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  $VAR(d_{Mj}) = .6$ ,  $VAR(d_{Nj}) = .4$ ,  $VAR(a_j) = VAR(b_j) = .16$  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  $VAR(e_{Nij}) = .45$ . 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).

#### 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.

	inst 12 obser various of the data set with the wild variable.						
	id	Х	m	у	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	

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

#### **Restructured data:**

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

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	Х	W	id	Index1	Z	Sy	Sm	SmX	SyX	SyM	Sy₩	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	у	.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	У	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	у	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	у	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	у	.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	у	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	у	.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	У	.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	У	-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	у	-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	У	-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	у	-3.22	1.00	.00	.00	-1.26	-2.30	.11	.00

Creating a MDM file from a SPSS file

After launching	HLM, select ]	File → Make 1	new MDM file	$\rightarrow$ Stat packag	e input:
-----------------	---------------	---------------	--------------	---------------------------	----------

🚟 HLM for Windows		
File Basic Settings Other Settings Run Analysis Help		
Create a new model using an existing MDM file Edit/Run old command(.hlm/.mlm) file Manually edit command(.hlm/.mlm) file Save		
Save As Save model as .emf Save mixed model as .emf	Anthony Bryk Richard Congdon	
Make new MDM file Make new MDM from old MDM template(.mdmt) file Display MDM stats	ASCII input Stat package input	
View Output Graph Equations Graph Data	M	
Preferences Exit		
	ar and Nonlinear Modeling	
		Mixed

Select HLM2, which will bring up this screen:

Make MDM - HLM2		
MDM template file	MDM File Name (use .mdm suffix)	
File Name: U:\simdata.mdmt	U:\simdata.mdm	1) Name MDM
Open mdmt file Save mdmt file Edit mdmt file	Input File Type SPSS/Windows	
Nesting of input data		2.) Click on
persons within groups	ins	Browse' and select
Level-1 Specification		Level-1 data file
Browse Level-1 File Name: U:\Simdata.sav	Choose Variables	
Missing Data? Delete missing data when:		
No C Yes C making mdm C running at	nalyses	3.) Click on
		Browse' and select
Level-2 Specification		Level-2 data file
Browse Level-2 File Name: U:\Simdata.sav	Choose Variables	
Make MDM Check Stats	Done	

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.

Choose variable	s - HLM2		
OBS	🔲 ID 📃 in MDM	SYW	🔲 ID 📄 in MDM
M	🔲 ID 📄 in MDM	SMW	🔲 ID 🥅 in MDM
x	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
W	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
ID	🔽 ID 📄 in MDM		🔲 ID 🔲 in MDM
INDEX1	🔲 🗖 🔲 in MDM		🔲 ID 🔲 in MDM
Z	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
SY	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
SM	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
SMX	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
SYX	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
SYM	🔲 ID 🔽 in MDM		🔲 ID 🔲 in MDM
Page 1 of	1	D 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 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.

Choose variable	s - HLM2		
OBS	🔲 ID 📄 in MDM	SYW	🔲 ID 🔽 in MDM
M	🔲 ID 📃 in MDM	SMW	🔲 ID 🔽 in MDM
X	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
W	🔲 ID 📃 in MDM		🔲 ID 🔲 in MDM
ID	🔽 ID 📄 in MDM		🔲 ID 🔲 in MDM
INDEX1	🔲 🗈 🥅 in MDM		🔲 ID 🔲 in MDM
Z	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
SY	🔲 ID 📃 in MDM		🔲 ID 🔲 in MDM
SM	🔲 ID 🔲 in MDM		🔲 ID 🔲 in MDM
SMX	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
SYX	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
SYM	🔲 ID 📄 in MDM		🔲 ID 🔲 in MDM
Page 1 of	f1 <b>I</b>	• OK	Cancel

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

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).

