ (XtoM4)*MindC
# Right side of model
  Warmth ~ (M1toY)*Intern + (M2toY)*Extern + (M3toY)*Hostile + (M4toY)*Benev
# Residual Covariances
  Intern  ~~ (Cov1)*Extern  + (Cov2)*Hostile + (Cov3)*Benev
  Extern  ~~ (Cov4)*Hostile + (Cov5)*Benev
  Hostile ~~ (Cov6)*Benev
# Indirect effects, total indirect+direct, and total indirect effects
  XtoM1toY := XtoM1*M1toY; XtoM2toY := XtoM2*M2toY
  XtoM3toY := XtoM3*M3toY; XtoM4toY := XtoM4*M4toY
  totXtoY  := XtoM1*M1toY + XtoM2*M2toY + XtoM3*M3toY + XtoM4*M4toY + XtoY
  totInd   := XtoM1*M1toY + XtoM2*M2toY + XtoM3*M3toY + XtoM4*M4toY
" # Now estimate model and get output
ModelSingle = lavaan(data=Mindful, model=SyntaxSingle, estimator="MLR", mimic="mplus")
summary(ModelSingle, fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
```

```
  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                        27
  Number of observations                           653
  Number of missing patterns                         3
```

```
Model Test User Model:
                                              Standard      Robust
  Test Statistic                                 0.000       0.000
  Degrees of freedom                                 0           0

Model Test Baseline Model:
  Test statistic                               439.601     396.087
  Degrees of freedom                                15          15
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.110

User Model versus Baseline Model:
  Comparative Fit Index (CFI)                    1.000       1.000
  Tucker-Lewis Index (TLI)                       1.000       1.000
  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Loglikelihood and Information Criteria:
  Loglikelihood user model (H0)              -5410.773   -5410.773
  Loglikelihood unrestricted model (H1)      -5410.773   -5410.773

  Akaike (AIC)                               10875.545   10875.545
  Bayesian (BIC)                             10996.548   10996.548
  Sample-size adjusted Bayesian (BIC)        10910.823   10910.823

Root Mean Square Error of Approximation:
  RMSEA                                          0.000       0.000
  90 Percent confidence interval - lower         0.000       0.000
  90 Percent confidence interval - upper         0.000       0.000
  P-value RMSEA <= 0.05                             NA          NA

  Robust RMSEA                                               0.000
  90 Percent confidence interval - lower                     0.000
  90 Percent confidence interval - upper                     0.000

Standardized Root Mean Square Residual:
  SRMR                                           0.000       0.000

Parameter Estimates:
  Standard errors                             Sandwich
  Information bread                           Observed
  Observed information based on                Hessian


Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Warmth ~
    MindC   (XtoY)   -0.012    0.213   -0.056    0.955   -0.012   -0.002
  Intern ~
    MindC   (XtM1)    0.335    0.120    2.785    0.005    0.335    0.112
  Extern ~
    MindC   (XtM2)    0.041    0.105    0.392    0.695    0.041    0.015
  Hostile ~
    MindC   (XtM3)   -0.196    0.071   -2.750    0.006   -0.196   -0.103
  Benev ~
    MindC   (XtM4)   -0.052    0.065   -0.801    0.423   -0.052   -0.029
  Warmth ~
    Intern  (M1tY)    0.563    0.075    7.478    0.000    0.563    0.307
    Extern  (M2tY)    0.058    0.074    0.777    0.437    0.058    0.029
    Hostile (M3tY)   -0.813    0.111   -7.343    0.000   -0.813   -0.282
    Benev   (M4tY)   -0.212    0.110   -1.928    0.054   -0.212   -0.069

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
 .Intern ~~
   .Extern  (Cov1)    0.602    0.077    7.850    0.000    0.602    0.377
   .Hostile (Cov2)   -0.374    0.052   -7.128    0.000   -0.374   -0.339
   .Benev   (Cov3)   -0.007    0.045   -0.149    0.881   -0.007   -0.006
 .Extern ~~
   .Hostile (Cov4)    0.036    0.045    0.815    0.415    0.036    0.036
   .Benev   (Cov5)    0.147    0.043    3.394    0.001    0.147    0.153
 .Hostile ~~
   .Benev   (Cov6)    0.112    0.031    3.654    0.000    0.112    0.169

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC   (Xint)    0.835    0.017   48.266    0.000    0.835    1.889
```

When you request MLR, those fit statistics appear in the right column (whereas the regular ML statistics are in the left column).

The LL, AIC, and BIC values all match SAS CALIS and STATA SEM because all variables are in the likelihood (after telling Mplus to estimate the mean and variance of the otherwise exogenous predictor X=Mindfulness by predicting it in an empty model.

Fit is perfect because the model is saturated (i.e., just-identified), such that there are direct relations (direct paths or covariances) between every pair of variables.

Under Covariances, Intercepts, and Variances, the dot in front of the term differentiates “residual” (conditional because the variable is being predicted as an outcome) from unconditional (unpredicted, but part of the likelihood)

```
   .Intern   (M1nt)    4.971    0.115   43.276    0.000    4.971    3.757
   .Extern   (M2nt)    4.063    0.100   40.820    0.000    4.063    3.342
   .Hostile  (M3nt)    4.069    0.067   60.988    0.000    4.069    4.826
   .Benev    (M4nt)    4.109    0.059   69.488    0.000    4.109    5.204
   .Warmth   (Yint)    7.456    0.845    8.821    0.000    7.456    3.074

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC    (Xvar)    0.195    0.012   16.398    0.000    0.195    1.000
   .Intern   (M1vr)    1.729    0.087   19.890    0.000    1.729    0.987
   .Extern   (M2vr)    1.478    0.081   18.154    0.000    1.478    1.000
   .Hostile  (M3vr)    0.704    0.047   15.003    0.000    0.704    0.989
   .Benev    (M4vr)    0.623    0.038   16.396    0.000    0.623    0.999
   .Warmth   (Yvar)    4.401    0.247   17.822    0.000    4.401    0.748

