Example 9a: Path Analysis for Mediation

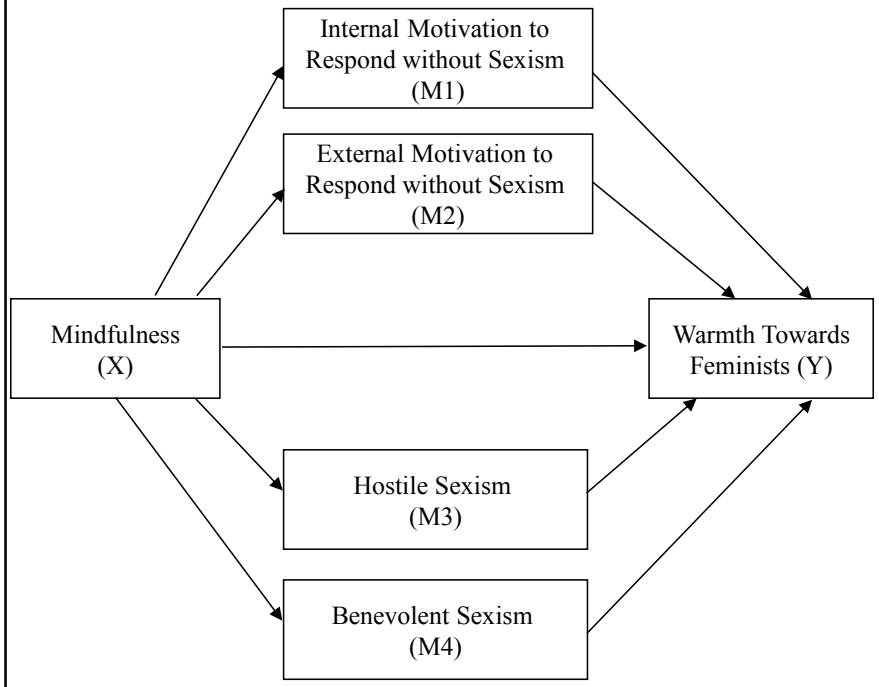

Figure 1 from: Gervais, S. J. & Hoffman, L. (2013). Just think about it: Mindfulness, sexism, and prejudice towards feminists. *Sex Roles, 68*(5), 283-295.

A sample of 653 undergraduates completed the six measures depicted in Figure 1 (residual covariances among the mediators are not shown for diagram clarity). Table 3 shows the correlations of the six variables by gender.

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 gender?

Accordingly, 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. From there, one would proceed by constraining specific direct and indirect effects to be equal across genders and note the decrease in model fit in doing so.

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*)

Single-Group Path Model

```
TITLE:   Example 9a Single-Group Path Model
DATA:    FILE IS Mindfull_Example.csv;
VARIABLE:
! Names of all variables in data set
  NAMES ARE pin1 SexMW age Mind1 Mind2 Hostile Benev Intern
            Extern NonTrado Career Fem WomMov;
! Names of all variables in model
  USEVARIABLES ARE Intern Extern Hostile Benev Mind1C NonTrad;
  MISSING ARE ALL(-999); ! Missing data indicator
  IDVARIABLE IS pin1;    ! ID variable indicator
DEFINE:
! Center mindfulness at 2 (out of 1 to 4)
  Mind1C = Mind1 - 2;
! Mean of feminists and womens' movement
  NonTrad = (Fem + WomMov) / 2;

ANALYSIS:    TYPE IS GENERAL;    ! For path models
             ESTIMATOR IS ML;    ! Regular ML for bootstrapping
             !BOOTSTRAP IS 1000; ! Boot for indirect effects
OUTPUT:      STDYX;              ! Standardized solution
             !CINTERVAL(BCBOOTSTRAP); ! CIs for indirect effects

! Model code: ON = Y ON X, WITH = correlation
! Labels can be used to name constraints between groups
MODEL:
! Bring X into the likelihood by estimating its mean, variance
  [Mind1C] (Xint); Mind1C (Xvar);
! Intercepts and residual variances for other variables
  [Intern Extern Hostile Benev NonTrad] (M1int M2int M3int M4int Yint);
   Intern Extern Hostile Benev NonTrad  (M1var M2var M3var M4var Yvar);
! Direct Mind1C --> NonTrad
  NonTrad  ON Mind1C (XtoY);
! Left side of model
  Intern   ON Mind1C (XtoM1);
  Extern   ON Mind1C (XtoM2);
  Hostile  ON Mind1C (XtoM3);
  Benev    ON Mind1C (XtoM4);
! Right side of model
  NonTrad ON Intern  (M1toY);
  NonTrad ON Extern  (M2toY);
  NonTrad ON Hostile (M3toY);
  NonTrad ON Benev   (M4toY);
! Residual covariances among mediator variables
  Intern Extern Hostile Benev WITH Intern Extern Hostile Benev (Cov1-Cov6);

! Testing indirect effects
  MODEL CONSTRAINT:
  NEW (XtoM1toY XtoM2toY XtoM3toY XtoM4toY);
  XtoM1toY = XtoM1*M1toY;
  XtoM2toY = XtoM2*M2toY;
  XtoM3toY = XtoM3*M3toY;
  XtoM4toY = XtoM4*M4toY;
```

```
MODEL FIT INFORMATION
Number of Free Parameters                       27

Loglikelihood
          H0 Value                      -5410.773
          H1 Value                      -5410.773

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
```

