

Testing Indirect Effects for Lower level Mediation Models in HLM

Here we provide syntax for fitting the lower-level mediation model using HLM6 as well as an excel calculator, **HLMEffectsCalc.xls**, that performs the computations necessary for evaluating the average indirect and total effects. In addition, a simulated data file is provided, named **sim.sas7bdat**, to which the lower level mediation model can be fit. Note that this file format is accepted by both SAS and SPSS, and either program can be used for data management purposes prior to fitting the model in HLM. The population model from which the simulated data were generated has the following form:

$$\begin{aligned}M_{ij} &= d_{Mj} + a_j X_{ij} + e_{Mij} \\ Y_{ij} &= d_{Yj} + b_j M_{ij} + c'_j X_{ij} + e_{Yij}\end{aligned}$$

In the population, the fixed-effects are $d_M = d_Y = 0$, $a = b = .6$ and $c' = .2$ and the variances of the random effects are $VAR(d_{Mj}) = .6$, $VAR(d_{Yj}) = .4$, $VAR(a_j) = VAR(b_j) = .16$ and $VAR(c'_j) = .04$.

The covariance between a_j and b_j is $\sigma_{a_j, b_j} = .113$, and all other random effects are uncorrelated.

These values imply that the average indirect and total effects in the population are .473 and .673, respectively. Last, the Level 1 residual variances are $VAR(e_{Mij}) = .65$ and $VAR(e_{Yij}) = .45$. In the simulated data, the number of Level 2 units (indicated by j) is $N = 100$, the number of observations within each Level 2 unit (indicated by i) is $n_j = 8$. We recommend saving the simulated data file to a directory on the users computer to be analyzed as shown here. We now provide the step-by step instructions for fitting the model to the data using the procedures described in Bauer, Preacher, and Gil (2006).

Restructuring Data in SPSS

The data must first be prepared for the analysis through the creation of a single dependent variable (Z) from the values of the mediator (M) and the distal outcome (Y). Two selection variables are also created, labeled S_y and S_m , to indicate when Z represents M versus Y . This

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rearrangement of the data is shown visually in Table 1 of Bauer, Preacher, and Gil (2006). Here we show how to accomplish this rearrangement using SPSS on the assumption that this may be the most common data management software used by HLM users. SAS syntax is provided in other online material showing how to structure the data and fit the model within SAS. The SPSS syntax for restructuring the data is as follows:

```
*Creating Md variable to use in data restructuring.  
COMPUTE Md = m .  
EXECUTE .
```

```
*Restructuring data for multilevel analysis.  
VARSTOCASES /ID = obs  
/MAKE Z FROM Md y  
/INDEX = Index1(Z)  
/KEEP = m x id.
```

The first part of the syntax generates Md as the dependent M variable to be used to construct the single dependent variable (Z). Although Md is redundant with M, this redundancy allows for the creation of Z from both Y and M (now Md) *and* the retention of M as a predictor of Y within Z. The VARSTOCASES statement begins the data restructuring, with /ID = obs creating a variable (obs) to identify the row at which the observations were located in the original data file. The /MAKE Z FROM Md y statement creates the single dependent variable (Z) by stacking the values of the dependent mediator (Md) and the distal outcome (Y) so each measurement appears on a separate row. The statement /INDEX = Index1(Z) creates a variable (Index1) to distinguish Y from M values. The /KEEP = m x id statement indicates which variables should be kept as fixed variables, any variables that should appear in each row for a given observation. The following page includes visual representations of the data set with the Md variable and the restructured data set.

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First 12 observations of the data set with the Md variable:

*Simdata.sav [DataSet1] - SPSS Data Editor

	id	x	m	y	Md
1	1	1.55	.11	.57	.11
2	1	2.28	2.11	1.21	2.11
3	1	.79	.04	-.26	.04
4	1	-.06	.48	-.76	.48
5	1	.12	.59	.52	.59
6	1	1.48	.89	-.63	.89
7	1	.89	-.23	.15	-.23
8	1	.92	.73	.23	.73
9	2	1.00	-.36	-1.15	-.36
10	2	-1.19	-2.97	-3.72	-2.97
11	2	-1.80	-3.65	-4.47	-3.65
12	2	-1.26	-2.30	-3.22	-2.30

Restructured data:

File Edit View Data Transform Analyze Graphs Utilities Window Help

	obs	m	x	id	Index1	Z
1	1	.11	1.55	1	Md	.11
2	1	.11	1.55	1	y	.57
3	2	2.11	2.28	1	Md	2.11
4	2	2.11	2.28	1	y	1.21
5	3	.04	.79	1	Md	.04
6	3	.04	.79	1	y	-.26
7	4	.48	-.06	1	Md	.48
8	4	.48	-.06	1	y	-.76
9	5	.59	.12	1	Md	.59
10	5	.59	.12	1	y	.52
11	6	.89	1.48	1	Md	.89
12	6	.89	1.48	1	y	-.63
13	7	-.23	.89	1	Md	-.23
14	7	-.23	.89	1	y	.15
15	8	.73	.92	1	Md	.73
16	8	.73	.92	1	y	.23
17	9	-.36	1.00	2	Md	-.36
18	9	-.36	1.00	2	y	-1.15
19	10	-2.97	-1.19	2	Md	-2.97
20	10	-2.97	-1.19	2	y	-3.72
21	11	-3.65	-1.80	2	Md	-3.65
22	11	-3.65	-1.80	2	y	-4.47
23	12	-2.30	-1.26	2	Md	-2.30
24	12	-2.30	-1.26	2	y	-3.22

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The following syntax creates the two selection variables labeled **Sy** and **Sm**, to indicate when **Z** represents **M** versus **Y**:

*Creating Sy indicator variable.

RECODE

Index1

('Md'=0) ('y'=1) INTO Sy .

VARIABLE LABELS Sy 'Sy'.

EXECUTE .

*Creating Sm indicator variable.

RECODE

Index1

('Md'=1) ('y'=0) INTO Sm .

VARIABLE LABELS Sm 'Sm'.

EXECUTE .

The following syntax creates the product variables **SMX**, **SYX**, and **SYM** for the analysis:

*Computing variables for analysis.

COMPUTE SmX = Sm * X .

EXECUTE .

COMPUTE SyX = Sy * X .

EXECUTE .

COMPUTE SyM = Sy * M .

EXECUTE .