Make MDM - HLM2	
MDM template file	MDM File Name (use .mdm suffix)
File Name: U:\simdata.mdmt	U:\simdata.mdm
Open mdmt file Save mdmt file Edit mdmt file	Input File Type SPSS/Windows
<ul> <li>Nesting of input data</li> <li>persons within groups</li> <li>measures within personal</li> </ul>	ins
Level-1 Specification	
Browse Level-1 File Name: U:\Simdata.sav	Choose Variables
Missing Data? Delete missing data when:	
No C Yes     C making mdm     C running as	nalyses
Level-2 Specification	
Browse Level-2 File Name: U:\Simdata.sav	Choose Variables
Make MDM Check Stats	Done
	3

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

#### 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:

File Basic Settings Other Settings Run Analysis Help	
Outcome         LEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)           >> Level-1 <<	
INTRCPT1 LEVEL 2 MODEL (bold italic: grand-mean centering)	
$\sum_{SV} \beta_0 = \gamma_{00} + u_0$	
SM Outcome variable SM add variable uncentered SY add variable grand centered Delete variable from model	Mixed 💌

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

writem, huhz mom rite, shiridata, huhi	
File Basic Settings Other Settings Run Analysis Help	
OutcomeLEVEL 1 MODEL (bold: group-mean centering; bold italic: grand-mean centering)>> Level-1 <	
INTROPT Z Outcome variable SY add variable group centered add variable group centered add variable grand centered SYX Delete variable from model SYM $\beta_3 = \gamma_{30} + u_3$ $\beta_4 = \gamma_{40} + u_4$ $\beta_5 = \gamma_{50} + u_5$	×ed v

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:

🚟 WHLM: hlm2	MDM File: sim2data.mdm	
File Basic Settings	Other Settings Run Analysis Help	
Outcome Level-1	<b>LEVEL 1 MODEL</b> (bold: group-mean centering; bold italic: grand-mean centering) 7 = 8 (SV) + 8 (SM) + 8 (SMO) + 8 (SVO) + 8 (SVM) + r	
>> Level-2 <<	$2 = p_1(01) + p_2(000) + p_3(0000) + p_4(010) + p_5(0100) + 7$	
INTRCPT2	LEVEL 2 MODEL (bold italic: grand-mean centering)	
SYW	$\beta_1 = \gamma_{10} + u_{12}$	
	$\beta_2 = \gamma_{20} + u_2^{-\infty}$	
	$\beta_3 = \gamma_{30} + u_3$	
	$\beta_{4} = \gamma_{40} + u_{4}$	
	$\beta_5 = \gamma_{50} + u_5$	
		Mixed ⊻

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

🚟 WHLM: hlm2	MDM File: sim2data.mdm	
File Basic Settings	Other Settings Run Analysis Help	
Outcome	Iteration Settings an centering; bold italic: grand-mean centering)	^
Level-1	Estimation Settings $MX + \beta (SYX) + \beta (SYM) + r$	
>> Level-2 <<	Avpotnesis Testing 7% 7% 74(017) 1 P <sub>5</sub> (017%) 1 P	
INTRCPT2 SYW SMW	Output Settings         Exploratory Analysis (level 2)         Exploratory Analysis (level 3) $\beta_2 = \gamma_{20} + u_2$ $\beta_3 = \gamma_{30} + u_3$ $\beta_4 = \gamma_{40} + u_4$ $\beta_5 = \gamma_{50} + u_5$	
		Mixed ⊻

Select Full maximum likelihood then click on Heterogeneous sigma<sup>2</sup>:

Estimation Settings - HLM2	
Type of Likelihood © Restricted maximum likelihood	
LaPlace Iteration Control	
Constraint of fixed effects       Heterogeneous sigma*2       Plausible values       Multiple         Level-1 Deletion Variables       Weighting       Latent Variable	e imputation Regression
Fix sigma^2 to specific value computed (Set to "computed" if you want sigma^2 random or if over-dispersion is desired)	ОК