Note that H0=H1, meaning that the model is just-identified (and thus fits perfectly).

MODEL RESULTS (UNSTANDARDIZED)

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
NONTRAD ON				
MIND1C	-0.012	0.189	-0.063	0.950
INTERN	0.563	0.073	7.690	0.000
EXTERN	0.058	0.076	0.761	0.446
HOSTILE	-0.813	0.107	-7.571	0.000
BENEV	-0.212	0.107	-1.981	0.048
INTERN ON				
MIND1C	0.335	0.116	2.880	0.004
EXTERN ON				
MIND1C	0.041	0.108	0.383	0.702
HOSTILE ON				
MIND1C	-0.196	0.074	-2.637	0.008
BENEV ON				
MIND1C	-0.052	0.070	-0.746	0.455
INTERN WITH				
EXTERN	0.602	0.067	8.938	0.000
HOSTILE	-0.374	0.046	-8.206	0.000
BENEV	-0.007	0.041	-0.165	0.869
EXTERN WITH				
HOSTILE	0.036	0.040	0.909	0.363
BENEV	0.147	0.038	3.862	0.000
HOSTILE WITH				
BENEV	0.112	0.026	4.257	0.000
Means (OF PREDICTORS IN THE LIKELIHOOD)				
MIND1C	0.835	0.017	48.266	0.000
Intercepts				
INTERN	4.971	0.110	45.208	0.000
EXTERN	4.063	0.102	39.929	0.000
HOSTILE	4.069	0.070	58.010	0.000
BENEV	4.109	0.066	62.245	0.000
NONTRAD	7.457	0.731	10.203	0.000
Variances (OF PREDICTORS IN THE LIKELIHOOD)				
MIND1C	0.195	0.011	18.069	0.000
Residual Variances				
INTERN	1.729	0.096	18.070	0.000
EXTERN	1.478	0.082	17.995	0.000
HOSTILE	0.704	0.039	18.070	0.000
BENEV	0.623	0.034	18.069	0.000
NONTRAD	4.400	0.245	17.987	0.000
New/Additional Parameters				
XTOM1TOY	0.189	0.070	2.697	0.007
XTOM2TOY	0.002	0.007	0.341	0.733
XTOM3TOY	0.159	0.064	2.490	0.013
XTOM4TOY	0.011	0.016	0.699	0.485

STDYX Standardization

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
NONTRAD ON				
MIND1C	-0.002	0.034	-0.063	0.950
INTERN	0.307	0.039	7.934	0.000
EXTERN	0.029	0.038	0.762	0.446
HOSTILE	-0.282	0.036	-7.799	0.000
BENEV	-0.069	0.035	-1.985	0.047
INTERN ON				
MIND1C	0.112	0.039	2.898	0.004
EXTERN ON				
MIND1C	0.015	0.039	0.383	0.702
HOSTILE ON				
MIND1C	-0.103	0.039	-2.651	0.008
BENEV ON				
MIND1C	-0.029	0.039	-0.747	0.455
INTERN WITH				
EXTERN	0.377	0.034	11.117	0.000
HOSTILE	-0.339	0.035	-9.789	0.000
BENEV	-0.006	0.039	-0.165	0.869
EXTERN WITH				
HOSTILE	0.036	0.039	0.910	0.363
BENEV	0.153	0.038	4.002	0.000
HOSTILE WITH				
BENEV	0.169	0.038	4.444	0.000
Means				
MIND1C	1.889	0.065	28.928	0.000
Intercepts				
INTERN	3.757	0.142	26.489	0.000
EXTERN	3.342	0.126	26.509	0.000
HOSTILE	4.826	0.148	32.597	0.000
BENEV	5.204	0.164	31.760	0.000
NONTRAD	3.074	0.309	9.948	0.000
Variances				
MIND1C	1.000	0.000	999.000	999.000
Residual Variances				
INTERN	0.987	0.009	114.104	0.000
EXTERN	1.000	0.001	847.222	0.000
HOSTILE	0.989	0.008	124.491	0.000
BENEV	0.999	0.002	437.584	0.000
NONTRAD	0.748	0.029	25.413	0.000