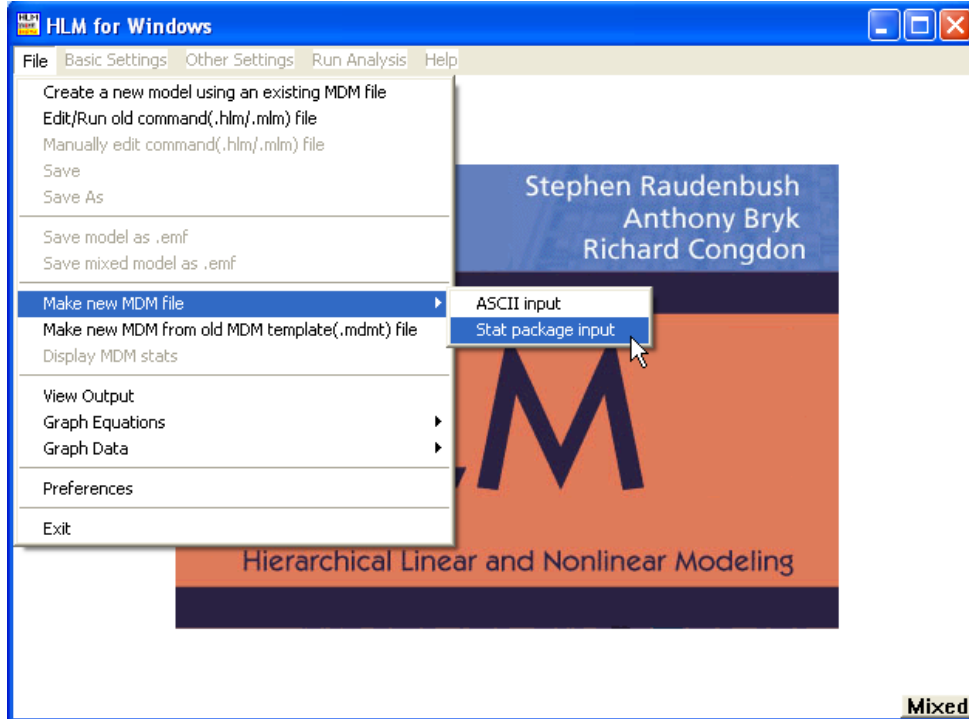
This data file will serve as both the level 1 and level 2 data file for HLM (it is not necessary to create separate level 1 and level 2 data files) The final data set should look like this:

File Edit View Data Transform Analyze Graphs Utilities Window Help											
1 : obs											
	obs	m	x	id	Index1	Z	Sy	Sm	SmX	SyX	Vis
1	1	.11	1.55	1	Md	.11	.00	1.00	1.55	.00	
2	1	.11	1.55	1	y	.57	1.00	.00	.00	1.55	
3	2	2.11	2.28	1	Md	2.11	.00	1.00	2.28	.00	
4	2	2.11	2.28	1	y	1.21	1.00	.00	.00	2.28	
5	3	.04	.79	1	Md	.04	.00	1.00	.79	.00	
6	3	.04	.79	1	y	-.26	1.00	.00	.00	.79	
7	4	.48	-.06	1	Md	.48	.00	1.00	-.06	.00	
8	4	.48	-.06	1	y	-.76	1.00	.00	.00	-.06	
9	5	.59	.12	1	Md	.59	.00	1.00	.12	.00	
10	5	.59	.12	1	y	.52	1.00	.00	.00	.12	
11	6	.89	1.48	1	Md	.89	.00	1.00	1.48	.00	
12	6	.89	1.48	1	y	-.63	1.00	.00	.00	1.48	
13	7	-.23	.89	1	Md	-.23	.00	1.00	.89	.00	
14	7	-.23	.89	1	y	.15	1.00	.00	.00	.89	
15	8	.73	.92	1	Md	.73	.00	1.00	.92	.00	
16	8	.73	.92	1	y	.23	1.00	.00	.00	.92	
17	9	-.36	1.00	2	Md	-.36	.00	1.00	1.00	.00	
18	9	-.36	1.00	2	y	-1.15	1.00	.00	.00	1.00	
19	10	-2.97	-1.19	2	Md	-2.97	.00	1.00	-1.19	.00	
20	10	-2.97	-1.19	2	y	-3.72	1.00	.00	.00	-1.19	
21	11	-3.65	-1.80	2	Md	-3.65	.00	1.00	-1.80	.00	
22	11	-3.65	-1.80	2	y	-4.47	1.00	.00	.00	-1.80	
23	12	-2.30	-1.26	2	Md	-2.30	.00	1.00	-1.26	.00	
24	12	-2.30	-1.26	2	y	-3.22	1.00	.00	.00	-1.26	

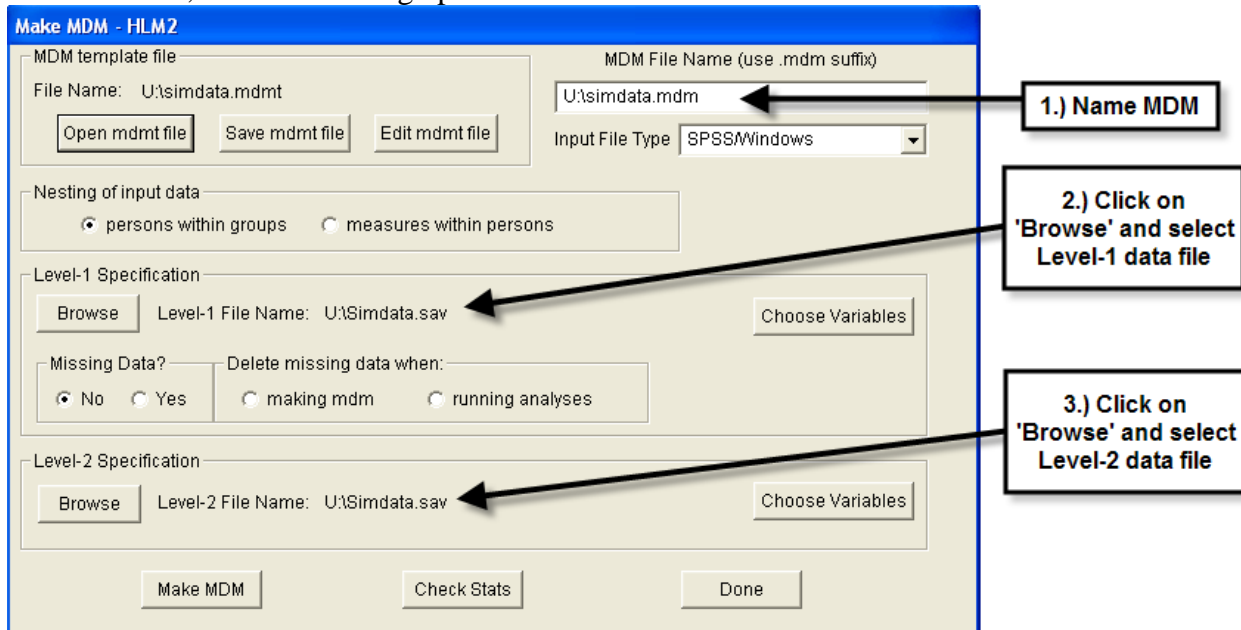
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Creating a MDM file from a SPSS file

After launching HLM, select **File** → **Make new MDM file** → **Stat package input**:



Select **HLM2**, which will bring up this screen:



Begin by naming the MDM file (1), then identify the Level-1 (2) and Level 2 (3) data files. These will both be the same data file that was created within SPSS. The choice of 'persons within groups' or 'measures within persons' is not important for our example; both will fit the same model, the only difference is the notation HLM uses to display the model.