R-Square:
                   Estimate
    Intern             0.013
    Extern             0.000
    Hostile            0.011
    Benev              0.001
    Warmth             0.252

Defined Parameters:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    XtoM1toY           0.189    0.072    2.609    0.009    0.189    0.034
    XtoM2toY           0.002    0.007    0.346    0.730    0.002    0.000
    XtoM3toY           0.159    0.062    2.579    0.010    0.159    0.029
    XtoM4toY           0.011    0.015    0.717    0.474    0.011    0.002
    totXtoY            0.349    0.235    1.484    0.138    0.349    0.064
    totInd             0.361    0.109    3.328    0.001    0.361    0.066
```

Mplus Syntax and Partial Output for Single-Group Path Model using Robust FIML and Standard Errors:

```
TITLE:  Mplus Example 6a Single-Group Path Model with Indirect Effects
DATA:   FILE = Mindful.csv;     ! Can just list file name if data are in same folder
        FORMAT = free;          ! FREE (default) or FIXED format
        TYPE = individual;      ! Individual (default) or matrix data as input

VARIABLE:
! Names of all variables in data set
  NAMES = ID SexMW MindC Intern Extern Hostile Benev Warmth;
! Names of all variables in model
  USEVARIABLES = MindC Intern Extern Hostile Benev Warmth;
! Missing data indicator
  MISSING = ALL(-999);

ANALYSIS:   TYPE = GENERAL;             ! For path models
            ESTIMATOR = MLR;            ! Robust ML (cannot use with bootstrapping)
            !BOOTSTRAP = 1000;          ! Bootstrapping for indirect effects
OUTPUT:     STDYX;                      ! Standardized solution
            !MODINDICES (3.84);         ! Cheat codes to improve model fit (not with CONSTRAINT)
            CINTERVAL;                  ! Confidence interval for indirect effects
            !CINTERVAL(BCBOOTSTRAP);    ! Bootstrap CI for indirect effects (not with MLR)

! Model code: ON = Y ON X, WITH = covariance (labels to do math on)
MODEL:
! Bring X into the likelihood by estimating its mean and variance in an empty model
   [MindC] (Xint); MindC (Xvar);
! Intercepts and residual variances for other variables
   [Intern Extern Hostile Benev Warmth] (M1int M2int M3int M4int Yint);
    Intern Extern Hostile Benev Warmth  (M1var M2var M3var M4var Yvar);
! Direct MindC --> Warmth
  Warmth ON MindC (XtoY);
! Left side of model
  Intern Extern Hostile Benev ON MindC (XtoM1 XtoM2 XtoM3 XtoM4);
! Right side of model
  Warmth ON Intern Extern Hostile Benev (M1toY M2toY M3toY M4toY);
! All possible residual covariances among mediator variables (not labeled)
  Intern Extern Hostile Benev WITH Intern Extern Hostile Benev;
```

```
! First list newly created parameters to be defined below
MODEL CONSTRAINT:
  NEW (XtoM1toY XtoM2toY XtoM3toY XtoM4toY totXtoY totInd);
! Then define indirect effects, total indirect+direct, and total indirect effects
! (as done for you here using MODEL INDIRECT below, which is not always possible to use)
  XtoM1toY = XtoM1*M1toY; XtoM2toY = XtoM2*M2toY;
  XtoM3toY = XtoM3*M3toY; XtoM4toY = XtoM4*M4toY;
  totXtoY  = XtoM1toY + XtoM2toY + XtoM3toY + XtoM4toY + XtoY;
  totInd   = XtoM1toY + XtoM2toY + XtoM3toY + XtoM4toY;

! Get all indirect and total effects between Y IND X
MODEL INDIRECT: ! Only available for MVN outcomes
  Warmth IND MindC;
```

```
MODEL FIT INFORMATION
Number of Free Parameters                        27
Loglikelihood
          H0 Value                        -5410.773
          H0 Scaling Correction Factor       1.0785
            for MLR
          H1 Value                        -5410.773
          H1 Scaling Correction Factor       1.0785
            for MLR
Information Criteria
          Akaike (AIC)                    10875.545
          Bayesian (BIC)                  10996.548
          Sample-Size Adjusted BIC        10910.823
            (n* = (n + 2) / 24)
Chi-Square Test of Model Fit
          Value                               0.000
          Degrees of Freedom                      0
          P-Value                            0.0000

RMSEA (Root Mean Square Error Of Approximation)
          Estimate                            0.000
          90 Percent C.I.                     0.000  0.000
          Probability RMSEA <= .05            0.000
CFI/TLI
          CFI                                 1.000
          TLI                                 1.000

Chi-Square Test of Model Fit for the Baseline Model
          Value                             439.601
          Degrees of Freedom                     15
          P-Value                            0.0000
SRMR (Standardized Root Mean Square Residual)
          Value                               0.000
```

The LL, AIC, and BIC values all match SAS CALIS and STATA SEM because all variables are in the likelihood (after requesting Mplus estimate the mean and variance of the otherwise exogenous predictor X=Mindfulness.

Fit is perfect because the model is saturated (i.e., just-identified), such that there are direct relations (direct paths or covariances) between every pair of variables.

