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 **sim2.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. Here we show how to rearrange the raw data 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 population model from which the simulated data were generated has the following form:

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

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 (e.g., c:\example\) to be analyzed as shown here. We now provide step-by step instructions for fitting the model to the data in HLM6 using the procedures described in Bauer, Preacher, and Gil (2006).

Prepared by Ruth Mathiowetz and Daniel Bauer, 6/2/2008

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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 *Sy* and *Sm*, to indicate when *Z* represents *M* versus *Y*. A level-2 variable (W) is also included in the rearranged data, although the present model does not include this variable as a predictor of either Y or M. This rearrangement of the data is shown visually in Table 1 of Bauer, Preacher, and Gil (2006). The SPSS syntax for restructuring the data is:

```
*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 w id.
EXECUTE .
```

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 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 w id statement indicates which variables should be kept as fixed variables, any variables that should appear in each row for a given ID value. Our level-2 variable (W) is an example of a variable that should appear as the same value for a given ID value. The following page includes visual representations of the data set with the Md variable and the restructured data set.

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

	id	x	m	y	w	Md
1	1	1.55	.11	.57	-.88	.11
2	1	2.28	2.11	1.21	-.88	2.11
3	1	.79	.04	-.26	-.88	.04
4	1	-.06	.48	-.76	-.88	.48
5	1	.12	.59	.52	-.88	.59
6	1	1.48	.89	-.63	-.88	.89
7	1	.89	-.23	.15	-.88	-.23
8	1	.92	.73	.23	-.88	.73
9	2	1.00	-.36	-1.15	.11	-.36
10	2	-1.19	-2.97	-3.72	.11	-2.97
11	2	-1.80	-3.65	-4.47	.11	-3.65
12	2	-1.26	-2.30	-3.22	.11	-2.30

Restructured data:

	obs	m	x	w	id	Index1	Z
1	1	.11	1.55	-.88	1	Md	.11
2	1	.11	1.55	-.88	1	y	.57
3	2	2.11	2.28	-.88	1	Md	2.11
4	2	2.11	2.28	-.88	1	y	1.21
5	3	.04	.79	-.88	1	Md	.04
6	3	.04	.79	-.88	1	y	-.26
7	4	.48	-.06	-.88	1	Md	.48
8	4	.48	-.06	-.88	1	y	-.76
9	5	.59	.12	-.88	1	Md	.59
10	5	.59	.12	-.88	1	y	.52
11	6	.89	1.48	-.88	1	Md	.89
12	6	.89	1.48	-.88	1	y	-.63
13	7	-.23	.89	-.88	1	Md	-.23
14	7	-.23	.89	-.88	1	y	.15
15	8	.73	.92	-.88	1	Md	.73
16	8	.73	.92	-.88	1	y	.23
17	9	-.36	1.00	.11	2	Md	-.36
18	9	-.36	1.00	.11	2	y	-1.15
19	10	-2.97	-1.19	.11	2	Md	-2.97
20	10	-2.97	-1.19	.11	2	y	-3.72
21	11	-3.65	-1.80	.11	2	Md	-3.65
22	11	-3.65	-1.80	.11	2	y	-4.47
23	12	-2.30	-1.26	.11	2	Md	-2.30
24	12	-2.30	-1.26	.11	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 level-1 product variables SMX, SYX, and SYM, as well as the level-2 product variables SYW and SMW:

```
*Computing variables for analysis.
COMPUTE SmX = Sm * X .
COMPUTE SyX = Sy * X .
COMPUTE SyM = Sy * M .
COMPUTE SyW = Sy * w .
COMPUTE SmW = Sm * w .
EXECUTE .
```

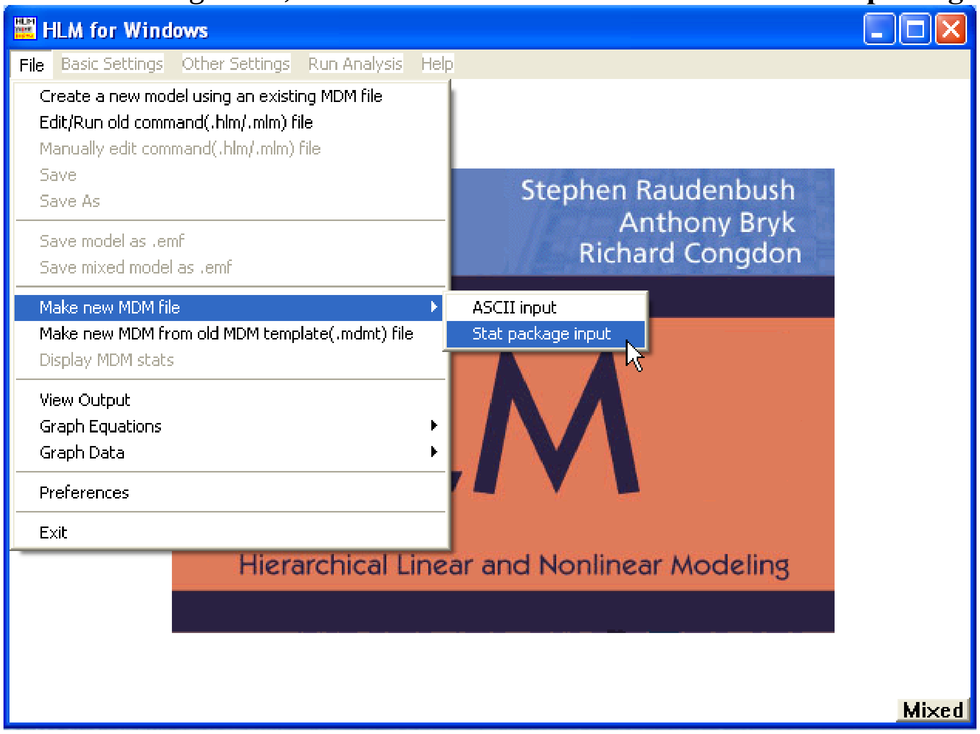
This data file will serve as both the level 1 and level 2 data file for HLM (it is not necessary to create separate level 1 and level 2 data files). The final data set should look like this:

	obs	m	x	w	id	Index1	Z	Sy	Sm	SmX	SyX	SyM	SyW	SmW
1	1	.11	1.55	-.88	1	Md	.11	.00	1.00	1.55	.00	.00	.00	-.88
2	1	.11	1.55	-.88	1	y	.57	1.00	.00	.00	1.55	.11	-.88	.00
3	2	2.11	2.28	-.88	1	Md	2.11	.00	1.00	2.28	.00	.00	.00	-.88
4	2	2.11	2.28	-.88	1	y	1.21	1.00	.00	.00	2.28	2.11	-.88	.00
5	3	.04	.79	-.88	1	Md	.04	.00	1.00	.79	.00	.00	.00	-.88
6	3	.04	.79	-.88	1	y	-.26	1.00	.00	.00	.79	.04	-.88	.00
7	4	.48	-.06	-.88	1	Md	.48	.00	1.00	-.06	.00	.00	.00	-.88
8	4	.48	-.06	-.88	1	y	-.76	1.00	.00	.00	-.06	.48	-.88	.00
9	5	.59	.12	-.88	1	Md	.59	.00	1.00	.12	.00	.00	.00	-.88
10	5	.59	.12	-.88	1	y	.52	1.00	.00	.00	.12	.59	-.88	.00
11	6	.89	1.48	-.88	1	Md	.89	.00	1.00	1.48	.00	.00	.00	-.88
12	6	.89	1.48	-.88	1	y	-.63	1.00	.00	.00	1.48	.89	-.88	.00
13	7	-.23	.89	-.88	1	Md	-.23	.00	1.00	.89	.00	.00	.00	-.88
14	7	-.23	.89	-.88	1	y	.15	1.00	.00	.00	.89	-.23	-.88	.00
15	8	.73	.92	-.88	1	Md	.73	.00	1.00	.92	.00	.00	.00	-.88
16	8	.73	.92	-.88	1	y	.23	1.00	.00	.00	.92	.73	-.88	.00
17	9	-.36	1.00	.11	2	Md	-.36	.00	1.00	1.00	.00	.00	.00	.11
18	9	-.36	1.00	.11	2	y	-1.15	1.00	.00	.00	1.00	-.36	.11	.00
19	10	-2.97	-1.19	.11	2	Md	-2.97	.00	1.00	-1.19	.00	.00	.00	.11
20	10	-2.97	-1.19	.11	2	y	-3.72	1.00	.00	.00	-1.19	-2.97	.11	.00
21	11	-3.65	-1.80	.11	2	Md	-3.65	.00	1.00	-1.80	.00	.00	.00	.11
22	11	-3.65	-1.80	.11	2	y	-4.47	1.00	.00	.00	-1.80	-3.65	.11	.00
23	12	-2.30	-1.26	.11	2	Md	-2.30	.00	1.00	-1.26	.00	.00	.00	.11
24	12	-2.30	-1.26	.11	2	y	-3.22	1.00	.00	.00	-1.26	-2.30	.11	.00

