

Example 9a: Path Analysis for Mediation using Mplus

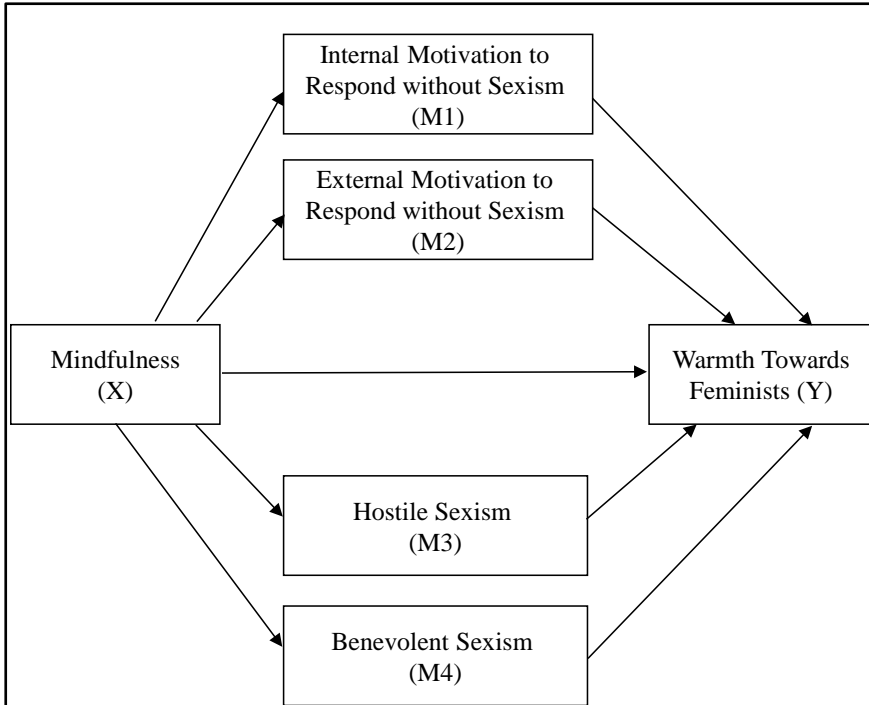


Figure 1 from: Gervais, S. J. & Hoffman, L. (2013). Just think about it: Mindfulness, sexism, and prejudice towards feminists. *Sex Roles*, 68(5), 283-295.

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

<pre> 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; </pre>	<pre> 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 </pre>
	<p>Note that H0=H1, meaning that the model is just-identified (and thus fits perfectly).</p>

MODEL RESULTS (UNSTANDARDIZED)					STDYX Standardization				
	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value		Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
NONTRAD ON					NONTRAD ON				
MIND1C	-0.012	0.189	-0.063	0.950	MIND1C	-0.002	0.034	-0.063	0.950
INTERN	0.563	0.073	7.690	0.000	INTERN	0.307	0.039	7.934	0.000
EXTERN	0.058	0.076	0.761	0.446	EXTERN	0.029	0.038	0.762	0.446
HOSTILE	-0.813	0.107	-7.571	0.000	HOSTILE	-0.282	0.036	-7.799	0.000
BENEV	-0.212	0.107	-1.981	0.048	BENEV	-0.069	0.035	-1.985	0.047
INTERN ON					INTERN ON				
MIND1C	0.335	0.116	2.880	0.004	MIND1C	0.112	0.039	2.898	0.004
EXTERN ON					EXTERN ON				
MIND1C	0.041	0.108	0.383	0.702	MIND1C	0.015	0.039	0.383	0.702
HOSTILE ON					HOSTILE ON				
MIND1C	-0.196	0.074	-2.637	0.008	MIND1C	-0.103	0.039	-2.651	0.008
BENEV ON					BENEV ON				
MIND1C	-0.052	0.070	-0.746	0.455	MIND1C	-0.029	0.039	-0.747	0.455
INTERN WITH					INTERN WITH				
EXTERN	0.602	0.067	8.938	0.000	EXTERN	0.377	0.034	11.117	0.000
HOSTILE	-0.374	0.046	-8.206	0.000	HOSTILE	-0.339	0.035	-9.789	0.000
BENEV	-0.007	0.041	-0.165	0.869	BENEV	-0.006	0.039	-0.165	0.869
EXTERN WITH					EXTERN WITH				
HOSTILE	0.036	0.040	0.909	0.363	HOSTILE	0.036	0.039	0.910	0.363
BENEV	0.147	0.038	3.862	0.000	BENEV	0.153	0.038	4.002	0.000
HOSTILE WITH					HOSTILE WITH				
BENEV	0.112	0.026	4.257	0.000	BENEV	0.169	0.038	4.444	0.000
Means (OF PREDICTORS IN THE LIKELIHOOD)					Means				
MIND1C	0.835	0.017	48.266	0.000	MIND1C	1.889	0.065	28.928	0.000
Intercepts					Intercepts				
INTERN	4.971	0.110	45.208	0.000	INTERN	3.757	0.142	26.489	0.000
EXTERN	4.063	0.102	39.929	0.000	EXTERN	3.342	0.126	26.509	0.000
HOSTILE	4.069	0.070	58.010	0.000	HOSTILE	4.826	0.148	32.597	0.000
BENEV	4.109	0.066	62.245	0.000	BENEV	5.204	0.164	31.760	0.000
NONTRAD	7.457	0.731	10.203	0.000	NONTRAD	3.074	0.309	9.948	0.000
Variances (OF PREDICTORS IN THE LIKELIHOOD)					Variances				
MIND1C	0.195	0.011	18.069	0.000	MIND1C	1.000	0.000	999.000	999.000
Residual Variances					Residual Variances				
INTERN	1.729	0.096	18.070	0.000	INTERN	0.987	0.009	114.104	0.000
EXTERN	1.478	0.082	17.995	0.000	EXTERN	1.000	0.001	847.222	0.000
HOSTILE	0.704	0.039	18.070	0.000	HOSTILE	0.989	0.008	124.491	0.000
BENEV	0.623	0.034	18.069	0.000	BENEV	0.999	0.002	437.584	0.000
NONTRAD	4.400	0.245	17.987	0.000	NONTRAD	0.748	0.029	25.413	0.000
New/Additional Parameters					R-SQUARE				
XTOM1TOY	0.189	0.070	2.697	0.007	Observed				
XTOM2TOY	0.002	0.007	0.341	0.733	Variable	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
XTOM3TOY	0.159	0.064	2.490	0.013	INTERN	0.013	0.009	1.449	0.147
XTOM4TOY	0.011	0.016	0.699	0.485	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