```
MODEL RESULTS
                                                    Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
WARMTH   ON
    MINDC             -0.012      0.213     -0.056      0.955
    INTERN             0.563      0.075      7.477      0.000
    EXTERN             0.058      0.074      0.777      0.437
    HOSTILE           -0.813      0.111     -7.343      0.000
    BENEV             -0.212      0.110     -1.928      0.054
 INTERN    ON
    MINDC              0.335      0.120      2.785      0.005
 EXTERN    ON
    MINDC              0.041      0.105      0.393      0.695
 HOSTILE   ON
    MINDC             -0.196      0.071     -2.750      0.006
 BENEV     ON
    MINDC             -0.052      0.065     -0.801      0.423
 INTERN    WITH
    EXTERN             0.602      0.077      7.851      0.000
    HOSTILE           -0.374      0.052     -7.127      0.000
    BENEV             -0.007      0.045     -0.148      0.882
 EXTERN    WITH
    HOSTILE            0.036      0.045      0.816      0.415
    BENEV              0.147      0.043      3.395      0.001
 HOSTILE   WITH
    BENEV              0.112      0.031      3.654      0.000
```

```
 Means
    MINDC              0.835       0.017      48.266      0.000
 Intercepts
    INTERN             4.971       0.115      43.275      0.000
    EXTERN             4.063       0.100      40.820      0.000
    HOSTILE            4.069       0.067      60.988      0.000
    BENEV              4.109       0.059      69.488      0.000
    WARMTH             7.457       0.845       8.822      0.000
 Variances
    MINDC              0.195       0.012      16.398      0.000
 Residual Variances
    INTERN             1.729       0.087      19.891      0.000
    EXTERN             1.478       0.081      18.155      0.000
    HOSTILE            0.704       0.047      15.003      0.000
    BENEV              0.623       0.038      16.396      0.000
    WARMTH             4.400       0.247      17.823      0.000
New/Additional Parameters
    XTOM1TOY           0.189       0.072       2.610      0.009
    XTOM2TOY           0.002       0.007       0.346      0.729
    XTOM3TOY           0.159       0.062       2.579      0.010
    XTOM4TOY           0.011       0.015       0.716      0.474
    TOTXTOY            0.349       0.235       1.484      0.138
    TOTIND             0.361       0.109       3.328      0.001
```

“Means” are for unpredicted variables in the likelihood, whereas “intercepts” are for predicted variables (conditional)

“Variances” are for unpredicted variables forced into the likelihood, whereas “residual variances” are for predicted variables (leftover outcomes)

Indirect and total effects are also provided by MODEL INDIRECT below (but only for MVN outcomes), so this way is more generally useful

```
TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS
                                                    Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
Effects from MINDC to WARMTH
  Total                0.349       0.235       1.484      0.138
  Total indirect       0.361       0.109       3.328      0.001
  Specific indirect 1
    WARMTH
    INTERN
    MINDC              0.189       0.072       2.610      0.009
  Specific indirect 2
    WARMTH
    EXTERN
    MINDC              0.002       0.007       0.346      0.729
  Specific indirect 3
    WARMTH
    HOSTILE
    MINDC              0.159       0.062       2.579      0.010

Specific indirect 4
    WARMTH
    BENEV
    MINDC              0.011       0.015       0.716      0.474
  Direct
    WARMTH
    MINDC             -0.012       0.213      -0.056      0.955
```

Total effects and total indirect effects given from X to Y (sum of all direct + indirect effects, or just sum or indirect effects, respectively)

Next, we will estimate the same path model separately but simultaneously for men and women in order to test “Moderated Mediation”—whether the model parameters (and direct/indirect effects specifically) differ by group. This model estimates all parameters separately by gender and uses Wald tests to examine gender differences.

STATA SEM Syntax for <u>Multiple-Group</u> Path Model using Regular FIML and Robust Standard Errors:

```
display "STATA Multiple-Group Path Model with Indirect Effects using Regular FIML and Robust SEs"
sem                                                 ///
    (intern extern hostile benev warmth <- _cons)   /// All intercepts estimated (by default)
    (warmth <- mindc)                               /// Regression X to Y
    (intern extern hostile benev <- mindc)          /// Regressions X to M1,M2,M3,M4
    (warmth <- intern extern hostile benev),        /// Regressions M1,M2,M3,M4 to Y
     means(mindc) var(mindc)                        /// Print X mean and variance (not default)
     var(e.intern e.extern e.hostile e.benev e.warmth)  /// All residual variances (by default)
     covstruct(e.intern e.extern e.hostile e.benev, unstructured) /// All possible residual covars
     method(mlmv) vce(robust)             /// Full-information ML and robust SEs (fit is same)
     group(sexmw) ginvariant(none)         // none= full non-invariance
     estat teffects                        // Direct, indirect (not correct), and total effects
```

```
// Men and women indirect effect XtoM1toY and difference
     nlcom _b[intern:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.intern]
     nlcom _b[intern:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.intern]
     nlcom _b[intern:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.intern] - ///
           _b[intern:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.intern]
     // Men and women indirect effect XtoM2toY and difference
     nlcom _b[extern:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.extern]
     nlcom _b[extern:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.extern]
     nlcom _b[extern:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.extern] - ///
           _b[extern:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.extern]
     // Men and women indirect effect XtoM3toY and difference
     nlcom _b[hostile:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.hostile]
     nlcom _b[hostile:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.hostile]
     nlcom _b[hostile:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.hostile] - ///
           _b[hostile:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.hostile]
     // Men and women indirect effect XtoM4toY and difference
     nlcom _b[benev:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.benev]
     nlcom _b[benev:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.benev]
     nlcom _b[benev:0bn.sexmw#c.mindc]*_b[warmth:0bn.sexmw#c.benev] - ///
           _b[benev:1.sexmw#c.mindc]  *_b[warmth:1.sexmw#c.benev]
     // Total and total indirect per group would be computed as for single-group model
     sem, coeflegend                          // Print parameter labels (to use in lincom)
     sem, standardized                        // Print standardized solution
     estat gof, stats(all)                    // Print model fit statistics
     estat eqgof                              // Print R2 per variable
     estat ginvariant      // Wald or Score test for each parm's invariance
                           // Wald  = test of constraining equal if unequal
                           // Score = test of allowing unequal if equal
```

R Syntax and Output for <u>Multiple-Group</u> Path Model using Robust FIML and Standard Errors:

```
print("R Multiple-Group Path Model with Indirect Effects using Robust FIML and Standard Errors")
# Create model syntax as separate text object
SyntaxMultiple = "
# Means/Intercepts and Variances/Residual Variances (labels)
  MindC   ~ c(mXint,  wXint)*1;  MindC   ~~ c(mXvar,  wXvar)*MindC;
  Intern  ~ c(mM1int, wM1int)*1; Intern  ~~ c(mM1var, wM1var)*Intern;
  Extern  ~ c(mM2int, wM2int)*1; Extern  ~~ c(mM2var, wM2var)*Extern;
  Hostile ~ c(mM3int, wM3int)*1; Hostile ~~ c(mM3var, wM3var)*Hostile;
  Benev   ~ c(mM4int, wM4int)*1; Benev   ~~ c(mM4var, wM4var)*Benev;
  Warmth  ~ c(mYint,  wYint)*1;  Warmth  ~~ c(mYvar,  wYvar)*Warmth;
# Direct MindC --> Warmth
  Warmth ~ c(mXtoY, wXtoY)*MindC
# Left side of model
  Intern  ~ c(mXtoM1, wXtoM1)*MindC
  Extern  ~ c(mXtoM2, wXtoM2)*MindC
  Hostile ~ c(mXtoM3, wXtoM3)*MindC
  Benev   ~ c(mXtoM4, wXtoM4)*MindC
# Right side of model
  Warmth ~ c(mM1toY, wM1toY)*Intern  + c(mM2toY, wM2toY)*Extern
         + c(mM3toY, wM3toY)*Hostile + c(mM4toY, wM4toY)*Benev
# Residual Covariances
  Intern  ~~ c(mCov1, wCov1)*Extern  + c(mCov2, wCov2)*Hostile + c(mCov3, wCov3)*Benev
  Extern  ~~ c(mCov4, wCov4)*Hostile + c(mCov5, wCov5)*Benev
  Hostile ~~ c(mCov6, wCov6)*Benev
# Indirect effects for both groups
  mXtoM1Y := mXtoM1*mM1toY; wXtoM1Y := wXtoM1*wM1toY
  mXtoM2Y := mXtoM2*mM2toY; wXtoM2Y := wXtoM2*wM2toY
  mXtoM3Y := mXtoM3*mM3toY; wXtoM3Y := wXtoM3*wM3toY
  mXtoM4Y := mXtoM4*mM4toY; wXtoM4Y := wXtoM4*wM4toY
# Total indirect+direct and total indirect effects for both groups
  mtotXtoY  := mXtoM1*mM1toY + mXtoM2*mM2toY + mXtoM3*mM3toY + mXtoM4*mM4toY + mXtoY
  mtotInd   := mXtoM1*mM1toY + mXtoM2*mM2toY + mXtoM3*mM3toY + mXtoM4*mM4toY
  wtotXtoY  := wXtoM1*wM1toY + wXtoM2*wM2toY + wXtoM3*wM3toY + wXtoM4*wM4toY + wXtoY
  wtotInd   := wXtoM1*wM1toY + wXtoM2*wM2toY + wXtoM3*wM3toY + wXtoM4*wM4toY
# Differences in direct effects across groups
  dXtoM1 := mXtoM1-wXtoM1; dXtoM2 := mXtoM2-wXtoM2;
  dXtoM3 := mXtoM3-wXtoM3; dXtoM4 := mXtoM4-wXtoM4;
```

Two labels are given per parameter to request different parameters by group

```
  dM1toY := mM1toY-wM1toY; dM2toY := mM2toY-wM2toY;
  dM3toY := mM3toY-wM3toY; dM4toY := mM4toY-wM4toY;
# Differences in indirect effects across groups
  dXtoM1Y := mXtoM1Y-wXtoM1Y; dXtoM2Y := mXtoM2Y-wXtoM2Y
  dXtoM3Y := mXtoM3Y-wXtoM3Y; dXtoM4Y := mXtoM4Y-wXtoM4Y
# Differences in total indirect+direct and total indirect effects across groups
  dtotXtoY := mtotXtoY-wtotXtoY; dtotInd := mtotInd-wtotInd
" # Now estimate model and get output
ModelMultiple = lavaan(data=Mindful, model=SyntaxMultiple, estimator="MLR", mimic="mplus",
                          group="SexMW") # group lists variable to define separate groups
summary(ModelMultiple, fit.measures=TRUE, rsquare=TRUE, standardized=TRUE)
```

```
  Estimator                                         ML
  Optimization method                           NLMINB
  Number of model parameters                        54

  Number of observations per group:
    0                                              273
    1                                              380
  Number of missing patterns per group:
    0                                                3
    1                                                3

Model Test User Model:
                                              Standard      Robust
  Test Statistic                                 0.000       0.000
  Degrees of freedom                                 0           0
  Test statistic for each group:
    0                                            0.000       0.000
    1                                            0.000       0.000
```

Fit is perfect because the model is still just-identified (all model parameters are separately estimated across groups).

```
Model Test Baseline Model:
  Test statistic                               399.257     363.321
  Degrees of freedom                                30          30
  P-value                                        0.000       0.000
  Scaling correction factor                                  1.099

User Model versus Baseline Model:
  Comparative Fit Index (CFI)                    1.000       1.000
  Tucker-Lewis Index (TLI)                       1.000       1.000
  Robust Comparative Fit Index (CFI)                            NA
  Robust Tucker-Lewis Index (TLI)                               NA

Loglikelihood and Information Criteria
  Loglikelihood user model (H0)              -5332.207   -5332.207
  Loglikelihood unrestricted model (H1)      -5332.207   -5332.207

  Akaike (AIC)                               10772.414   10772.414
  Bayesian (BIC)                             11014.420   11014.420
  Sample-size adjusted Bayesian (BIC)        10842.970   10842.970

Root Mean Square Error of Approximation:
  RMSEA                                          0.000       0.000
  90 Percent confidence interval - lower         0.000       0.000
  90 Percent confidence interval - upper         0.000       0.000
  P-value RMSEA <= 0.05                             NA          NA


  Robust RMSEA                                               0.000
  90 Percent confidence interval - lower                     0.000
  90 Percent confidence interval - upper                     0.000

Standardized Root Mean Square Residual:
  SRMR                                           0.000       0.000

Parameter Estimates:
  Standard errors                             Sandwich
  Information bread                           Observed
  Observed information based on                Hessian
```

Group 1 [0]: → Model for Men