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

This window should appear: Heterogeneous sigma^2: Predictors Double-click to move variables	s of level-1 variance s in and out of Predictors column
Possible choices SY SMX SYX SYM	Predictors of level-1 variance
Iteration Control Macro Iterations 100 Stopping Criterion 0.00010	Micro Iterations 100 00000 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	<b>LEVEL 1 MODEL</b> (bold: group-mean centering; bold italic: grand-mean centering) $Z = \beta_1(SY) + \beta_2(SM) + \beta_3(SMX) + \beta_4(SYX) + \beta_5(SYM) + r$	
INTRCPT1 Z SY	$\forall ar(r) = \sigma^2 and \log(\sigma^2) = \alpha_0 + \alpha_1(SM)$ LEVEL 2 MODEL (bold italic: grand-mean ventering)	
SM SMX SYX	$\beta_1 = \gamma_{10} + u_1$ $\beta_2 = \gamma_{10} + u_2$	
SYM	$\beta_2 = \gamma_{20} + \alpha_2$ $\beta_3 = \gamma_{30} + \alpha_3$	
	$\beta_{4} = \gamma_{40} + u_{4}$ $\beta_{5} = \gamma_{50} + u_{5}$	
		Mixed 💌

The specification of:

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

Allows for the estimation of heterogeneous  $\sigma^2$  values for SY and SM, such that the level 1 residual variance of SY is obtained by  $e^{\alpha_0}$  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**  $\rightarrow$  **Output Settings**:



This window should appear:

Ouput Settings - HLM2	
# of OLS estimates shown 10	
Print variance-covariance matrices	
Reduced output	ок

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.

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

Covariance estimates in the HLM output:



The estimates for  $\alpha_0$  and  $\alpha_1$  in the HLM output:

\_\_\_\_

```
DRESULTS FOR HETEROGENEOUS SIGMA-SQUARED
(macro iteration 8)
Var(R) = Sigma_squared and
log(Sigma_squared) = alpha0 + alpha1(SM)
Model for level-1 variance
 _____
                       _____
                              Standard
                Coefficient
   Parameter
                              Error
                                        Z-ratio
                                                P-value
                             _____
   _____
                                        _____
                                               _____
          ,alpha0
INTROPT1
                   -0.67489
                              0.059303
                                        -11.380
                                                  0.000
          ,alpha1
     SM
                    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

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  $\gamma_{30}$ ,  $\gamma_{40}$ , and  $\gamma_{50}$  (which correspond to a, c' and b, respectively) and their estimated sampling variances and covariances.

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 Form	at View Help					
3. 5. 1. -5. -1.	-0.0969 7902621E- 6720978E- 2682015E- 1892133E- 1549748E-	142 0.0 003 5.672097 004 7.900869 004 3.233388 005 -4.986553 004 9.098647	927667 78E-004 1.26 74E-003 3.23 81E-004 2.13 73E-005 -2.01 73E-005 9.80	0.6119077 82015E-004 33881E-004 53704E-003 41513E-004 17947E-004	0.220 -5.1892133E -4.9865533E -2.0141513E 1.3670709E -4.7303124E	00085 0.6 -005 -1.154974 -005 9.098647 -004 9.801794 -003 -4.730312 -004 2.040837	112021 8E-004 3E-005 7E-004 4E-004 2E-003
	A	В	С	D	E	F	
1	N						
2	- K	Calculator for	Random Indire	ct and Total F	⊧ =ffects in Mul	tilevel Models	
3			Equations from	m Bauer Pre	acher and Gi	1 2006	
4							
5							
6	Fixed Effe	ect and Variar	nce-Covarian	ce Paramete	er estimates		
7		а	b	с'			
8	Gammas	0.6119077	0.6112021	0.2200085	From GAMV	C.DAT	
9	Covarian	ce Matrix of th	e Fixed effe	cts			
10		а	b	c'			
11	а	0.00213537	Х	Х	From GAM∨	C.DAT	
12	b	0.00098018	0.00204084	Х			
13	c'	-0.00020142	-0.00047303	0.00136707			
14	Covarian	ce Matrix of R	andom Slope	s			
15		a(j)	b(j)	c'(j)			
16	a(j)	0.1181218	X	X	From TAUV	C.DAT	
17	b(j)	0.0985146	0.1091824	X			
18	c'(j)	-0.0218558	0.0061177	0.0311016			
19							
20	Estimated	Sampling Va	riance for Es	timated Cov	ariance Bet	ween a(j) with	
21	Va	ar[cov(a(j),b(j))]	0.0005209	From TAUV	C.DAT		
22							
23	<u>Random In</u>	idirect Effect			Random Tot	al Effect	
24		<b>F</b>				7	
25		eq. 5	eq. b			eq. /	
26		Average	Variance			Average	
27		0.472513871	0.18129853			0.692522371	

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)

🖪 tauwo dat - No	tenad							
	repara							
File Edit Format	view Heip							
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	0.000028	-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	
-0.0000865	0.000085	0.0000249	0.0000641	0.0004196	-0.0000396	0.0001923		
-0.0100589	-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		
-0.0000//0	0.0000250	0.0000099	0.0003/01	0.000056/	0.0000249	-0.0001469	-0.00002/1	
-0.0000098	0.0000130	0.000/240	0.0001136	0.0000131	-0.0000084	-0.0000411	0 0003700	
-0.0000168	-0.0000818	0.0001439	0.0000532	0.000//56	0.0000641	-0.0000188	-0.0003706	
-0.00001/3	0.0000051	0.0001136	0.0010000	0.0000/45	-0.0000153	-0.0000387	-0.0000137	
-0.0000034	-0.000000/	0.0000031	-0.0000151	0.0000516	0.0004196	-0.0000025	-0.000013/	
-0.0001219	-0.0000218	-0.0000031	-0 000012	-0 0000069	-0.0000881	-0.0004002	0.0000151	
0.0000575	-0.0000004	-0.0000002	-0.0000012	-0.0000069	-0.0000396	-0.0000105	0.0000151	
-0 0000986	-0.0000936	-0.0000084	-0.0000153	-0.0000881	0.0002/69	-0.0001/36	-0.0000091	
-0.0000300	-0.0000012	-0.0000411	0.0000244	0.0000101	-0.0001726	0.0007950	-0.000091	
-0.0000930	0.0000064	-0.0000411	0.000038/	0.0004002	-0.0001/36	0.000/950		~