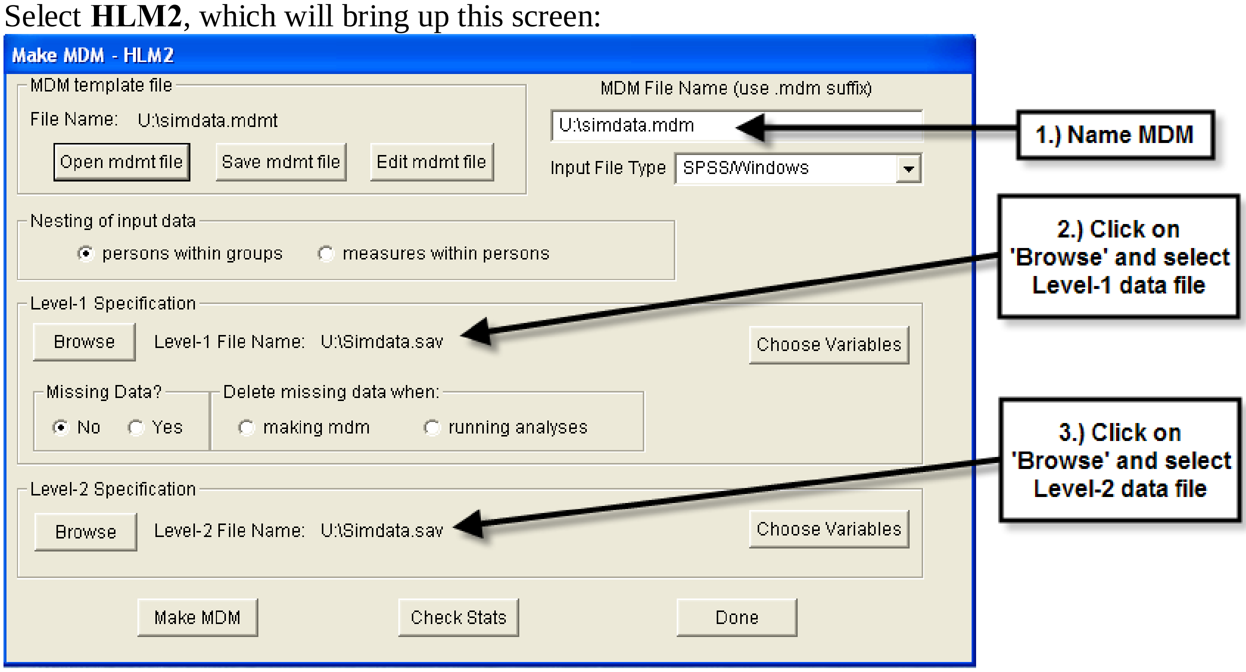
Testing Indirect Effects for Lower level Mediation Models in HLM

Creating a MDM file from a SPSS file

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

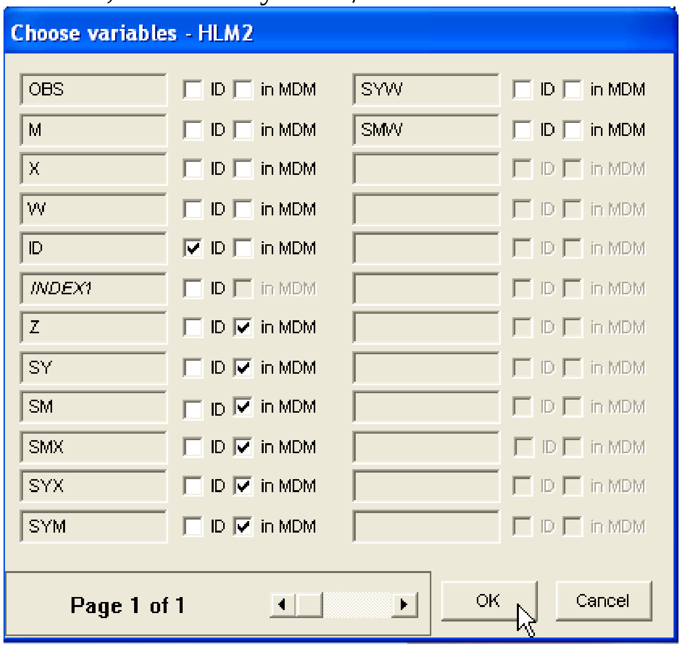


Select **HLM2**, which will bring up this screen:

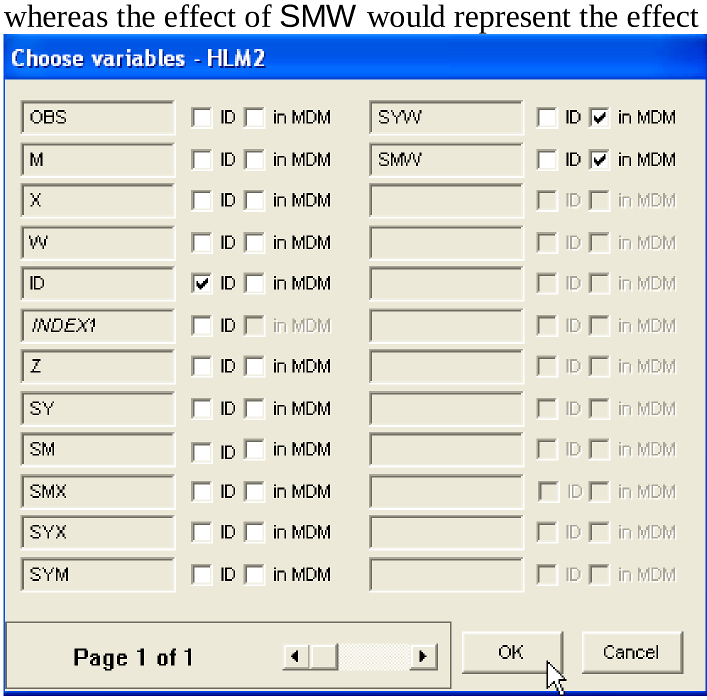


Begin by naming the MDM file (1), then identify the Level-1 (2) and Level 2 (3) data files. These will both be the same data file that was created within SPSS. The choice of 'persons within groups' or 'measures within persons' is not important for our example; both will fit the same model, the only difference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