R-SQUARE

Observed Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
INTERN	0.013	0.009	1.449	0.147
EXTERN	0.000	0.001	0.192	0.848
HOSTILE	0.011	0.008	1.325	0.185
BENEV	0.001	0.002	0.373	0.709
NONTRAD	0.252	0.029	8.563	0.000

Multiple-Group Path Model (all parameters estimated separately by gender)

```
TITLE:   Example 9a Multiple-Group Path Model (all paths separate)

DATA:    FILE IS Mindfull_Example.csv;
VARIABLE:
! Names of all variables in data set
  NAMES ARE pin1 SexMW age Mind1 Mind2 Hostile Benev Intern
            Extern NonTrado Career Fem WomMov;
! Names of all variables in model
  USEVARIABLES ARE Intern Extern Hostile Benev Mind1C NonTrad;
  MISSING ARE ALL(-999); ! Missing data indicator
  IDVARIABLE IS pin1;    ! ID variable indicator
  GROUPING IS SexMW (0=Men, 1=Women); ! Grouping variable
DEFINE:
! Center mindfulness at 2 (out of 1 to 4)
  Mind1C = Mind1 - 2;
! Mean of feminists and womens' movement
  NonTrad = (Fem + WomMov) / 2;
ANALYSIS:    TYPE IS GENERAL;    ! For path models
             ESTIMATOR IS ML;    ! Regular ML for bootstrapping
             !BOOTSTRAP IS 1000; ! Boot for indirect effects
OUTPUT:      STDYX;              ! Standardized solution
             !CINTERVAL(BCBOOTSTRAP); ! CIs for indirect effects
! Model code: ON = Y ON X, WITH = correlation
! Labels can be used to name constraints between groups

MODEL: MODEL FOR MEN AS REFERENCE GROUP
! Bring X into the likelihood by estimating its mean, variance
  [Mind1C] (mXint); Mind1C (mXvar);
! Intercepts and residual variances for other variables
  [Intern Extern Hostile] (mM1int mM2int mM3int);
  [Benev NonTrad] (mM4int mYint);
   Intern Extern Hostile (mM1var mM2var mM3var);
   Benev NonTrad (mM4var mYvar);

! Direct Mind1C --> NonTrad
  NonTrad  ON Mind1C (mXtoY);
! Left side of model
  Intern   ON Mind1C (mXtoM1);
  Extern   ON Mind1C (mXtoM2);
  Hostile  ON Mind1C (mXtoM3);
  Benev    ON Mind1C (mXtoM4);
! Right side of model
  NonTrad ON Intern  (mM1toY);
  NonTrad ON Extern  (mM2toY);
  NonTrad ON Hostile (mM3toY);
  NonTrad ON Benev   (mM4toY);
! Residual covariances among mediator variables
  Intern WITH Extern Hostile Benev (mCov1-mCov4);
  Extern WiTH Hostile Benev (mCov5-mCov6);

! Testing indirect effects
  MODEL CONSTRAINT:
  NEW (mXtoM1Y mXtoM2Y mXtoM3Y mXtoM4Y);
  mXtoM1Y = mXtoM1*mM1toY; mXtoM2Y = mXtoM2*mM2toY;
  mXtoM3Y = mXtoM3*mM3toY; mXtoM4Y = mXtoM4*mM4toY;
```

```
MODEL Women:
! Bring X into the likelihood by estimating its mean and variance
  [Mind1C] (wXint); Mind1C (wXvar);
! Intercepts and residual variances for other variables
  [Intern Extern Hostile Benev NonTrad] (wM1int wM2int wM3int wM4int wYint);
   Intern Extern Hostile Benev NonTrad  (wM1var wM2var wM3var wM4var wYvar);
! Direct Mind1C --> NonTrad
  NonTrad  ON Mind1C (wXtoY);
! Left side of model
  Intern   ON Mind1C (wXtoM1);
  Extern   ON Mind1C (wXtoM2);
  Hostile  ON Mind1C (wXtoM3);
  Benev    ON Mind1C (wXtoM4);
! Right side of model
  NonTrad ON Intern  (wM1toY);
  NonTrad ON Extern  (wM2toY);
  NonTrad ON Hostile (wM3toY);
  NonTrad ON Benev   (wM4toY);
! Residual covariances among mediator variables
  Intern Extern Hostile Benev WITH Intern Extern Hostile Benev (wCov1-wCov6);
! Testing indirect effects
  MODEL CONSTRAINT:
  NEW (wXtoM1Y wXtoM2Y wXtoM3Y wXtoM4Y);
  wXtoM1Y = wXtoM1*wM1toY; wXtoM2Y = wXtoM2*wM2toY;
  wXtoM3Y = wXtoM3*wM3toY; wXtoM4Y = wXtoM4*wM4toY;
```

```
MODEL FIT INFORMATION
Number of Free Parameters                       54

Loglikelihood
          H0 Value                      -5332.207
          H1 Value                      -5332.207
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
```