```
Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Warmth ~
    MindC    (mXtY)    0.213    0.364    0.585    0.558    0.213    0.038
```

```
  Intern ~
    MindC   (mXM1)    0.633    0.199    3.179    0.001    0.633    0.197
  Extern ~
    MindC   (mXM2)    0.273    0.166    1.648    0.099    0.273    0.095
  Hostile ~
    MindC   (mXM3)   -0.171    0.126   -1.357    0.175   -0.171   -0.084
  Benev ~
    MindC   (mXM4)   -0.314    0.111   -2.829    0.005   -0.314   -0.170
  Warmth ~
    Intern  (mM1Y)    0.548    0.107    5.127    0.000    0.548    0.316
    Extern  (mM2Y)    0.047    0.109    0.433    0.665    0.047    0.024
    Hostile (mM3Y)   -0.845    0.155   -5.454    0.000   -0.845   -0.311
    Benev   (mM4Y)   -0.158    0.168   -0.937    0.349   -0.158   -0.052

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
 .Intern ~~
   .Extern  (mCv1)    0.640    0.132    4.857    0.000    0.640    0.380
   .Hostile (mCv2)   -0.475    0.088   -5.406    0.000   -0.475   -0.393
   .Benev   (mCv3)    0.107    0.074    1.445    0.148    0.107    0.099
 .Extern ~~
   .Hostile (mCv4)    0.058    0.077    0.750    0.453    0.058    0.053
   .Benev   (mCv5)    0.154    0.067    2.299    0.021    0.154    0.158
 .Hostile ~~
   .Benev   (mCv6)    0.036    0.048    0.742    0.458    0.036    0.051

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC   (mXnt)    0.817    0.026   31.181    0.000    0.817    1.887
   .Intern  (mM1n)    4.391    0.185   23.735    0.000    4.391    3.159
   .Extern  (mM2n)    3.871    0.158   24.499    0.000    3.871    3.123
   .Hostile (mM3n)    4.334    0.113   38.332    0.000    4.334    4.877
   .Benev   (mM4n)    4.460    0.093   48.212    0.000    4.460    5.567
   .Warmth  (mYnt)    6.815    1.258    5.418    0.000    6.815    2.823

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC   (mXvr)    0.187    0.019   10.023    0.000    0.187    1.000
   .Intern  (mM1v)    1.857    0.147   12.667    0.000    1.857    0.961
   .Extern  (mM2v)    1.522    0.126   12.056    0.000    1.522    0.991
   .Hostile (mM3v)    0.784    0.076   10.385    0.000    0.784    0.993
   .Benev   (mM4v)    0.623    0.059   10.504    0.000    0.623    0.971
   .Warmth  (mYvr)    4.124    0.394   10.465    0.000    4.124    0.708

R-Square:
                   Estimate
    Intern            0.039
    Extern            0.009
    Hostile           0.007
    Benev             0.029
    Warmth            0.292

Group 2 [1]: → Model for Women
Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  Warmth ~
    MindC   (wXtY)   -0.126    0.254   -0.498    0.618   -0.126   -0.026
  Intern ~
    MindC   (wXM1)    0.099    0.146    0.676    0.499    0.099    0.036
  Extern ~
    MindC   (wXM2)   -0.117    0.133   -0.874    0.382   -0.117   -0.044
  Hostile ~
    MindC   (wXM3)   -0.181    0.081   -2.250    0.024   -0.181   -0.109
  Benev ~
    MindC   (wXM4)    0.138    0.079    1.762    0.078    0.138    0.081
  Warmth ~
    Intern  (wM1Y)    0.449    0.105    4.264    0.000    0.449    0.247
    Extern  (wM2Y)    0.084    0.099    0.841    0.401    0.084    0.045
    Hostile (wM3Y)   -0.535    0.161   -3.328    0.001   -0.535   -0.180
    Benev   (wM4Y)   -0.159    0.151   -1.054    0.292   -0.159   -0.055

Covariances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
 .Intern ~~
   .Extern  (wCv1)    0.556    0.085    6.556    0.000    0.556    0.383
   .Hostile (wCv2)   -0.184    0.047   -3.900    0.000   -0.184   -0.205
   .Benev   (wCv3)   -0.012    0.050   -0.233    0.816   -0.012   -0.013
```

```
 .Extern ~~
   .Hostile  (wCv4)    0.023    0.044    0.522    0.602    0.023    0.026
   .Benev    (wCv5)    0.157    0.052    3.000    0.003    0.157    0.171
 .Hostile ~~
   .Benev    (wCv6)    0.118    0.032    3.656    0.000    0.118    0.210

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC    (wXnt)    0.847    0.023   36.886    0.000    0.847    1.892
   .Intern   (wM1n)    5.414    0.138   39.269    0.000    5.414    4.457
   .Extern   (wM2n)    4.200    0.125   33.482    0.000    4.200    3.504
   .Hostile  (wM3n)    3.853    0.077   50.063    0.000    3.853    5.185
   .Benev    (wM4n)    3.848    0.074   51.657    0.000    3.848    5.025
   .Warmth   (wYnt)    7.172    1.081    6.633    0.000    7.172    3.256
Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    MindC    (wXvr)    0.200    0.015   13.042    0.000    0.200    1.000
   .Intern   (wM1v)    1.473    0.089   16.634    0.000    1.473    0.999
   .Extern   (wM2v)    1.433    0.105   13.603    0.000    1.433    0.998
   .Hostile  (wM3v)    0.545    0.043   12.743    0.000    0.545    0.988
   .Benev    (wM4v)    0.583    0.046   12.659    0.000    0.583    0.993
   .Warmth   (wYvr)    4.230    0.303   13.972    0.000    4.230    0.872

R-Square:
                   Estimate
    Intern             0.001
    Extern             0.002
    Hostile            0.012
    Benev              0.007
    Warmth             0.128