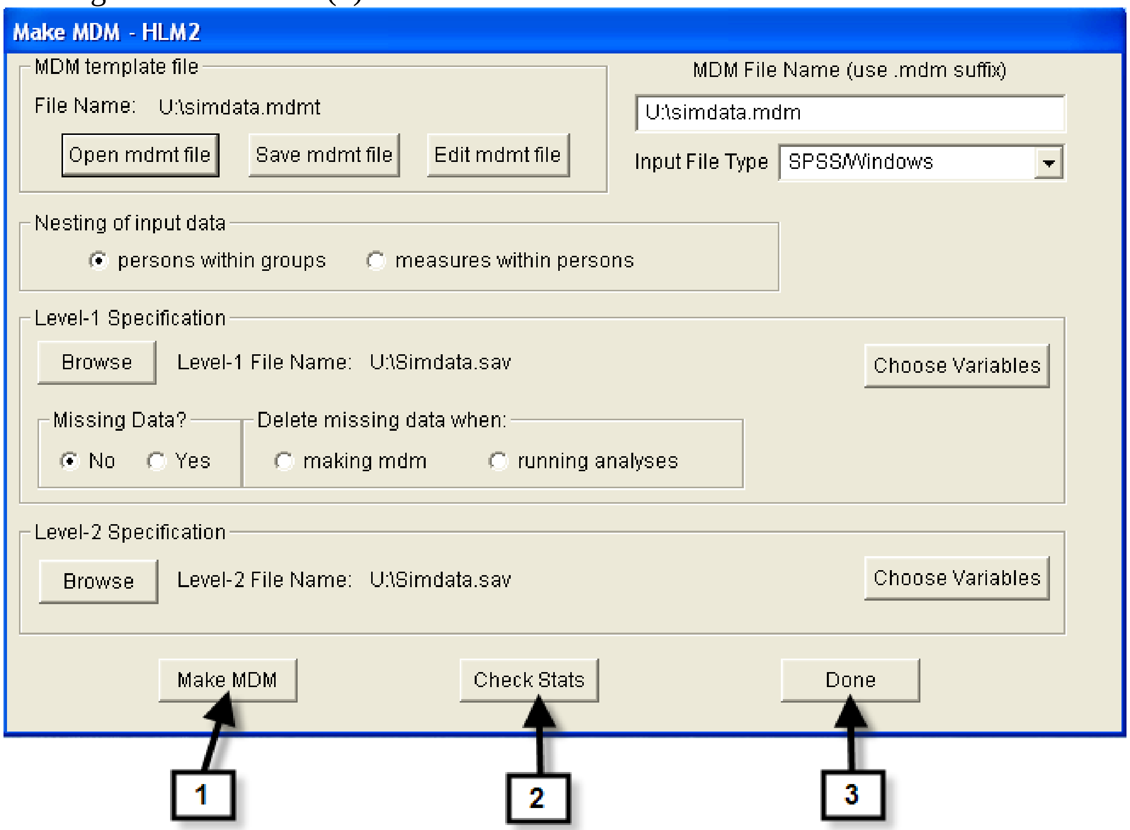
Next click on **Choose Variables** under "Level-1 Specification" to select Level-1 variables for analysis. For our analysis the single dependent variable Z, the selection variables SY and SM, as well as the product variables SMX, SYX, and SYM are included as Level-1 variables. The grouping variable,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



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 the product variables SYW, and SMW are included as Level-2 variables. We will not include the Level-2 variables in our example model, but one could 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). The effect of SYW would represent the effect of W on Y, whereas the effect of SMW would represent the effect of M on Y.



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).



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

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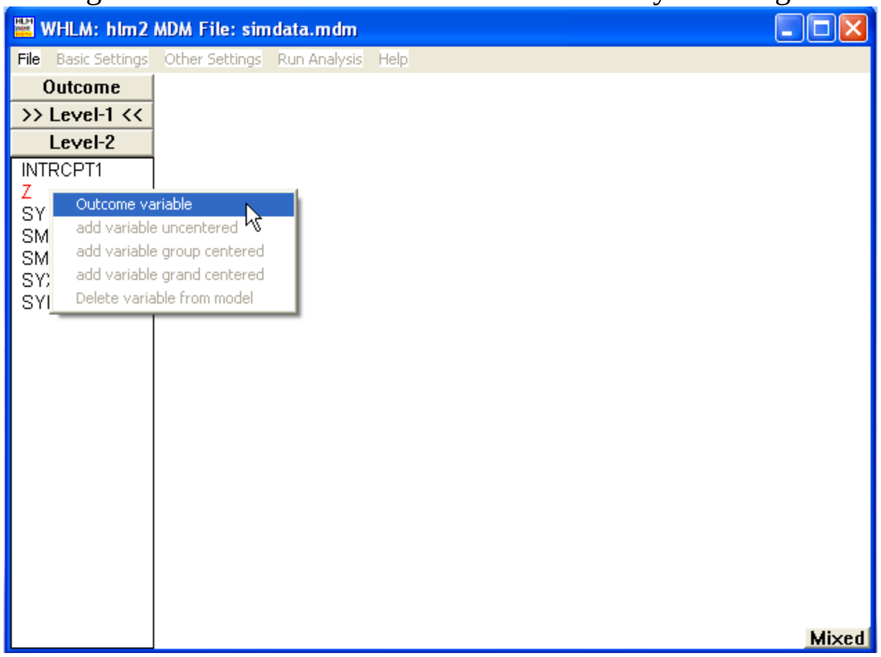
Building the model

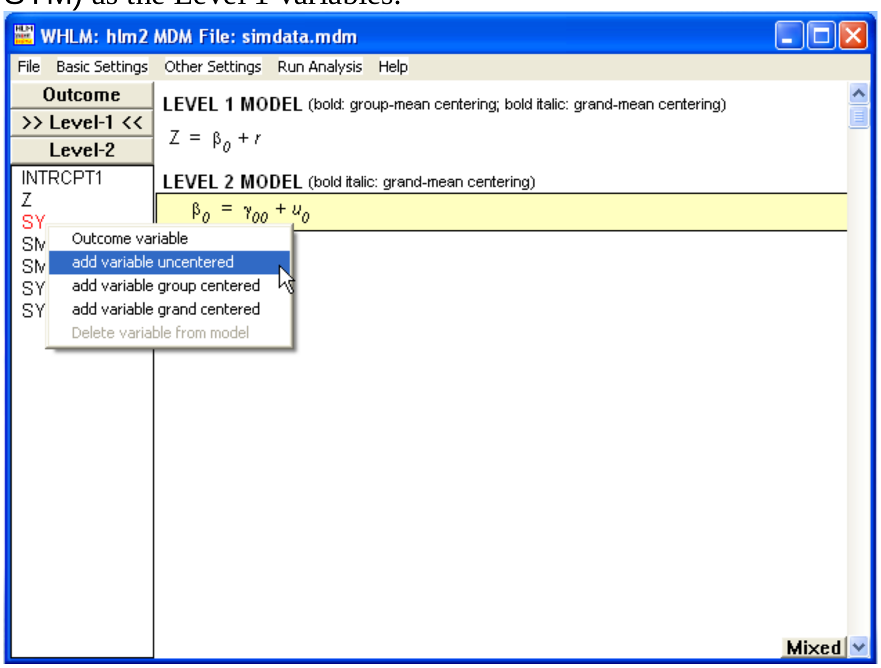
The model of interest (equivalent the two equations shown in the first paragraph) is given by the single equation:

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

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

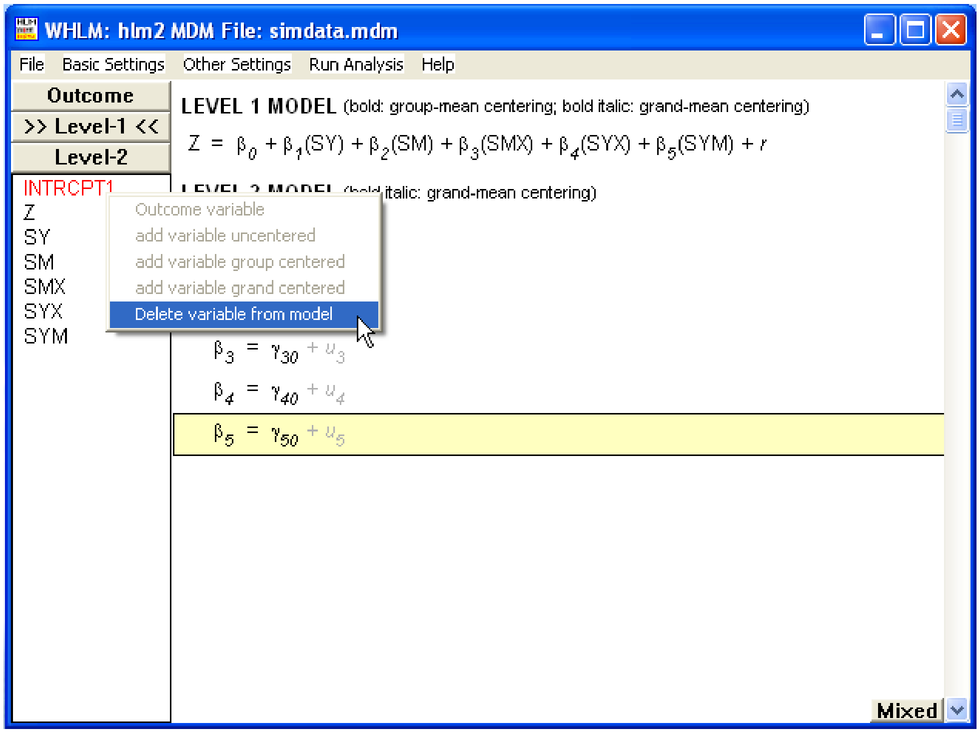


Next select the two selection variables (SY and SM), and the product variables (SMX, SYX and SYM) as the Level 1 variables:

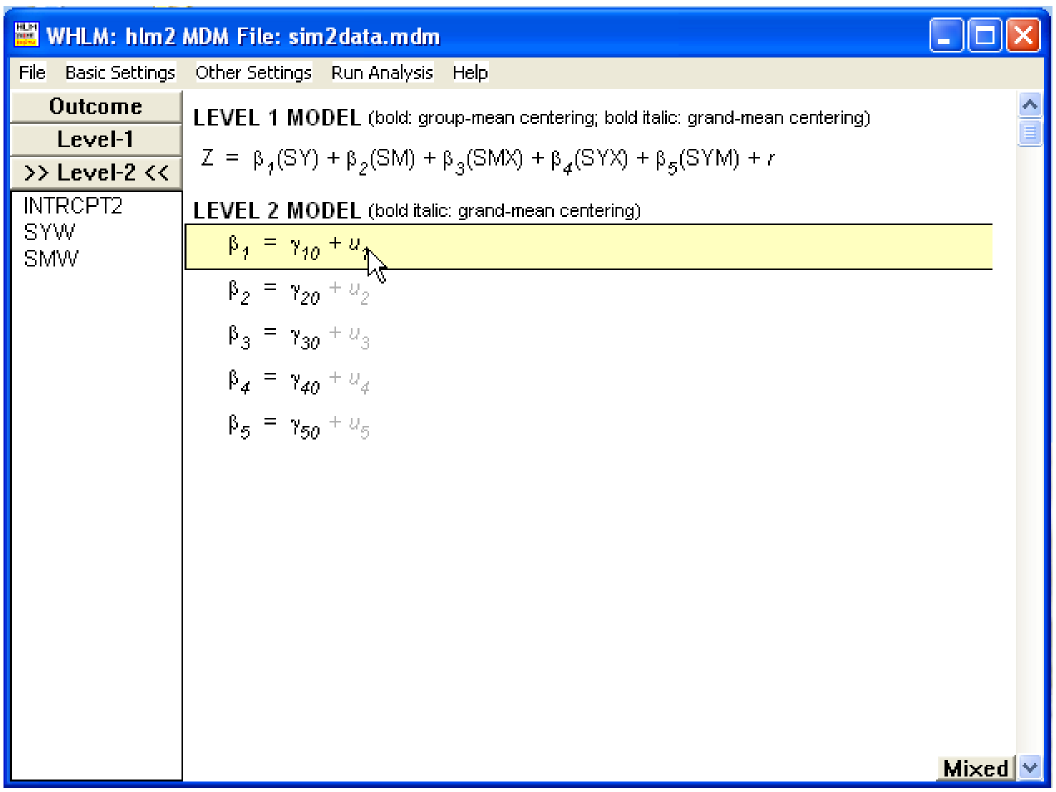


Testing Indirect Effects for Lower level Mediation Models in HLM

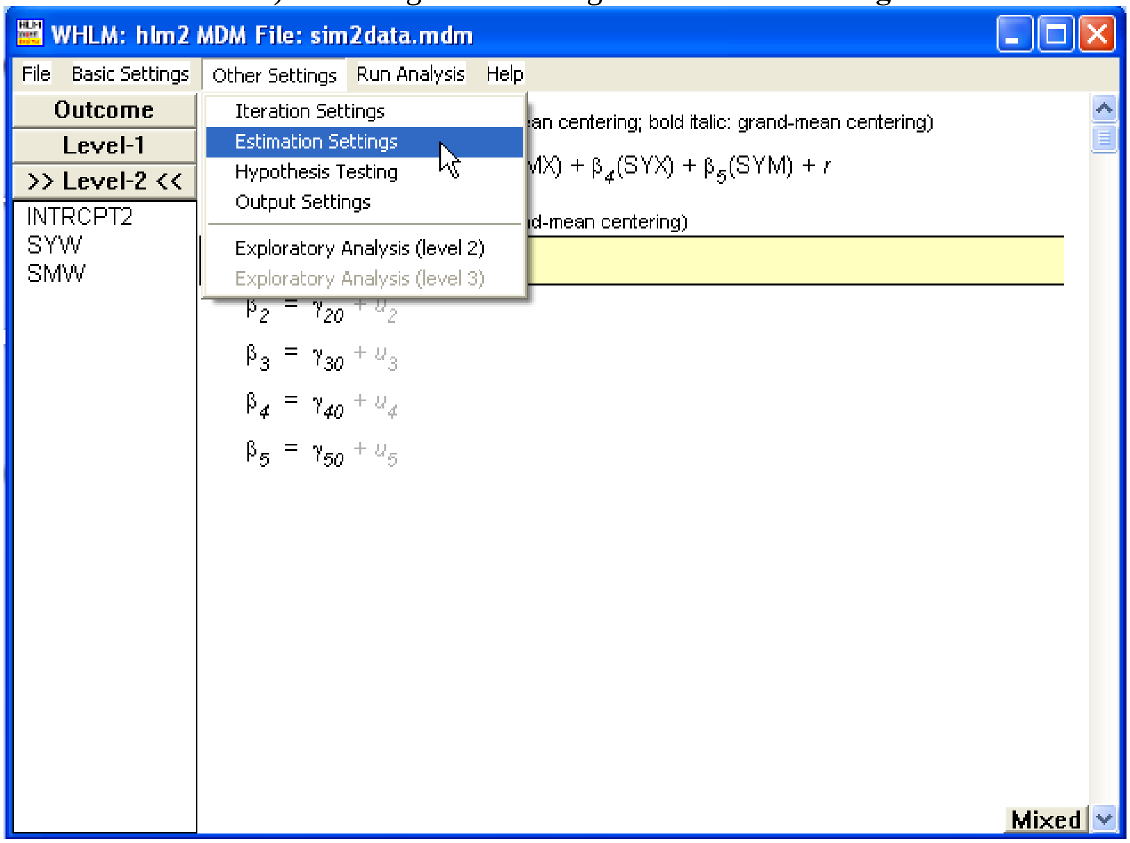
Unlike most HLM models this model does not have an intercept. Remove the intercept by clicking on **INTRCPT1 →Delete variable from model:**