UNSTANDARDIZED MODEL RESULTS

Group MEN

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
NONTRAD ON				
MIND1C	0.213	0.301	0.707	0.479
INTERN	0.548	0.110	4.995	0.000
EXTERN	0.047	0.113	0.419	0.675
HOSTILE	-0.845	0.156	-5.402	0.000
BENEV	-0.158	0.159	-0.991	0.322
INTERN ON				
MIND1C	0.633	0.191	3.324	0.001
EXTERN ON				
MIND1C	0.273	0.173	1.581	0.114
HOSTILE ON				
MIND1C	-0.171	0.124	-1.385	0.166
BENEV ON				
MIND1C	-0.314	0.110	-2.842	0.004
INTERN WITH				
EXTERN	0.640	0.110	5.807	0.000
HOSTILE	-0.475	0.078	-6.047	0.000
BENEV	0.107	0.065	1.633	0.102
EXTERN WITH				
HOSTILE	0.058	0.067	0.869	0.385
BENEV	0.154	0.060	2.576	0.010
HOSTILE WITH				
BENEV	0.036	0.042	0.846	0.397
Means				
MIND1C	0.817	0.026	31.181	0.000
Intercepts				
INTERN	4.391	0.176	24.928	0.000
EXTERN	3.871	0.159	24.272	0.000
HOSTILE	4.334	0.114	37.859	0.000
BENEV	4.460	0.102	43.703	0.000
NONTRAD	6.814	1.125	6.059	0.000
Variances				
MIND1C	0.187	0.016	11.683	0.000
Residual Variances				
INTERN	1.857	0.159	11.683	0.000
EXTERN	1.522	0.131	11.636	0.000
HOSTILE	0.784	0.067	11.683	0.000
BENEV	0.623	0.053	11.683	0.000
NONTRAD	4.124	0.356	11.576	0.000
New/Additional Parameters				
MXTOM1Y	0.347	0.125	2.767	0.006
MXTOM2Y	0.013	0.032	0.405	0.685
MXTOM3Y	0.145	0.108	1.341	0.180
MXTOM4Y	0.050	0.053	0.935	0.350

UNSTANDARDIZED MODEL RESULTS

Group WOMEN

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
NONTRAD ON				
MIND1C	-0.126	0.239	-0.528	0.597
INTERN	0.449	0.097	4.626	0.000
EXTERN	0.084	0.099	0.847	0.397
HOSTILE	-0.535	0.150	-3.566	0.000
BENEV	-0.159	0.144	-1.105	0.269
INTERN ON				
MIND1C	0.099	0.139	0.709	0.478
EXTERN ON				
MIND1C	-0.117	0.138	-0.846	0.397
HOSTILE ON				
MIND1C	-0.181	0.085	-2.143	0.032
BENEV ON				
MIND1C	0.138	0.087	1.582	0.114
INTERN WITH				
EXTERN	0.556	0.080	6.934	0.000
HOSTILE	-0.184	0.047	-3.913	0.000
BENEV	-0.012	0.048	-0.245	0.806
EXTERN WITH				
HOSTILE	0.023	0.045	0.508	0.612
BENEV	0.157	0.048	3.285	0.001
HOSTILE WITH				
BENEV	0.118	0.030	4.008	0.000
Means				
MIND1C	0.847	0.023	36.886	0.000
Intercepts				
INTERN	5.414	0.133	40.622	0.000
EXTERN	4.200	0.132	31.900	0.000
HOSTILE	3.853	0.081	47.513	0.000
BENEV	3.848	0.084	45.915	0.000
NONTRAD	7.172	0.938	7.646	0.000
Variances				
MIND1C	0.200	0.015	13.784	0.000
Residual Variances				
INTERN	1.473	0.107	13.784	0.000
EXTERN	1.433	0.104	13.732	0.000
HOSTILE	0.545	0.040	13.784	0.000
BENEV	0.583	0.042	13.784	0.000
NONTRAD	4.230	0.307	13.765	0.000
New/Additional Parameters				
WXTOM1Y	0.044	0.063	0.701	0.483
WXTOM2Y	-0.010	0.016	-0.602	0.547
WXTOM3Y	0.097	0.053	1.837	0.066
WXTOM4Y	-0.022	0.024	-0.906	0.365