Defined Parameters:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    mXtoM1Y            0.347    0.126    2.750    0.006    0.347    0.062
    wXtoM1Y            0.044    0.066    0.671    0.502    0.044    0.009
    mXtoM2Y            0.013    0.030    0.434    0.665    0.013    0.002
    wXtoM2Y           -0.010    0.015   -0.644    0.520   -0.010   -0.002
    mXtoM3Y            0.145    0.111    1.300    0.194    0.145    0.026
    wXtoM3Y            0.097    0.053    1.846    0.065    0.097    0.020
    mXtoM4Y            0.050    0.058    0.855    0.393    0.050    0.009
    wXtoM4Y           -0.022    0.024   -0.937    0.349   -0.022   -0.004
    mtotXtoY           0.768    0.402    1.910    0.056    0.768    0.138
    mtotInd            0.554    0.204    2.717    0.007    0.554    0.099
    wtotXtoY          -0.017    0.257   -0.066    0.948   -0.017   -0.003
    wtotInd            0.109    0.097    1.127    0.260    0.109    0.022
    dXtoM1             0.535    0.247    2.166    0.030    0.535    0.161
    dXtoM2             0.389    0.213    1.831    0.067    0.389    0.139
    dXtoM3             0.010    0.150    0.066    0.948    0.010    0.026
    dXtoM4            -0.452    0.136   -3.327    0.001   -0.452   -0.250
    dM1toY             0.099    0.150    0.661    0.509    0.099    0.068
    dM2toY            -0.036    0.148   -0.245    0.806   -0.036   -0.021
    dM3toY            -0.310    0.223   -1.390    0.164   -0.310   -0.131
    dM4toY             0.001    0.226    0.006    0.995    0.001    0.003
    dXtoM1Y            0.303    0.142    2.126    0.034    0.303    0.053
    dXtoM2Y            0.023    0.033    0.678    0.498    0.023    0.004
    dXtoM3Y            0.048    0.123    0.389    0.697    0.048    0.006
    dXtoM4Y            0.072    0.063    1.144    0.253    0.072    0.013
    dtotXtoY           0.784    0.477    1.644    0.100    0.784    0.141
    dtotInd            0.445    0.226    1.969    0.049    0.445    0.077
```

Indirect effects by group

Total indirect+direct and total indirect effects by group

Differences in direct effects by group

Differences in indirect, total indirect + direct, and total indirect effects by group

Mplus Syntax and Partial Output for Multiple-Group Path Model using Robust FIML and Standard Errors:

```
DATA:    FILE IS Mindful.csv;     ! Can just list file name if in same folder
         FORMAT = free;           ! FREE (default) or FIXED format
         TYPE = individual;       ! Individual (default) or matrix data as input
VARIABLE:
! Names of all variables in data set
  NAMES = ID SexMW MindC Intern Extern Hostile Benev Warmth;
! Names of all variables in model
  USEVARIABLES = SexMW MindC Intern Extern Hostile Benev Warmth;
! Missing data indicator
  MISSING = ALL(-999);
! Grouping variable for multiple group analysis
  GROUPING = SexMW (0=Men, 1=Women);
```

SexMW is now in USEVARIABLES

GROUPING defines groups for multiple-group model for MVN outcomes.

```
ANALYSIS:    TYPE = GENERAL;          ! For path models
             ESTIMATOR = MLR;         ! Robust ML (cannot use with bootstrapping)
             !BOOTSTRAP = 1000;       ! Bootstrapping for indirect effects
OUTPUT:      STDYX;                   ! Standardized solution
             !MODINDICES (3.84);      ! Cheat codes to improve model fit (not with CONSTRAINT)
             CINTERVAL;               ! Confidence interval for indirect effects
             !CINTERVAL(BCBOOTSTRAP); ! Bootstrap CI for indirect effects (not with MLR)

! Model code: ON = Y ON X, WITH = correlation
! Labels in parentheses (can be used to name constraints between groups)
MODEL:
! Bring X into the likelihood by estimating its mean and variance
  [MindC] (mXint); MindC (mXvar);
! Intercepts and residual variances for other variables
  [Intern Extern Hostile Benev Warmth] (mM1int mM2int mM3int mM4int mYint);
   Intern Extern Hostile Benev Warmth  (mM1var mM2var mM3var mM4var mYvar);
! Direct MindC --> Warmth
  Warmth ON MindC (mXtoY);
! Left side of model
  Intern Extern Hostile Benev ON MindC (mXtoM1 mXtoM2 mXtoM3 mXtoM4);
! Right side of model
  Warmth ON Intern Extern Hostile Benev (mM1toY mM2toY mM3toY mM4toY);
! All possible residual covariances among mediator variables (not labeled)
  Intern Extern Hostile Benev WITH Intern Extern Hostile Benev;

MODEL Women:
! Bring X into the likelihood by estimating its mean and variance
  [MindC] (wXint); MindC (wXvar);
! Intercepts and residual variances for other variables
  [Intern Extern Hostile Benev Warmth] (wM1int wM2int wM3int wM4int wYint);
   Intern Extern Hostile Benev Warmth  (wM1var wM2var wM3var wM4var wYvar);
! Direct MindC --> Warmth
  Warmth ON MindC (wXtoY);
! Left side of model
  Intern Extern Hostile Benev ON MindC (wXtoM1 wXtoM2 wXtoM3 wXtoM4);
! Right side of model
  Warmth ON Intern Extern Hostile Benev (wM1toY wM2toY wM3toY wM4toY);
! All possible residual covariances among mediator variables (not labeled)
  Intern Extern Hostile Benev WITH Intern Extern Hostile Benev;