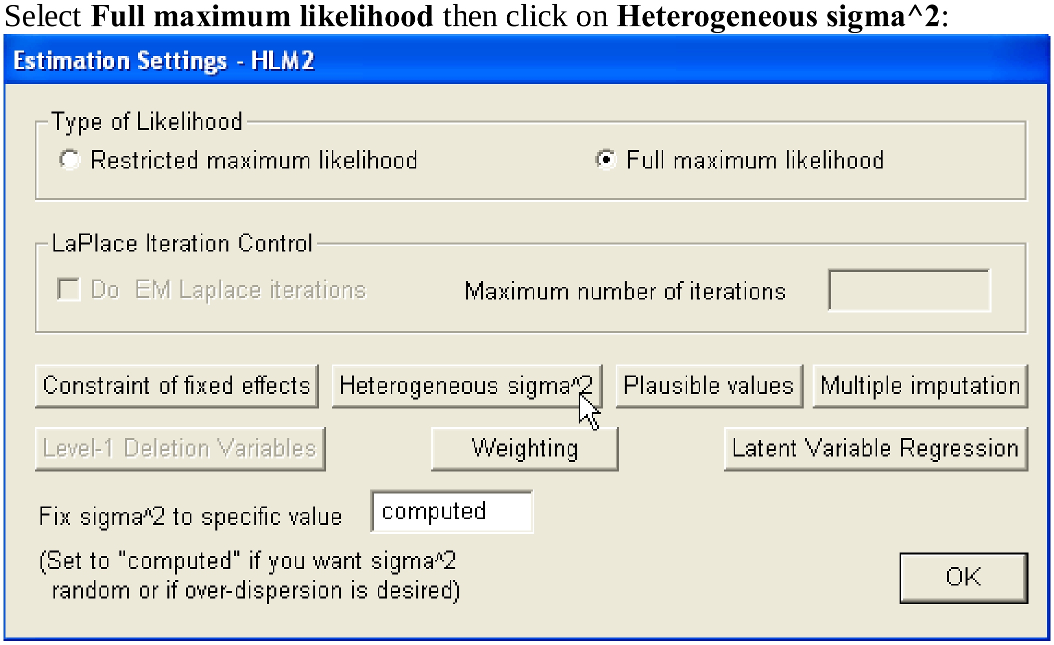
To allow the coefficients to have random effects (representing differences across Level-2 units, select **Level-2** and add random components to all Level 1 variables by clicking on all the **u** variables:



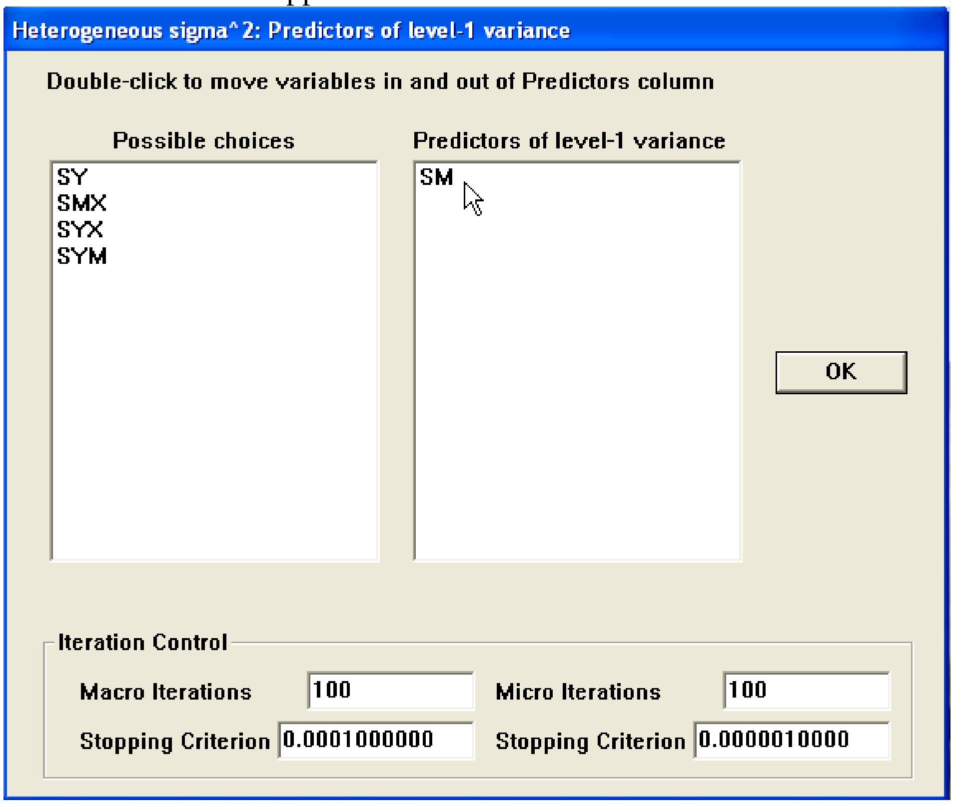
After the fixed and random effects are specified the estimation settings need to be modified in order to obtain estimates for the heterogeneous σ^2 values for SY and SM(i.e., different residual variances for the two outcomes). To change these settings select **Other Settings → Estimation Settings**:



Select **Full maximum likelihood** then click on **Heterogeneous sigma^2**:

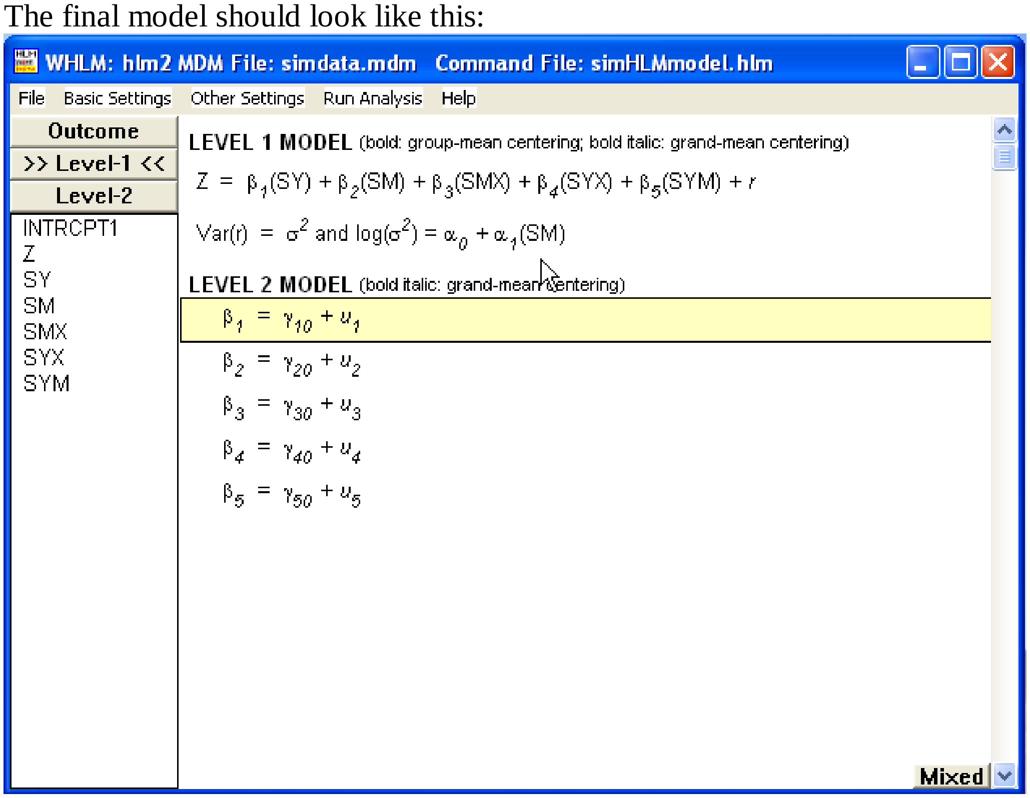


This window should appear:



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

The final model should look like this:



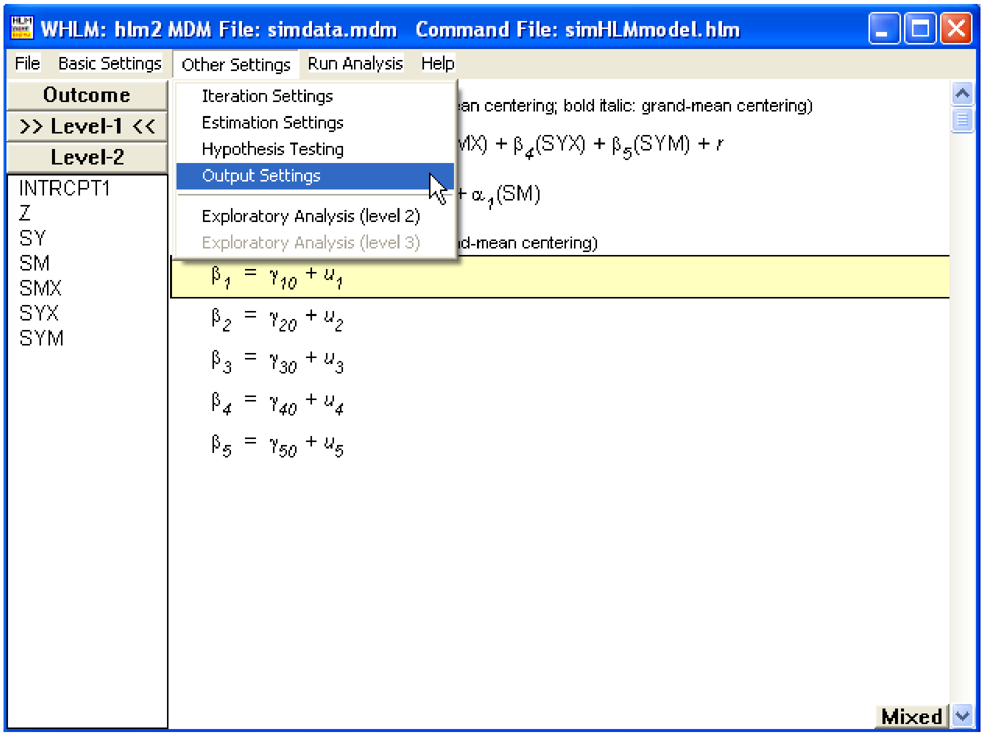
Testing Indirect Effects for Lower level Mediation Models in HLM

The specification of:

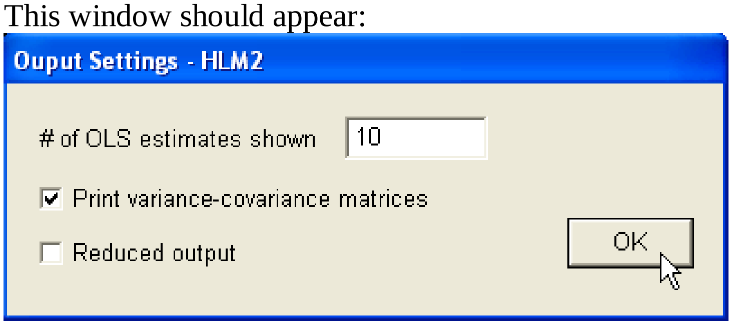
$$\text{Var}(r) = \sigma^2 \text{ and } \log(\sigma^2) = \alpha_0 + \alpha_1(\text{SM})$$

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 effect and variance component estimates 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:



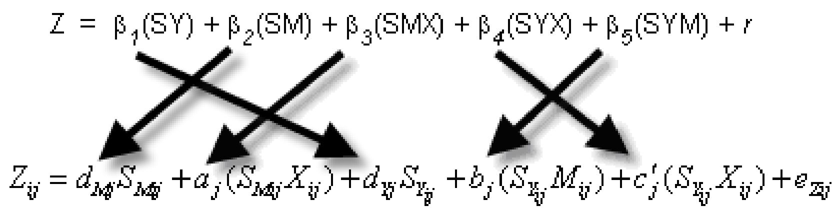
Select **Print variance-covariance matrices**, then select **OK.**

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

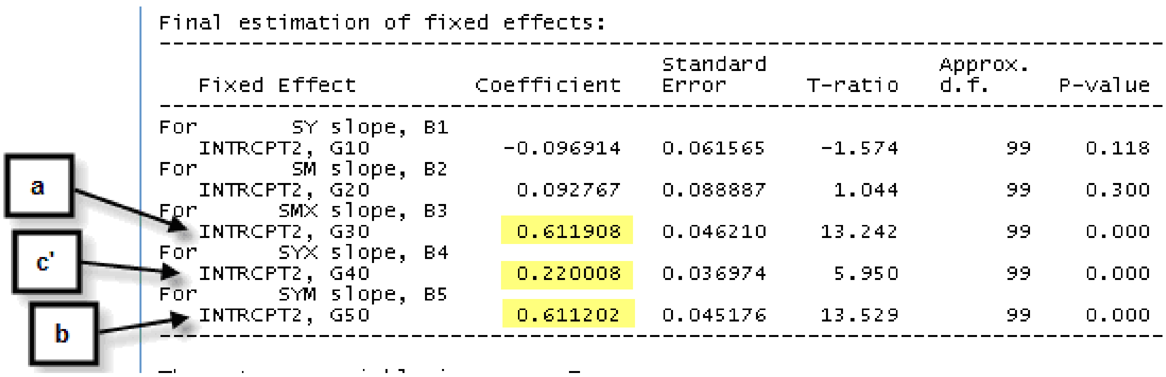
Testing Indirect Effects for Lower level Mediation Models in HLM

HLM Model Output

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

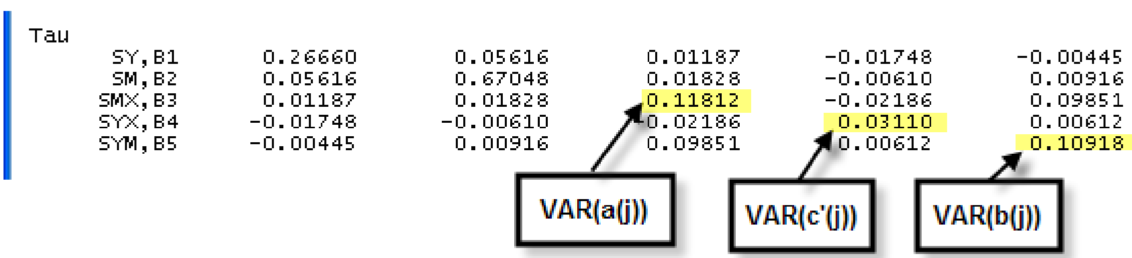


The estimates for the fixed and random effects can be found in both the HLM output and the data files **gamvc.dat** and **tauvc.dat.** Fixed effects in the HLM output:



```
Final estimation of fixed effects:
----------------------------------------------------------------------------
                                          Standard              Approx.
   Fixed Effect         Coefficient       Error       T-ratio   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:

```
0RESULTS FOR HETEROGENEOUS SIGMA-SQUARED
(macro iteration 8)

 Var(R) = Sigma_squared and
 log(Sigma_squared) = alpha0 + alpha1(SM)


 Model for level-1 variance
 -----------------------------------------------------------------------
                                       Standard
   Parameter          Coefficient      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