UNSTANDARDIZED MODEL RESULTS					UNSTANDARDIZED MODEL RESULTS				
	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value		Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Group MEN					Group WOMEN				
NONTRAD ON					NONTRAD ON				
MIND1C	0.213	0.301	0.707	0.479	MIND1C	-0.126	0.239	-0.528	0.597
INTERN	0.548	0.110	4.995	0.000	INTERN	0.449	0.097	4.626	0.000
EXTERN	0.047	0.113	0.419	0.675	EXTERN	0.084	0.099	0.847	0.397
HOSTILE	-0.845	0.156	-5.402	0.000	HOSTILE	-0.535	0.150	-3.566	0.000
BENEV	-0.158	0.159	-0.991	0.322	BENEV	-0.159	0.144	-1.105	0.269
INTERN ON					INTERN ON				
MIND1C	0.633	0.191	3.324	0.001	MIND1C	0.099	0.139	0.709	0.478
EXTERN ON					EXTERN ON				
MIND1C	0.273	0.173	1.581	0.114	MIND1C	-0.117	0.138	-0.846	0.397
HOSTILE ON					HOSTILE ON				
MIND1C	-0.171	0.124	-1.385	0.166	MIND1C	-0.181	0.085	-2.143	0.032
BENEV ON					BENEV ON				
MIND1C	-0.314	0.110	-2.842	0.004	MIND1C	0.138	0.087	1.582	0.114
INTERN WITH					INTERN WITH				
EXTERN	0.640	0.110	5.807	0.000	EXTERN	0.556	0.080	6.934	0.000
HOSTILE	-0.475	0.078	-6.047	0.000	HOSTILE	-0.184	0.047	-3.913	0.000
BENEV	0.107	0.065	1.633	0.102	BENEV	-0.012	0.048	-0.245	0.806
EXTERN WITH					EXTERN WITH				
HOSTILE	0.058	0.067	0.869	0.385	HOSTILE	0.023	0.045	0.508	0.612
BENEV	0.154	0.060	2.576	0.010	BENEV	0.157	0.048	3.285	0.001
HOSTILE WITH					HOSTILE WITH				
BENEV	0.036	0.042	0.846	0.397	BENEV	0.118	0.030	4.008	0.000
Means					Means				
MIND1C	0.817	0.026	31.181	0.000	MIND1C	0.847	0.023	36.886	0.000
Intercepts					Intercepts				
INTERN	4.391	0.176	24.928	0.000	INTERN	5.414	0.133	40.622	0.000
EXTERN	3.871	0.159	24.272	0.000	EXTERN	4.200	0.132	31.900	0.000
HOSTILE	4.334	0.114	37.859	0.000	HOSTILE	3.853	0.081	47.513	0.000
BENEV	4.460	0.102	43.703	0.000	BENEV	3.848	0.084	45.915	0.000
NONTRAD	6.814	1.125	6.059	0.000	NONTRAD	7.172	0.938	7.646	0.000
Variances					Variances				
MIND1C	0.187	0.016	11.683	0.000	MIND1C	0.200	0.015	13.784	0.000
Residual Variances					Residual Variances				
INTERN	1.857	0.159	11.683	0.000	INTERN	1.473	0.107	13.784	0.000
EXTERN	1.522	0.131	11.636	0.000	EXTERN	1.433	0.104	13.732	0.000
HOSTILE	0.784	0.067	11.683	0.000	HOSTILE	0.545	0.040	13.784	0.000
BENEV	0.623	0.053	11.683	0.000	BENEV	0.583	0.042	13.784	0.000
NONTRAD	4.124	0.356	11.576	0.000	NONTRAD	4.230	0.307	13.765	0.000
New/Additional Parameters					New/Additional Parameters				
MX TOM1Y	0.347	0.125	2.767	0.006	WXTOM1Y	0.044	0.063	0.701	0.483
MX TOM2Y	0.013	0.032	0.405	0.685	WXTOM2Y	-0.010	0.016	-0.602	0.547
MX TOM3Y	0.145	0.108	1.341	0.180	WXTOM3Y	0.097	0.053	1.837	0.066
MX TOM4Y	0.050	0.053	0.935	0.350	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)