Testing differences between paths across groups can be done in three different ways (in order of most to least work):

1. Constrain paths to be equal; re-estimate the model (for direct or indirect effects; same procedure as when testing invariance)
2. Multivariate Wald test of differences between multiple paths (for indirect effects) using MODEL TEST (only one per model)
3. Univariate Wald test of differences between single paths (for direct effects) using MODEL CONSTRAINT (multiple per model)

Demonstrating options 2 and 3 using previous model:

```
! 2. Test gender differences between 2 paths at once
! using multivariate Wald tests
  MODEL TEST:
  mXtoM1=wXtoM1;
  mM1toY=wM1toY;


! 3. Test gender differences between paths
!    using univariate Wald tests
  MODEL CONSTRAINT:
  NEW(dXtoM1 dXtoM2 dXtoM3 dXtoM4)
  NEW(dXtoY dM1toY dM2toY dM3toY dM4toY);
  dXtoM1=mXtoM1-wXtoM1;
  dXtoM2=mXtoM2-wXtoM2;
  dXtoM3=mXtoM3-wXtoM3;
  dXtoM4=mXtoM4-wXtoM4;
   dXtoY=mXtoY-wXtoY;
  dM1toY=mM1toY-wM1toY;
  dM2toY=mM2toY-wM2toY;
  dM3toY=mM3toY-wM3toY;
  dM4toY=mM4toY-wM4toY;
```

```
Wald Test of Parameter Constraints → test of difference in indirect effect
          Value                             5.595
          Degrees of Freedom                    2
          P-Value                           0.0610


                                                    Two-Tailed
                    Estimate       S.E.  Est./S.E.    P-Value
New/Additional Parameters
    DXTOM1             0.535      0.236      2.267      0.023
    DXTOM2             0.389      0.221      1.763      0.078
    DXTOM3             0.010      0.150      0.066      0.948
    DXTOM4            -0.452      0.141     -3.210      0.001
    DXTOY              0.340      0.385      0.882      0.378
    DM1TOY             0.099      0.146      0.677      0.499
    DM2TOY            -0.036      0.150     -0.241      0.809
    DM3TOY            -0.310      0.217     -1.432      0.152
    DM4TOY             0.001      0.215      0.006      0.995
```

Note: Z^2 will be approximately equal to the chi-square values reported in Table 4 for the differences in direct effects (which were obtained via option 1 model constraints). However, the chi-square values for the indirect effects are incorrect because they should be based on df=2 from constraining the constituent direct effects to be both be equal.

Demonstrating option 1 using a constrained model (just new code shown):

```
MODEL:  ! MODEL FOR MEN
! Left side of model
  Intern   ON Mind1C (XtoM1);
! Right side of model
  NonTrad ON Intern  (M1toY);
  MODEL CONSTRAINT:
  NEW (XtoM1Y mXtoM2Y mXtoM3Y mXtoM4Y);
   XtoM1Y =  XtoM1*M1toY;  mXtoM2Y = mXtoM2*mM2toY;
  mXtoM3Y = mXtoM3*mM3toY; mXtoM4Y = mXtoM4*mM4toY;

MODEL Women:
! Left side of model
  Intern   ON Mind1C (XtoM1);
! Right side of model
  NonTrad ON Intern  (M1toY);
  MODEL CONSTRAINT:
  NEW (wXtoM2Y wXtoM3Y wXtoM4Y);
                           wXtoM2Y = wXtoM2*wM2toY;
  wXtoM3Y = wXtoM3*wM3toY; wXtoM4Y = wXtoM4*wM4toY;
```

```
MODEL FIT INFORMATION

Number of Free Parameters                       52
Loglikelihood

          H0 Value                       -5334.992
          H1 Value                       -5332.207

Information Criteria
          Akaike (AIC)                   10773.985
          Bayesian (BIC)                 11007.027
          Sample-Size Adjusted BIC       10841.927
            (n* = (n + 2) / 24)

Chi-Square Test of Model Fit
→ test of difference in indirect effect
          Value                              5.570
          Degrees of Freedom                     2
          P-Value                           0.0617
```