Testing Indirect Effects for Lower level Mediation Models in HLM

Next click on **Choose Variables** under “Level-1 Specification” to select Level-1 variables for analysis. For our analysis the single dependent variable **Z**, the selection variables **SY** and **SM**, as well as the product variables **SMX**, **SYX**, and **SYM** are included as Level-1 variables. The grouping variable, in our analysis **ID**, is chosen as the ID variable.

Choose variables - HLM2

Variable	ID	in MDM
OBS	<input type="checkbox"/>	<input type="checkbox"/>
M	<input type="checkbox"/>	<input type="checkbox"/>
X	<input type="checkbox"/>	<input type="checkbox"/>
ID	<input checked="" type="checkbox"/>	<input type="checkbox"/>
INDEX1	<input type="checkbox"/>	<input type="checkbox"/>
Z	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SY	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SM	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SMX	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SYX	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SYM	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>

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OK Cancel

Next click on **Choose Variables** under “Level-2 Specification” to select Level-2 variables for analysis. For our analysis the grouping variable **ID**, is chosen as the ID variable and there are no level 2 variables. One could however include such variables, for instance when wishing to control for level 2 covariates, or when evaluating moderated mediation (as in the empirical example in Bauer, Preacher & Gil, 2006).

Choose variables - HLM2

Variable	ID	in MDM
OBS	<input type="checkbox"/>	<input type="checkbox"/>
M	<input type="checkbox"/>	<input type="checkbox"/>
X	<input type="checkbox"/>	<input type="checkbox"/>
ID	<input checked="" type="checkbox"/>	<input type="checkbox"/>
INDEX1	<input type="checkbox"/>	<input type="checkbox"/>
Z	<input type="checkbox"/>	<input type="checkbox"/>
SY	<input type="checkbox"/>	<input type="checkbox"/>
SM	<input type="checkbox"/>	<input type="checkbox"/>
SMX	<input type="checkbox"/>	<input type="checkbox"/>
SYX	<input type="checkbox"/>	<input type="checkbox"/>
SYM	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>

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OK Cancel

Testing Indirect Effects for Lower level Mediation Models in HLM

After the Level 1 and 2 variables have been specified, you can save the MDM template file by clicking **Save mdmt file**. Next select **Make MDM(1)**. This produces the HLM data file and flashes up some summary statistics for the level 1 and level 2 variables. You can access these again by clicking on **Check Stats (2)**.

The screenshot shows the 'Make MDM - HLM2' dialog box. It has a blue title bar and a light beige background. The dialog is organized into several sections:

- MDM template file**: Contains a 'File Name' field with 'U:\simdata.mdmt', three buttons ('Open mdmt file', 'Save mdmt file', 'Edit mdmt file'), an 'MDM File Name (use .mdm suffix)' field with 'U:\simdata.mdm', and an 'Input File Type' dropdown menu set to 'SPSS/Windows'.
- Nesting of input data**: Contains two radio buttons, 'persons within groups' (selected) and 'measures within persons'.
- Level-1 Specification**: Contains a 'Browse' button, a 'Level-1 File Name' field with 'U:\Simdata.sav', a 'Choose Variables' button, a 'Missing Data?' section with 'No' (selected) and 'Yes' radio buttons, and a 'Delete missing data when:' section with 'making mdm' (selected) and 'running analyses' radio buttons.
- Level-2 Specification**: Contains a 'Browse' button, a 'Level-2 File Name' field with 'U:\Simdata.sav', and a 'Choose Variables' button.
- Bottom Buttons**: Three buttons are arranged horizontally: 'Make MDM', 'Check Stats', and 'Done'. Below each button is a black arrow pointing up to it, and below each arrow is a white box with a black border containing a black number: '1' under 'Make MDM', '2' under 'Check Stats', and '3' under 'Done'.

To start building the model click on **Check Stats (2)**. then **Done(3)**.

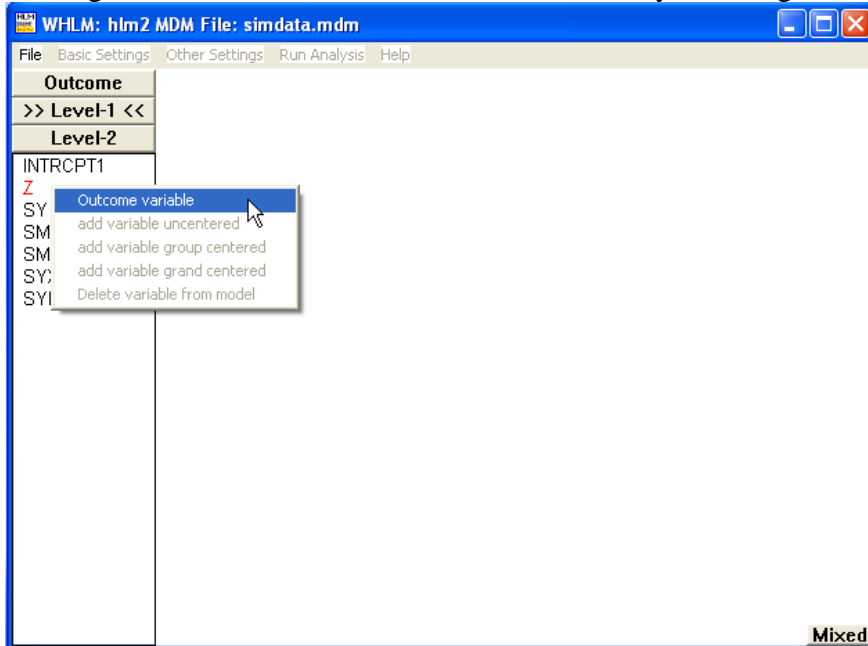
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Building the model