Prepared by Ruth Mathiowetz and Daniel Bauer, 6/2/2008

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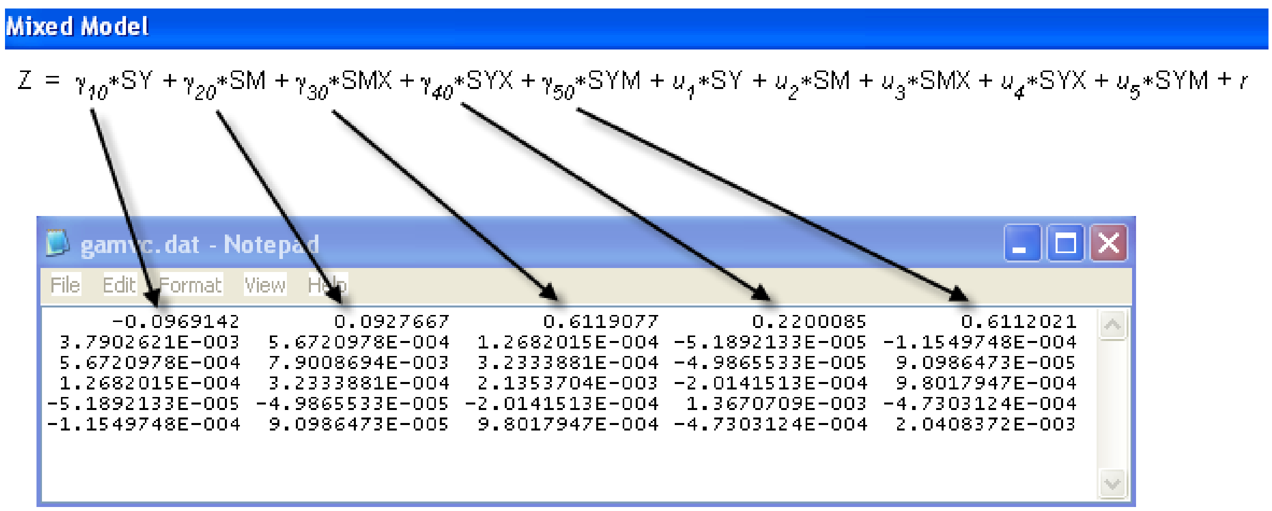
At the end of the HLM output there should be a note indicating the creation of 3 data files:

```
tauvc.dat, containing tau and the variance-covariance matrix of tauhas 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.



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.

gamvc.dat - Notepad

File Edit Format View Help

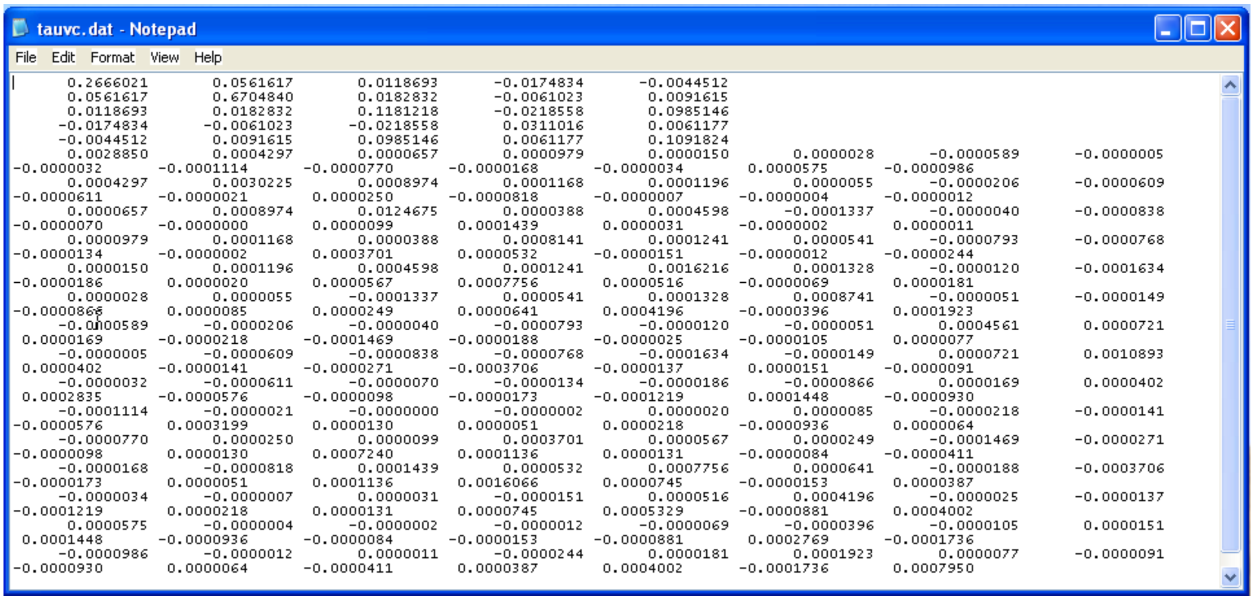
-0.0969142	0.0927667	0.6119077	0.2200085	0.6112021
3.7902621E-003	5.6720978E-004	1.2682015E-004	-5.1892133E-005	-1.1549748E-004
5.6720978E-004	7.9008694E-003	3.2333881E-004	-4.9865533E-005	9.0986473E-005
1.2682015E-004	3.2333881E-004	2.1353704E-003	-2.0141513E-004	9.8017947E-004
-5.1892133E-005	-4.9865533E-005	-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

Prepared by Ruth Mathiowetz and Daniel Bauer, 6/2/2008

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)



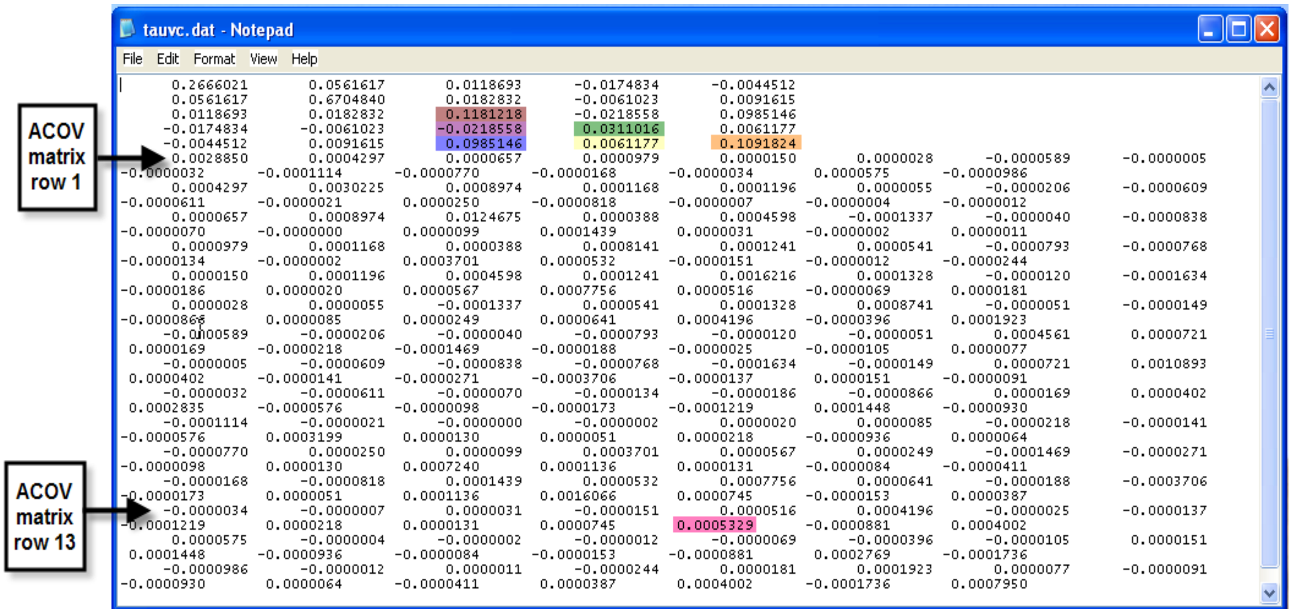
```
tauvc.dat - Notepad
File  Edit  Format  View  Help
       0.2666021       0.0561617       0.0118693      -0.0174834      -0.0044512
       0.0561617       0.6704840       0.0182832      -0.0061023       0.0091615
       0.0118693       0.0182832       0.1181218      -0.0218558       0.0985146
      -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       0.0000099       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
       0.0000150       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
       0.0000028       0.0000055      -0.0001337       0.0000541       0.0001328       0.0008741      -0.0000051      -0.0000149
-0.0000866       0.0000085       0.0000249       0.0000641       0.0004196      -0.0000396       0.0001923
      -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
      -0.0000005      -0.0000609      -0.0000838      -0.0000768      -0.0001634      -0.0000149       0.0000721       0.0010893
 0.0000402      -0.0000141      -0.0000271      -0.0003706      -0.0000137       0.0000151      -0.0000091
      -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
      -0.0001114      -0.0000021      -0.0000000      -0.0000002       0.0000020       0.0000085      -0.0000218      -0.0000141
-0.0000576       0.0003199       0.0000130       0.0000051       0.0000218      -0.0000936       0.0000064
      -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
      -0.0000168      -0.0000818       0.0001439       0.0000532       0.0007756       0.0000641      -0.0000188      -0.0003706
-0.0000173       0.0000051       0.0001136       0.0016066       0.0000745      -0.0000153       0.0000387
      -0.0000034      -0.0000007       0.0000031      -0.0000151       0.0000516       0.0004196      -0.0000025      -0.0000137
-0.0001219       0.0000218       0.0000131       0.0000745       0.0005329      -0.0000881       0.0004002
       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
      -0.0000986      -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
```

The estimate that is challenging to identify is the asymptotic variance of the random effect 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 COV(a_j , b_j) in the covariance matrix for the random effects. For example in our matrix the COV(a_j , b_j) is located in the 13th element of the asymptotic covariance matrix for the variance component estimates:

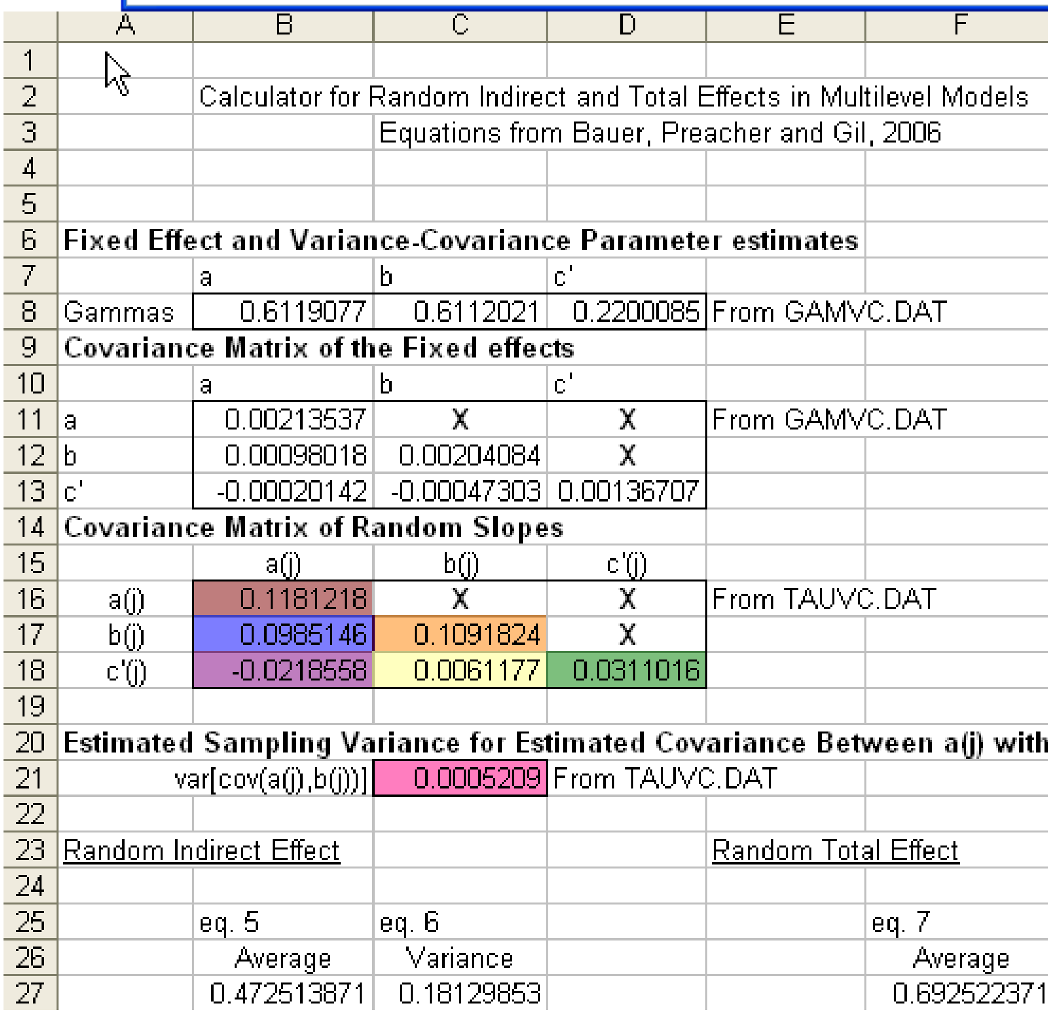
	SY	SM	SMX	SYX	SYM
SY	1				
SM	2	3			
SMX	4	5	6		
SYX	7	8	9	10	
SYM	11	12	13	14	15

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

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.