<p>Demonstrating options 2 and 3 using previous model:</p> <pre> ! 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; </pre>	<p>Wald Test of Parameter Constraints → test of difference in indirect effect</p> <table border="1"> <tr> <td>Value</td> <td>5.595</td> </tr> <tr> <td>Degrees of Freedom</td> <td>2</td> </tr> <tr> <td>P-Value</td> <td>0.0610</td> </tr> </table> <table border="1"> <thead> <tr> <th></th> <th>Estimate</th> <th>S.E.</th> <th>Est./S.E.</th> <th>Two-Tailed P-Value</th> </tr> </thead> <tbody> <tr> <td colspan="5">New/Additional Parameters</td> </tr> <tr> <td>DXTOM1</td> <td>0.535</td> <td>0.236</td> <td>2.267</td> <td>0.023</td> </tr> <tr> <td>DXTOM2</td> <td>0.389</td> <td>0.221</td> <td>1.763</td> <td>0.078</td> </tr> <tr> <td>DXTOM3</td> <td>0.010</td> <td>0.150</td> <td>0.066</td> <td>0.948</td> </tr> <tr> <td>DXTOM4</td> <td>-0.452</td> <td>0.141</td> <td>-3.210</td> <td>0.001</td> </tr> <tr> <td>DXTOY</td> <td>0.340</td> <td>0.385</td> <td>0.882</td> <td>0.378</td> </tr> <tr> <td>DM1TOY</td> <td>0.099</td> <td>0.146</td> <td>0.677</td> <td>0.499</td> </tr> <tr> <td>DM2TOY</td> <td>-0.036</td> <td>0.150</td> <td>-0.241</td> <td>0.809</td> </tr> <tr> <td>DM3TOY</td> <td>-0.310</td> <td>0.217</td> <td>-1.432</td> <td>0.152</td> </tr> <tr> <td>DM4TOY</td> <td>0.001</td> <td>0.215</td> <td>0.006</td> <td>0.995</td> </tr> </tbody> </table> <p>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.</p>	Value	5.595	Degrees of Freedom	2	P-Value	0.0610		Estimate	S.E.	Est./S.E.	Two-Tailed 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
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<p>Demonstrating option 1 using a constrained model (just new code shown):</p> <pre> 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; </pre>	<p>MODEL FIT INFORMATION</p> <table border="1"> <tr> <td>Number of Free Parameters</td> <td>52</td> </tr> <tr> <td>Loglikelihood</td> <td></td> </tr> <tr> <td>H0 Value</td> <td>-5334.992</td> </tr> <tr> <td>H1 Value</td> <td>-5332.207</td> </tr> </table> <p>Information Criteria</p> <table border="1"> <tr> <td>Akaike (AIC)</td> <td>10773.985</td> </tr> <tr> <td>Bayesian (BIC)</td> <td>11007.027</td> </tr> <tr> <td>Sample-Size Adjusted BIC</td> <td>10841.927</td> </tr> <tr> <td colspan="2">(n* = (n + 2) / 24)</td> </tr> </table> <p>Chi-Square Test of Model Fit</p> <p>→ test of difference in indirect effect</p> <table border="1"> <tr> <td>Value</td> <td>5.570</td> </tr> <tr> <td>Degrees of Freedom</td> <td>2</td> </tr> <tr> <td>P-Value</td> <td>0.0617</td> </tr> </table>	Number of Free Parameters	52	Loglikelihood		H0 Value	-5334.992	H1 Value	-5332.207	Akaike (AIC)	10773.985	Bayesian (BIC)	11007.027	Sample-Size Adjusted BIC	10841.927	(n* = (n + 2) / 24)		Value	5.570	Degrees of Freedom	2	P-Value	0.0617
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