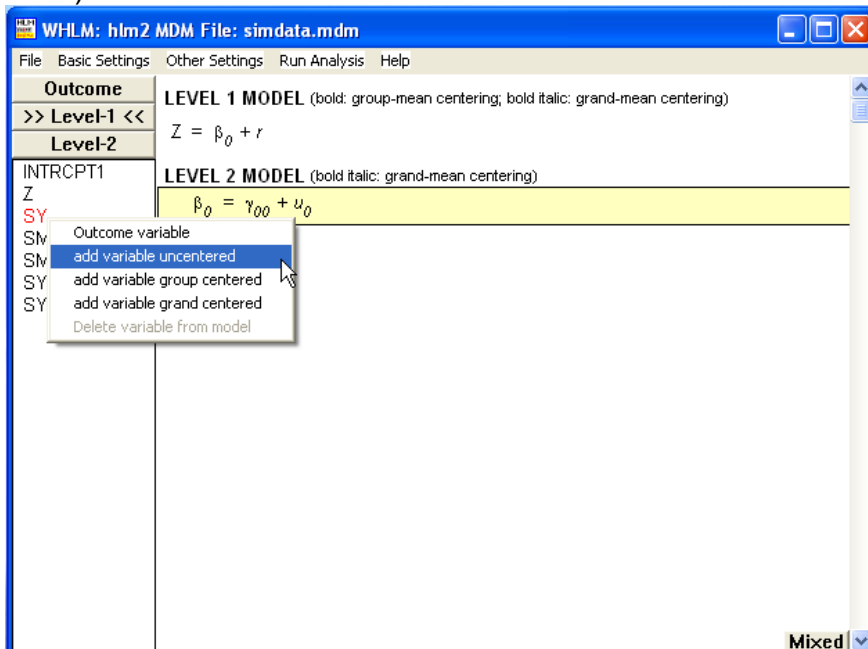
The model of interest (equivalent the two equations shown in the first paragraph) is given by the single equation:

$$Z_{ij} = d_{Mj}S_{Mij} + a_j(S_{Mij}X_{ij}) + d_{Yj}S_{Yij} + b_j(S_{Yij}M_{ij}) + c'_j(S_{Yij}X_{ij}) + e_{Zij}$$

We begin the construction of this model in HLM by selecting Z as the outcome variable:

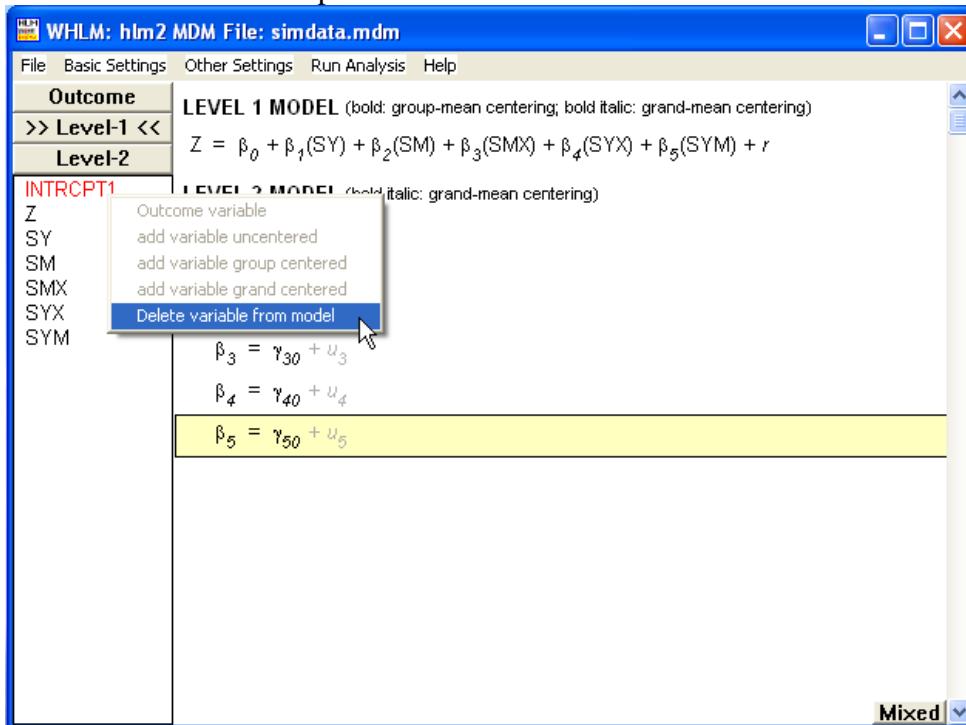


Next select the two selection variables (SY and SM), and the product variables (SMX, SYX and SYM) as the Level 1 variables:

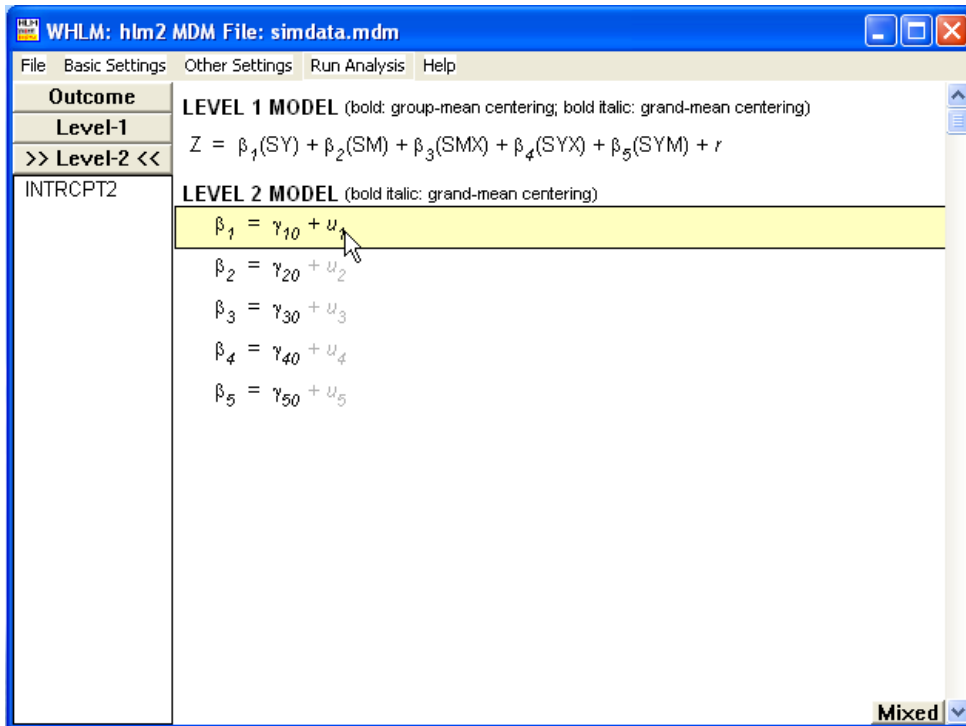


Testing Indirect Effects for Lower level Mediation Models in HLM

Then remove the intercept:

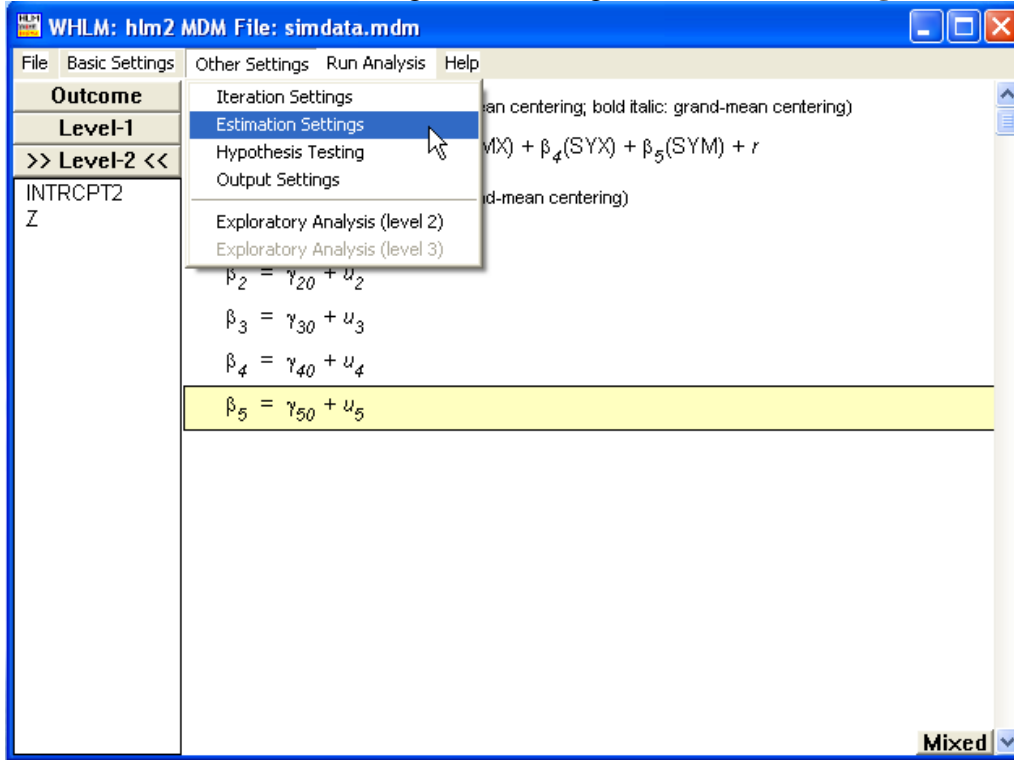


To allow the coefficients to have random effects (representing differences across Level-2 units, select **Level-2** and add random components to all Level 1 variables by clicking on all the **u** variables:

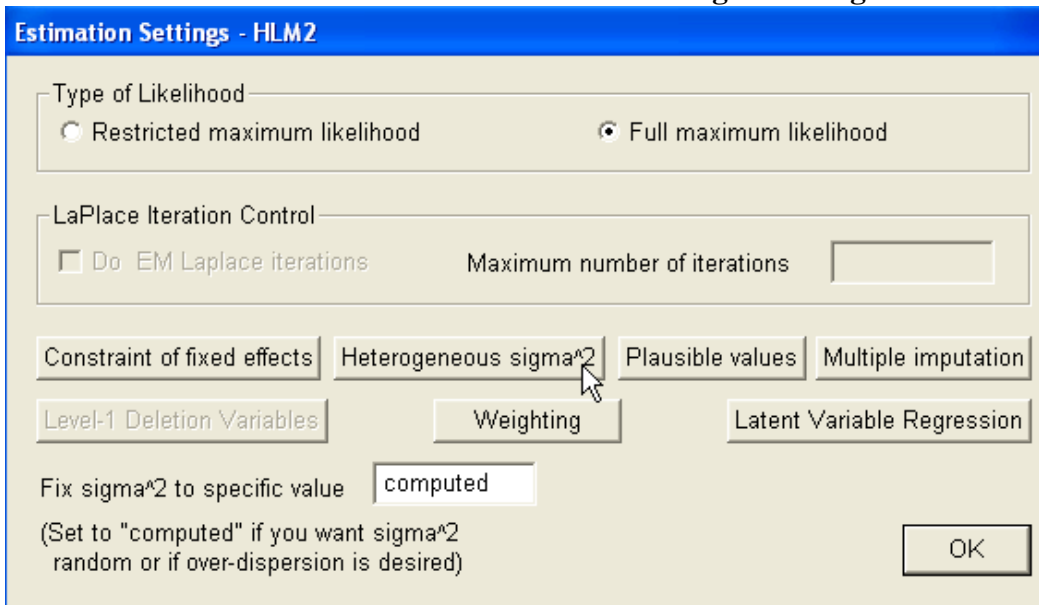


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After the fixed and random effects are specified the estimation settings need to be modified in order to obtain estimates for the heterogeneous σ^2 values for SY and SM (i.e., different residual variances for the two outcomes). To change these settings select **Other Settings** → **Estimation Settings**:



Select **Full maximum likelihood** then click on **Heterogeneous sigma²**:



Testing Indirect Effects for Lower level Mediation Models in HLM

This window should appear:

Heterogeneous sigma^2: Predictors of level-1 variance

Double-click to move variables in and out of Predictors column

Possible choices	Predictors of level-1 variance
SY SMX SYX SYM	SM

OK

Iteration Control

Macro Iterations	100	Micro Iterations	100
Stopping Criterion	0.0001000000	Stopping Criterion	0.0000010000

Select SM as a predictor of Level-1 variance by double-clicking, then select **OK**

The final model should look like this:

WHLM: hlm2 MDM File: simdata.mdm Command File: simHLMmodel.hlm

File Basic Settings Other Settings Run Analysis Help

Outcome

>> Level-1 <<

Level-2

INTRCPT1
Z
SY
SM
SMX
SYX
SYM

LEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)

$$Z = \beta_1(SY) + \beta_2(SM) + \beta_3(SMX) + \beta_4(SYX) + \beta_5(SYM) + r$$

$\text{Var}(r) = \sigma^2$ and $\log(\sigma^2) = \alpha_0 + \alpha_1(SM)$

LEVEL 2 MODEL (bold italic: grand-mean centering)

$\beta_1 = \gamma_{10} + u_1$

$\beta_2 = \gamma_{20} + u_2$

$\beta_3 = \gamma_{30} + u_3$

$\beta_4 = \gamma_{40} + u_4$

$\beta_5 = \gamma_{50} + u_5$

Mixed

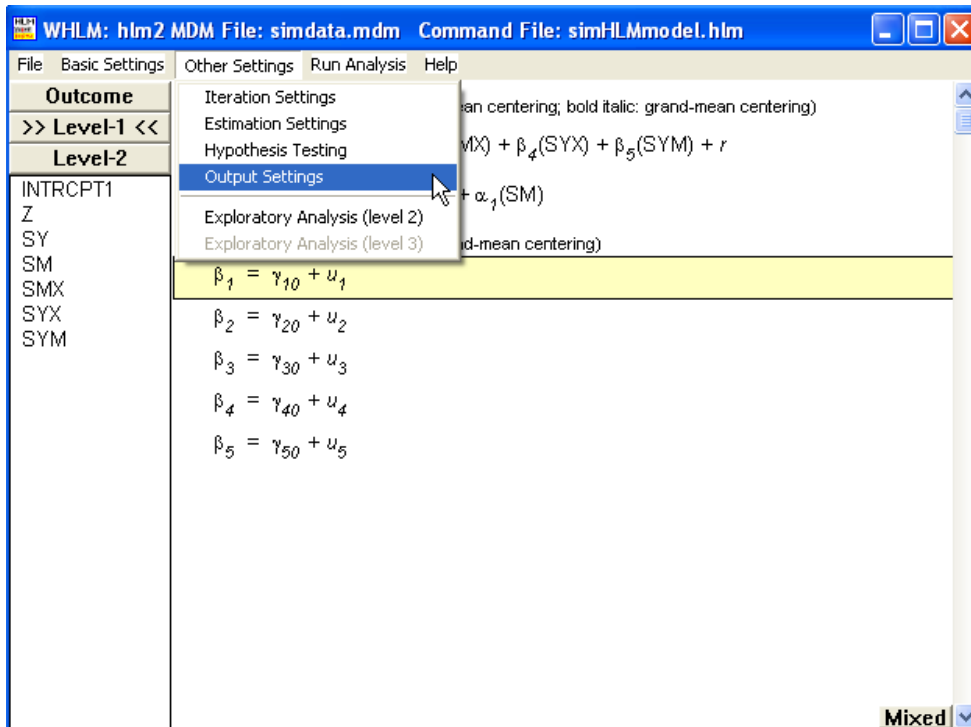
Testing Indirect Effects for Lower level Mediation Models in HLM