```
      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      0.0000099      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
      0.0000150       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
      0.0000028       0.0000055      -0.0001337       0.0000541       0.0001328       0.0008741      -0.0000051      -0.0000149
-0.0000866      0.0000085      0.0000249      0.0000641      0.0004196     -0.0000396      0.0001923
     -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
     -0.0000005      -0.0000609      -0.0000838      -0.0000768      -0.0001634      -0.0000149       0.0000721       0.0010893
 0.0000402     -0.0000141     -0.0000271     -0.0003706     -0.0000137      0.0000151     -0.0000091
     -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
     -0.0001114      -0.0000021      -0.0000000      -0.0000002       0.0000020       0.0000085      -0.0000218      -0.0000141
-0.0000576      0.0003199      0.0000130      0.0000051      0.0000218     -0.0000936      0.0000064
     -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
     -0.0000168      -0.0000818       0.0001439       0.0000532       0.0007756       0.0000641      -0.0000188      -0.0003706
-0.0000173      0.0000051      0.0001136      0.0016066      0.0000745     -0.0000153      0.0000387
     -0.0000034      -0.0000007       0.0000031      -0.0000151       0.0000516       0.0004196      -0.0000025      -0.0000137
-0.0001219      0.0000218      0.0000131      0.0000745      0.0005329     -0.0000881      0.0004002
      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
     -0.0000986      -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 are input, 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 the 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	Random Indirect Effect				Random Total Effect			
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	Random Indirect Effect							
31		eq. 5	sqrt(eq. 9)	eq. 11				
32			Standard	95 % Confidence Interval (alpha=0.05)				
33		Average	Error	Lower	Upper	Z-value	p-value	
34		0.472513871	0.053115456	0.36840758	0.57662016	8.895976944	4.9091E-17	
35								
36								
37	Random Total Effect							
38		eq. 7	sqrt(eq.10)	eq. 12				
39			Standard	95 % Confidence Interval (alpha=0.05)				
40		Average	Error	Lower	Upper	Z-value	p-value	
41		0.692522371	0.057993134	0.57885583	0.80618891	11.94145448	7.4593E-31	
42								