! First list newly created parameters to be defined below
MODEL CONSTRAINT:
  NEW (mXtoM1Y mXtoM2Y mXtoM3Y mXtoM4Y wXtoM1Y wXtoM2Y wXtoM3Y wXtoM4Y
       mtotXtoY mtotInd wtotXtoY wtotInd
       dXtoM1 dXtoM2 dXtoM3 dXtoM4 dM1toY dM2toY dM3toY dM4toY
       dXtoM1Y dXtoM2Y dXtoM3Y dXtoM4Y dtotXtoY dtotInd);
! Indirect effects for both groups
  mXtoM1Y = mXtoM1*mM1toY; wXtoM1Y = wXtoM1*wM1toY;
  mXtoM2Y = mXtoM2*mM2toY; wXtoM2Y = wXtoM2*wM2toY;
  mXtoM3Y = mXtoM3*mM3toY; wXtoM3Y = wXtoM3*wM3toY;
  mXtoM4Y = mXtoM4*mM4toY; wXtoM4Y = wXtoM4*wM4toY;
! Total indirect+direct and total indirect effects for both groups
  mtotXtoY = mXtoM1Y + mXtoM2Y + mXtoM3Y + mXtoM4Y + mXtoY;
  mtotInd  = mXtoM1Y + mXtoM2Y + mXtoM3Y + mXtoM4Y;
  wtotXtoY = wXtoM1Y + wXtoM2Y + wXtoM3Y + wXtoM4Y + wXtoY;
  wtotInd  = wXtoM1Y + wXtoM2Y + wXtoM3Y + wXtoM4Y;
! Differences in direct effects across groups
  dXtoM1 = mXtoM1-wXtoM1; dXtoM2 = mXtoM2-wXtoM2;
  dXtoM3 = mXtoM3-wXtoM3; dXtoM4 = mXtoM4-wXtoM4;
  dM1toY = mM1toY-wM1toY; dM2toY = mM2toY-wM2toY;
  dM3toY = mM3toY-wM3toY; dM4toY = mM4toY-wM4toY;
! Differences in indirect effects across groups
  dXtoM1Y = mXtoM1Y-wXtoM1Y; dXtoM2Y = mXtoM2Y-wXtoM2Y;
  dXtoM3Y = mXtoM3Y-wXtoM3Y; dXtoM4Y = mXtoM4Y-wXtoM4Y;
! Differences in total indirect+direct and total indirect effects across groups
  dtotXtoY = mtotXtoY-wtotXtoY; dtotInd = mtotInd-wtotInd;
```

```
! Get all indirect and total effects between Y IND X
MODEL INDIRECT: ! Only available for MVN outcomes
  Warmth IND MindC;
```

```
MODEL FIT INFORMATION
Number of Free Parameters                        54
Loglikelihood
          H0 Value                        -5332.207
          H0 Scaling Correction Factor       1.0648
            for MLR
          H1 Value                        -5332.207
          H1 Scaling Correction Factor       1.0648
            for MLR
Information Criteria
          Akaike (AIC)                    10772.414
          Bayesian (BIC)                  11014.420
          Sample-Size Adjusted BIC        10842.970
            (n* = (n + 2) / 24)
Chi-Square Test of Model Fit
          Value                               0.000
          Degrees of Freedom                      0
          P-Value                            0.0000
Chi-Square Contribution From Each Group
          MEN                                 0.000
          WOMEN                               0.000

RMSEA (Root Mean Square Error Of Approximation)
          Estimate                            0.000
          90 Percent C.I.                     0.000  0.000
          Probability RMSEA <= .05            0.000
CFI/TLI
          CFI                                 1.000
          TLI                                 1.000
Chi-Square Test of Model Fit for the Baseline Model
          Value                             399.257
          Degrees of Freedom                     30
          P-Value                            0.0000
SRMR (Standardized Root Mean Square Residual)
          Value                               0.000
```

Fit is perfect because the model is still just-identified (all model parameters are separately estimated across groups).

```
MODEL RESULTS
                                                  Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
Group MEN
 WARMTH   ON
    MINDC              0.213      0.364      0.585      0.558
    INTERN             0.548      0.107      5.127      0.000
    EXTERN             0.047      0.109      0.433      0.665
    HOSTILE           -0.845      0.155     -5.454      0.000
    BENEV             -0.158      0.168     -0.937      0.349
 INTERN   ON
    MINDC              0.633      0.199      3.179      0.001
 EXTERN   ON
    MINDC              0.273      0.166      1.648      0.099
 HOSTILE  ON
    MINDC             -0.171      0.126     -1.357      0.175
 BENEV    ON
    MINDC             -0.314      0.111     -2.829      0.005
 INTERN   WITH
    EXTERN             0.640      0.132      4.857      0.000
    HOSTILE           -0.475      0.088     -5.406      0.000
    BENEV              0.107      0.074      1.445      0.148
 EXTERN   WITH
    HOSTILE            0.058      0.077      0.750      0.453
    BENEV              0.154      0.067      2.299      0.021
 HOSTILE  WITH
    BENEV              0.036      0.048      0.742      0.458
 Means
    MINDC              0.817      0.026     31.181      0.000
 Intercepts
    INTERN             4.391      0.185     23.735      0.000
    EXTERN             3.871      0.158     24.499      0.000
    HOSTILE            4.334      0.113     38.332      0.000
    BENEV              4.460      0.093     48.212      0.000
    WARMTH             6.814      1.258      5.418      0.000
```

```
Variances
    MINDC              0.187      0.019     10.023      0.000
 Residual Variances
    INTERN             1.857      0.147     12.667      0.000
    EXTERN             1.522      0.126     12.056      0.000
    HOSTILE            0.784      0.076     10.385      0.000
    BENEV              0.623      0.059     10.504      0.000
    WARMTH             4.124      0.394     10.465      0.000