The specification of:

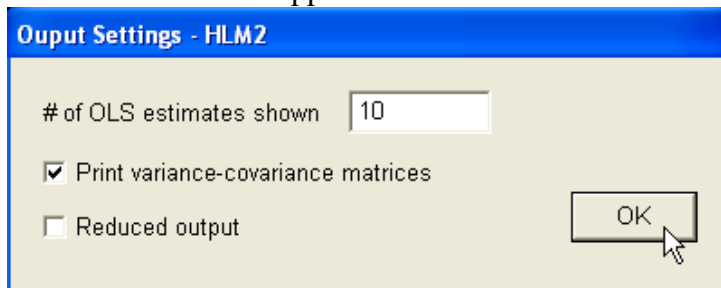
$$\text{Var}(r) = \sigma^2 \text{ and } \log(\sigma^2) = \alpha_0 + \alpha_1(\text{SM})$$

Allows for the estimation of heterogeneous σ^2 values for SY and SM, such that the level 1 residual variance of SY is obtained by e^{α_0} and the level 1 residual variance of SM is $e^{\alpha_0 + \alpha_1}$.

Lastly, the asymptotic covariance matrices of the fixed effects and variance components need to be requested. These values are required for the computation of the standard errors of the average indirect and total effects. To obtain these values select **Other Settings** → **Output Settings**:



This window should appear:



Select **Print variance-covariance matrices**, then select **OK**.

Now that the model, estimation and output settings have been specified select **Run Analysis** to fit the model to the data.

Testing Indirect Effects for Lower level Mediation Models in HLM

HLM Model Output

An illustration of how the final HLM model is related to the model of interest:

$$Z = \beta_1(SY) + \beta_2(SM) + \beta_3(SMX) + \beta_4(SYX) + \beta_5(SYM) + r$$

$$Z_{ij} = d_{1j}S_{1ij} + a_j(S_{1ij}X_{ij}) + d_{2j}S_{2ij} + b_j(S_{2ij}M_{ij}) + c'_j(S_{2ij}X_{ij}) + e_{2ij}$$

The estimates for the fixed and random effects can be found in both the HLM output and the data files **gamvc.dat** and **tauvc.dat**. Fixed effects in the HLM output:

Final estimation of fixed effects:

Fixed Effect	Coefficient	Standard Error	T-ratio	Approx. d.f.	P-value
For SY slope, B1					
INTRCPT2, G10	-0.096914	0.061565	-1.574	99	0.118
For SM slope, B2					
INTRCPT2, G20	0.092767	0.088887	1.044	99	0.300
For SMX slope, B3					
INTRCPT2, G30	0.611908	0.046210	13.242	99	0.000
For SYX slope, B4					
INTRCPT2, G40	0.220008	0.036974	5.950	99	0.000
For SYM slope, B5					
INTRCPT2, G50	0.611202	0.045176	13.529	99	0.000

Covariance estimates in the HLM output:

Tau

SY, B1	0.26660	0.05616	0.01187	-0.01748	-0.00445
SM, B2	0.05616	0.67048	0.01828	-0.00610	0.00916
SMX, B3	0.01187	0.01828	0.11812	-0.02186	0.09851
SYX, B4	-0.01748	-0.00610	0.02186	0.03110	0.00612
SYM, B5	-0.00445	0.00916	0.09851	0.00612	0.10918

The estimates for α_0 and α_1 in the HLM output:

RESULTS FOR HETEROGENEOUS SIGMA-SQUARED
(macro iteration 8)

Var(R) = sigma_squared and
log(sigma_squared) = alphas0 + alpha1(SM)

Model for level-1 variance

Parameter	Coefficient	Standard Error	Z-ratio	P-value
INTRCPT1	alpha0 -0.67489	0.059303	-11.380	0.000
SM	alpha1 0.23976	0.082155	2.918	0.004

Thus for our example, the estimated residual variance is $e^{-0.67489} = .508965$ for SY and $e^{-0.67489+0.23976} = .646731$ for SM

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At the end of the HLM output there should be a note indicating the creation of 3 data files:

```
tauvvc.dat, containing tau and the variance-covariance matrix of tau has been created.  
gamvc.dat, containing the variance-covariance matrix of gamma has been created.  
gamvcr.dat, containing the robust variance-covariance matrix of gamma has  
been created.
```

By default, these files are placed into the same directory as the program file used to fit the model.

Calculating Random Indirect and Total Effects:

To calculate the indirect and total effects begin by open the **gamvc.dat** output file from HLM and the excel effects calculator spreadsheet **HLMEffectsCalc.xls**. The first row of **gamvc.dat** provides the fixed effects estimates for the level 1 coefficients in the order that they were specified in the model.

Mixed Model

$$Z = \gamma_{10} * SY + \gamma_{20} * SM + \gamma_{30} * SMX + \gamma_{40} * SYX + \gamma_{50} * SYM + u_1 * SY + u_2 * SM + u_3 * SMX + u_4 * SYX + u_5 * SYM + r$$

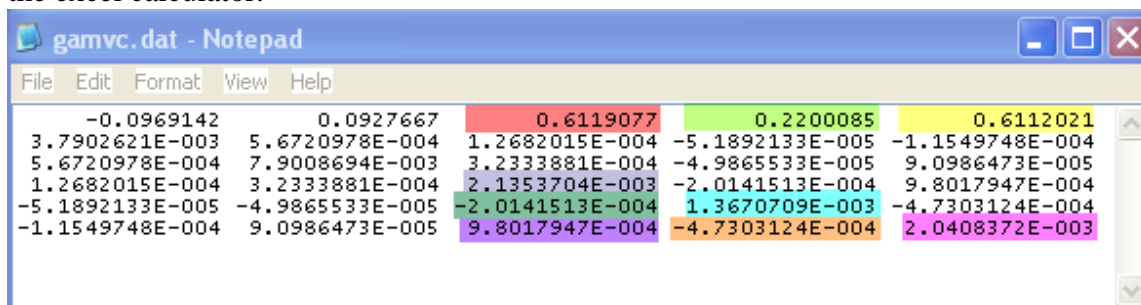
File	Edit	Format	View	Help
-0.0969142	0.0927667	0.6119077	0.2200085	0.6112021
3.7902621E-003	5.6720978E-004	1.2682015E-004	-5.1892133E-005	-1.1549748E-004
5.6720978E-004	7.9008694E-003	3.2333881E-004	-4.9865533E-005	9.0986473E-005
1.2682015E-004	3.2333881E-004	2.1353704E-003	-2.0141513E-004	9.8017947E-004
-5.1892133E-005	-4.9865533E-005	-2.0141513E-004	1.3670709E-003	-4.7303124E-004
-1.1549748E-004	9.0986473E-005	9.8017947E-004	-4.7303124E-004	2.0408372E-003

The second and subsequent rows of **gamvc.dat** represent the estimated sampling variances and covariances of the fixed effect estimates.


The values of interest are the estimated values of γ_{30} , γ_{40} , and γ_{50} (which correspond to a, c' and b, respectively) and their estimated sampling variances and covariances.

Testing Indirect Effects for Lower level Mediation Models in HLM

To better indicate which values are used in the calculations as well as where the values should be entered into the calculator the values have been **highlighted** in both the **gamvc.dat** output file and the excel calculator.



File	Edit	Format	View	Help
-0.0969142	0.0927667	0.6119077	0.2200085	0.6112021
3.7902621E-003	5.6720978E-004	1.2682015E-004	-5.1892133E-005	-1.1549748E-004
5.6720978E-004	7.9008694E-003	3.2333881E-004	-4.9865533E-005	9.0986473E-005
1.2682015E-004	3.2333881E-004	2.1353704E-003	-2.0141513E-004	9.8017947E-004
-5.1892133E-005	-4.9865533E-005	-2.0141513E-004	1.3670709E-003	-4.7303124E-004
-1.1549748E-004	9.0986473E-005	9.8017947E-004	-4.7303124E-004	2.0408372E-003

	A	B	C	D	E	F
1						
2		Calculator for Random Indirect and Total Effects in Multilevel Models				
3		Equations from Bauer, Preacher and Gil, 2006				
4						
5						
6	Fixed Effect and Variance-Covariance Parameter estimates					
7		a	b	c'		
8	Gammas	0.6119077	0.6112021	0.2200085	From GAMVC.DAT	
9	Covariance Matrix of the Fixed effects					
10		a	b	c'		
11	a	0.00213537	X	X	From GAMVC.DAT	
12	b	0.00098018	0.00204084	X		
13	c'	-0.00020142	-0.00047303	0.00136707		
14	Covariance Matrix of Random Slopes					
15		a(j)	b(j)	c'(j)		
16	a(j)	0.1181218	X	X	From TAUVC.DAT	
17	b(j)	0.0985146	0.1091824	X		
18	c'(j)	-0.0218558	0.0061177	0.0311016		
19						
20	Estimated Sampling Variance for Estimated Covariance Between a(j) with					
21		var[cov(a(j),b(j))]	0.0005209	From TAUVC.DAT		
22						
23	Random Indirect Effect			Random Total Effect		
24						
25		eq. 5	eq. 6			eq. 7
26		Average	Variance			Average
27		0.472513871	0.18129853			0.692522371

Testing Indirect Effects for Lower level Mediation Models in HLM

The other estimates needed for the calculations are located in the **tauvc.dat** output file from HLM. Like **gamvc.dat** the estimates appear in the order that they were specified in the model. The first 5 rows represent the covariance matrix for the random effects. In our example, row 3 corresponds to the variance/covariance estimates for SMX (a_j), while row 4 contains the estimates for SYX (c'_j) and row 5 has the SYM (b_j) estimates. The subsequent rows are the asymptotic covariance matrix for the variance component estimates. (It should be noted that this file has word wrapping so every 2 rows following the covariance matrix for the random effects represents 1 row of the asymptotic covariance matrix)

The screenshot shows a Notepad window titled "tauvc.dat - Notepad". The window displays a large matrix of numerical values. The first 5 rows represent the covariance matrix for the random effects. The subsequent rows represent the asymptotic covariance matrix for the variance component estimates. The matrix is organized into blocks, with the first 5 rows representing the random effects covariance matrix and subsequent rows representing the asymptotic covariance matrix.

The estimate that is challenging to identify is the asymptotic variance of the random effect $\text{COV}(a_j, b_j)$. This estimate is located in the n row and n column of the asymptotic covariance matrix for the variance component estimates, where n is the location of the $\text{COV}(a_j, b_j)$ in the covariance matrix for the random effects. For example in our matrix the $\text{COV}(a_j, b_j)$ is located in the 13th element of the asymptotic covariance matrix for the variance component estimates:

	SY	SM	SMX	SYX	SYM
SY	1				
SM	2	3			
SMX	4	5	6		
SYX	7	8	9	10	
SYM	11	12	13	14	15

Therefore the asymptotic variance $\text{COV}(a_j, b_j)$ is located in the 13th row and 13th column of the asymptotic covariance matrix for the variance component estimates.

Testing Indirect Effects for Lower level Mediation Models in HLM

As with the **gamvc.dat** the values are used in the calculations as well as where the values should be entered into the calculator the values have been **highlighted** in both the **tauvc.dat** output file and the excel calculator.