Group WOMEN
 WARMTH  ON
    MINDC             -0.126      0.254     -0.498      0.618
    INTERN             0.449      0.105      4.264      0.000
    EXTERN             0.084      0.099      0.841      0.401
    HOSTILE           -0.535      0.161     -3.328      0.001
    BENEV             -0.159      0.151     -1.054      0.292
 INTERN   ON
    MINDC              0.099      0.146      0.676      0.499
 EXTERN   ON
    MINDC             -0.117      0.133     -0.874      0.382
 HOSTILE  ON
    MINDC             -0.181      0.081     -2.250      0.024
 BENEV    ON
    MINDC              0.138      0.079      1.762      0.078
 INTERN   WITH
    EXTERN             0.556      0.085      6.556      0.000
    HOSTILE           -0.184      0.047     -3.900      0.000
    BENEV             -0.012      0.050     -0.233      0.816
 EXTERN   WITH
    HOSTILE            0.023      0.044      0.522      0.602
    BENEV              0.157      0.052      3.000      0.003
 HOSTILE  WITH
    BENEV              0.118      0.032      3.656      0.000
 Means
    MINDC              0.847      0.023     36.886      0.000
 Intercepts
    INTERN             5.414      0.138     39.269      0.000
    EXTERN             4.200      0.125     33.482      0.000
    HOSTILE            3.853      0.077     50.063      0.000
    BENEV              3.848      0.074     51.657      0.000
    WARMTH             7.172      1.081      6.633      0.000
```

"Means" are for unpredicted variables in the likelihood, whereas "intercepts" are for predicted variables (conditional)

```
 Variances
    MINDC              0.200      0.015     13.042      0.000
 Residual Variances
    INTERN             1.473      0.089     16.634      0.000
    EXTERN             1.433      0.105     13.603      0.000
    HOSTILE            0.545      0.043     12.743      0.000
    BENEV              0.583      0.046     12.659      0.000
    WARMTH             4.230      0.303     13.972      0.000
```

"Variances" are for unpredicted variables forced into the likelihood, whereas "residual variances" are for predicted variables (leftover outcomes)

```
New/Additional Parameters
    MXTOM1Y            0.347      0.126      2.750      0.006
    MXTOM2Y            0.013      0.030      0.434      0.665
    MXTOM3Y            0.145      0.111      1.300      0.194
    MXTOM4Y            0.050      0.058      0.855      0.393
    WXTOM1Y            0.044      0.066      0.671      0.502
    WXTOM2Y           -0.010      0.015     -0.644      0.520
    WXTOM3Y            0.097      0.053      1.846      0.065
    WXTOM4Y           -0.022      0.024     -0.937      0.349
```

Indirect effects by group

```
    MTOTXTOY           0.768      0.402      1.910      0.056
    MTOTIND            0.554      0.204      2.717      0.007
    WTOTXTOY          -0.017      0.257     -0.066      0.948
    WTOTIND            0.109      0.097      1.127      0.260
```

Total indirect+direct and total indirect effects by group

```
    DXTOM1             0.535      0.247      2.166      0.030
    DXTOM2             0.389      0.213      1.831      0.067
    DXTOM3             0.010      0.150      0.066      0.948
    DXTOM4            -0.452      0.136     -3.327      0.001
    DM1TOY             0.099      0.150      0.661      0.509
    DM2TOY            -0.036      0.148     -0.245      0.806
    DM3TOY            -0.310      0.223     -1.390      0.164
    DM4TOY             0.001      0.226      0.006      0.995
```

Differences in direct effects by group

```
    DXTOM1Y            0.303      0.142      2.126      0.034
    DXTOM2Y            0.023      0.033      0.678      0.498
    DXTOM3Y            0.048      0.123      0.389      0.697
    DXTOM4Y            0.072      0.063      1.144      0.253
    DTOTXTOY           0.784      0.477      1.644      0.100
    DTOTIND            0.445      0.226      1.969      0.049
```

Differences in indirect, total indirect + direct, and total indirect effects by group

New Syntax by Program for holding the XtoM1 path equal across genders—Model χ^2 then provides significance test of 1 new constraint (against null hypothesis of 0 difference across groups)

```
display "STATA Testing Equality of Direct effect XtoM1 by Holding it Equal by Sex with @a"
sem                                                  ///
    (intern extern hostile benev warmth <- _cons)    /// All intercepts estimated (by default)
    (warmth <- mindc)                                /// X to Y for both groups
    (0: intern@a extern hostile benev <- mindc)      /// X to M1,M2,M3,M4 for group 0
    (1: intern@a extern hostile benev <- mindc)      /// X to M1,M2,M3,M4 for group 1
    (warmth <- intern extern hostile benev)          /// M1,M2,M3,M4 to Y for both groups
```

```
print("R Testing Equality of Direct effect XtoM1 by Holding it Equal by Sex")
# Create model syntax as separate text object
SyntaxMultipleXtoM1 = "
# Left side of model
  Intern  ~ (XtoM1)*MindC
" # Now estimate model and get output
```

Single label is used instead of two labels—the rest of syntax is as for previous multiple group model

Mplus New Syntax and Partial Output for XtoM1 path now equal across genders

```
MODEL:
  Intern   ON MindC   (XtoM1);
MODEL Women:
  Intern   ON MindC   (XtoM1);

MODEL FIT INFORMATION
Number of Free Parameters                       53
Loglikelihood
          H0 Value                       -5334.764
          H0 Scaling Correction Factor      1.0641
            for MLR
          H1 Value                       -5332.207
          H1 Scaling Correction Factor      1.0648
            for MLR
Information Criteria
          Akaike (AIC)                   10775.527
          Bayesian (BIC)                 11013.051
          Sample-Size Adjusted BIC       10844.776
            (n* = (n + 2) / 24)
Chi-Square Test of Model Fit
          Value                              4.626*
          Degrees of Freedom                     1
          P-Value                           0.0315
          Scaling Correction Factor         1.1052
            for MLR
Chi-Square Contribution From Each Group
          MEN                                3.031
          WOMEN                              1.595
```

In the manuscript, indirect effects were tested individually by constraining both involved direct paths to be equal (mislabeled in the manuscript as DF=1 when it should be DF=2), although this is a conservative approach (i.e., one could also make an argument for testing the difference in the indirect effect specifically). Given that there are infinitely many ways two different sets of direct effects could yield the same indirect effect, it seems testing the direct effects specifically would be more informative as to what extent the pattern implied by the indirect effect differs across groups.

For a sample results section, please see the manuscript.

The test of the model is actually the test of whether the XtoM1 direct path differs across groups (as was given by a Wald test instead in the previous model).