tauvc.dat - Notepad

File Edit Format View Help

ACOV matrix row 1

ACOV matrix row 13

0.2666021	0.0561617	0.0118693	-0.0174834	-0.0044512					
0.0561617	0.6704840	0.0182832	-0.0061023	0.0091615					
0.0118693	0.0182832	-0.1181218	-0.0218558	0.0985146					
-0.0174834	-0.0061023	-0.0218558	0.0311016	0.0061177					
-0.0044512	0.0091615	0.0985146	0.0061177	0.1091824					
0.0028850	0.0004297	0.0000657	0.0000979	0.0000150	0.0000028	-0.0000589	-0.0000005		
-0.0000032	-0.0001114	-0.0000770	-0.0000168	-0.0000034	0.0000575	-0.0000986			
0.0004297	0.0030225	0.0008974	0.0001168	0.0001196	0.0000055	-0.0000206	-0.0000609		
-0.0000611	-0.0000021	0.0000250	-0.0000818	-0.0000007	-0.0000004	-0.0000012			
0.0000657	0.0008974	0.0124675	0.0000388	0.0004598	-0.0001337	-0.0000040	-0.0000838		
-0.0000070	-0.0000000	0.0000095	0.0001439	0.0000031	-0.0000002	0.0000011			
0.0000979	0.0001168	0.0000388	0.0008141	0.0001241	0.0000541	-0.0000793	-0.0000768		
-0.0000134	-0.0000002	0.0003701	0.0000532	-0.0000151	-0.0000012	-0.0000244	-0.0000120		
-0.0000150	0.0001196	0.0004598	0.0001241	0.0016216	0.0001328	0.0000120	-0.0001634		
-0.0000186	0.0000020	0.0000567	0.0007756	0.0000516	-0.0000069	0.0000181	-0.0001634		
-0.0000028	0.0000055	-0.0001337	0.0000541	0.0001328	-0.00008741	0.0000051	-0.0000149		
-0.0000868	0.0000085	0.0000249	0.0000641	0.0004196	-0.0000396	0.0001923	-0.0000721		
-0.0000589	-0.0000206	-0.0000040	-0.0000793	-0.0000120	-0.0000051	0.0004561	0.0000721		
0.0000169	-0.0000218	-0.0001469	-0.0000188	-0.0000025	-0.0000105	0.0000077	0.0010893		
-0.0000005	-0.0000609	-0.0000838	-0.0000768	-0.0001634	-0.0000149	0.0000091	0.0000402		
0.0000402	-0.0000141	-0.0000271	-0.0003706	-0.0000137	0.0000151	-0.0000077	0.0000169		
-0.0000032	-0.0000611	-0.0000070	-0.0000134	-0.0000186	-0.0000866	0.0000169	0.0000402		
0.0002835	-0.0000576	-0.0000098	-0.0000173	-0.0001219	0.0001448	-0.0000930	-0.0000141		
-0.0001114	-0.0000021	-0.0000000	-0.0000002	0.0000020	0.0000085	-0.00000218	-0.0000141		
-0.0000576	0.0003199	0.0000130	0.0000051	0.0000218	-0.0000936	0.0000064	-0.0000271		
-0.0000770	0.0000250	0.0000099	0.0003701	0.0000567	0.0000249	-0.0001469	-0.0000271		
-0.0000098	0.0000130	0.0007240	0.0001136	0.0000131	-0.0000084	-0.0000411	-0.00003706		
-0.0000168	-0.0000818	0.0001439	0.0000532	0.0007756	0.0000641	-0.0000188	-0.00003706		
-0.0000173	0.0000051	0.0001136	0.0016066	0.0000745	-0.0000153	0.0000387	-0.0000137		
-0.0000034	-0.0000007	0.0000031	-0.0000151	0.0000516	0.0004196	-0.0000025	-0.0000137		
-0.0001219	0.0000218	0.0000131	0.0000745	0.0000881	-0.0000881	0.0004002	0.0000151		
0.0000575	-0.0000004	-0.0000002	-0.0000012	-0.0000069	-0.0000396	-0.0000105	0.0000151		
0.0001448	-0.0000936	-0.0000084	-0.0000153	-0.0000881	0.0002769	-0.0001736	-0.0000077		
-0.0000986	-0.0000012	0.0000011	-0.0000244	0.0000181	0.0001923	0.0000077	-0.0000091		
-0.0000930	0.0000064	-0.0000411	0.0000387	0.0004002	-0.0001736	0.0007950			

	A	B	C	D	E	F
1						
2		Calculator for Random Indirect and Total Effects in Multilevel Models				
3		Equations from Bauer, Preacher and Gil, 2006				
4						
5						
6	Fixed Effect and Variance-Covariance Parameter estimates					
7		a	b	c'		
8	Gammas	0.6119077	0.6112021	0.2200085	From GAMVC.DAT	
9	Covariance Matrix of the Fixed effects					
10		a	b	c'		
11	a	0.00213537	X	X	From GAMVC.DAT	
12	b	0.00098018	0.00204084	X		
13	c'	-0.00020142	-0.00047303	0.00136707		
14	Covariance Matrix of Random Slopes					
15		a(j)	b(j)	c'(j)		
16	a(j)	0.1181218	X	X	From TAUVC.DAT	
17	b(j)	0.0985146	0.1091824	X		
18	c'(j)	-0.0218558	0.0061177	0.0311016		
19						
20	Estimated Sampling Variance for Estimated Covariance Between a(j) with					
21		var[cov(a(j),b(j))]	0.0005209	From TAUVC.DAT		
22						
23	Random Indirect Effect			Random Total Effect		
24						
25		eq. 5	eq. 6			eq. 7
26		Average	Variance			Average
27		0.472513871	0.18129853			0.692522371

Testing Indirect Effects for Lower level Mediation Models in HLM

Once all the estimates from both the **gamvc.dat** and the **tauvc.dat** data files the spreadsheet will calculate the formulas for the average (fixed) indirect and total effects (equations 5 and 7) and the standard errors (equation 9 and 10) and 95% confidence intervals (equations 11 and 12) of these average effect estimates. The variances of the random indirect and total effects are also computed (equations 6 and 8). The 95% CIs in this calculator are based on normal sampling distribution; the Monte Carlo (MC) method of constructing CI is not available with this calculator.

The final calculations:

	A	B	C	D	E	F	G	H
1								
2		Calculator for Random Indirect and Total Effects in Multilevel Models						
3		Equations from Bauer, Preacher and Gil, 2006						
4								
5								
6	Fixed Effect and Variance-Covariance Parameter estimates							
7		a	b	c'				
8	Gammas	0.6119077	0.6112021	0.2200085	From GAMVC.DAT			
9	Covariance Matrix of the Fixed effects							
10		a	b	c'				
11	a	0.00213537	X	X	From GAMVC.DAT			
12	b	0.00098018	0.00204084	X				
13	c'	-0.00020142	-0.00047303	0.00136707				
14	Covariance Matrix of Random Slopes							
15		a(j)	b(j)	c'(j)				
16	a(j)	0.1181218	X	X	From TAUVC.DAT			
17	b(j)	0.0985146	0.1091824	X				
18	c'(j)	-0.0218558	0.0061177	0.0311016				
19								
20	Estimated Sampling Variance for Estimated Covariance Between a(j) with b(j) Random Effects							
21		var[cov(a(j),b(j))]	0.0005209	From TAUVC.DAT				
22								
23	<u>Random Indirect Effect</u>			<u>Random Total Effect</u>				
24								
25		eq. 5	eq. 6			eq. 7	eq. 8	
26		Average	Variance			Average	Variance	
27		0.472513871	0.18129853			0.692522371	0.19317044	
28								
29								
30	<u>Random Indirect Effect</u>							
31		eq. 5	sqrt(eq. 9)	eq. 11				
32			Standard	95 % Confidence Interval (alpha=0.05)				
33		Average	Error	Lower	Upper			
34		0.472513871	0.053115456	0.36840758	0.57662016			
35								
36								
37	<u>Random Total Effect</u>							
38		eq. 7	sqrt(eq.10)	eq. 12				
39			Standard	95 % Confidence Interval (alpha=0.05)				
40		Average	Error	Lower	Upper			
41		0.692522371	0.057993134	0.57885583	0.80618891			