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 13<sup>th</sup> element of the asymptotic covariance matrix for the variance component estimates 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  $13^{th}$  row and  $13^{th}$  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.

	📕 tauv	c.dat - Notepad					
	File Edi	: Format View Help					
A		0.2666021 0.0561 0.0561617 0.6704 0.0118693 0.0182 0.0174834 -0.0061 0.0044512 0.0091 0.0024510 0.0091	617 0.0118693 840 0.0182832 832 0.1181218 023 -0.0218558 615 0.0985146 297 0.0000657	-0.0174834 -0.0061023 -0.0218558 0.0311016 0.0061177 0.0000979	-0.0044512 0.0091615 0.0985146 0.0061177 0.1091824 0.0000150	0.0000028 -0.0000	1589 -0.0000005
ro	w 1 -0.0000	032 -0.0001114 0.0004297 0.0030	-0.0000770 - 225 0.0008974	-0.0000168 - 0.0001168	0.0000034 0.00 0.0001196	0.0000055 -0.0000986	206 -0.0000609
_	-0.000	)611 -0.0000021 ).0000657 0.0008	0.0000250 - 974 0.0124675	0.0000818 - 0.0000388	0.0000007 -0.00 0.0004598	00004 -0.0000012 -0.0001337 -0.0000	040 -0.0000838
	-0.0000	070 -0.0000000 0.0000979 0.0001	0.0000099	0.0001439 0.0008141	0.0000031 -0.00 0.0001241	00002 0.0000011 0.0000541 -0.0000	-0.0000768
	-0.0000		0.0003701	0.0001241	0.0000151 -0.00 0.0016216 -0.00	0.00012 -0.0000244 0.0001328 -0.0000	120 -0.0001634
	-0.0000	0.0000020 0.0000028 0.0000 0865 0.0000085	0.0000587	0.0000541	0.0001328 0.0001328 0.0004196 -0.00	0.00089 0.0000181 0.0008741 -0.0000 00396 0.0001923	051 -0.0000149
	-0	).0000589 -0.0000 169 -0.0000218	206 -0.0000040 -0.0001469 -	-0.0000793	-0.0000120 0.0000025 -0.00	-0.0000051 0.0004 00105 0.0000077	561 0.0000721
	 0.0000	).0000005 -0.0000 )402 -0.0000141	609 -0.0000838 -0.0000271 -	-0.0000768 0.0003706 -	-0.0001634 0.0000137 0.00	-0.0000149 0.0000 00151 -0.0000091	0.0010893
	-0 0.0002	0.0000032 -0.0000	611 -0.0000070 -0.0000098 -	-0.0000134 -0.0000173	-0.0000186 0.0001219 0.00	-0.0000866 0.0000 01448 -0.0000930	169 0.0000402
	-0.000	0.0001114 -0.0000 0.0003199 0.0000770 0.0000		0.0000051	0.000020 -0.00	0.0000085 -0.0000 00936 0.0000064 0.0000249 -0.0001	469 -0.0000271
	-0.000	)098 0.0000130 ).0000168 -0.0000	0.0007240 818 0.0001439	0.0001136	0.0000131 -0.00 0.0007756	0.000064 -0.0000411 0.0000641 -0.0000	188 -0.0003706
ACO		)173 0.0000051 ).0000034 -0.0000	0.0001136 007 0.0000031	0.0016066 -0.0000151	0.0000745 -0.00 0.0000516	00153 0.0000387 0.0004196 -0.0000	025 -0.0000137
row	13	.219 0.0000218 ).0000575 -0.0000	0.0000131	0.0000745	0.0005329 -0.00 -0.0000069	00881 0.0004002 -0.0000396 -0.0000	105 0.0000151
_	-0.000	.448 -0.0000936 ).0000986 -0.0000 )930 0.0000064	-0.0000084 - 012 0.0000011 -0.0000411	-0.000244	0.0000881 0.00 0.0000181 0.0004002 -0.00	02769 -0.0001736 0.0001923 0.0000 01736 0.0007950	077 -0.0000091
	Δ	B	<u> </u>	D	F	F	<u>×</u>
1	N					•	
2	43	Calculator for	Random Indire	ct and Total	Effects in Mu	Itilevel Models	
3			Equations from	n Bauer Pr	eacher and Gi	1 2006	
4							
5							
6	Fixed Eff	ect and Varia	nce-Covarian	ce Parame	ter estimates		
7		а	b	с'			
8	Gammas	0.6119077	0.6112021	0.220008	5 From GAM\	/C.DAT	
9	Covarian	ce Matrix of th	ne Fixed effec	ts			
10		а	Ь	с'			
11	а	0.00213537	X	Х	From GAM	/C.DAT	
12	b	0.00098018	0.00204084	Х			
13	c'	-0.00020142	-0.00047303	0.0013670	7		
14	Covarian	ce Matrix of R	andom Slope	S			
15		a(j)	b(j)	c'(j)			
16	a(j)	0.1181218	X	X	From TAUV	C.DAT	
17	b(j)	0.0986146	0.1091824	X	-		
18	c'())	-0.0218558	0.0061177	0.031101	0		
19	<b>F</b>					45 1-1	
20	Estimated	i Sampling Va	riance for Es	timated Co	variance Bet	ween a(j) with	
21	V	ar[cov(a(j),b(j))]	0.0005209	From TAU	/C.DAT		
22	<b>D</b> · ·	<u>г</u>					
23	Random Ir	<u>nairect Effect</u>			Random Tot	ai ⊨ttect	
24			C				
25		eq. 5	eq. b			eq. 7	
26		Average	Variance			Average	
27		0.472513871	0.18129853			0.692522371	

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.

1 110	Δ	B	L C	П	F	F	G	Н
1						•		
2		Calculator for	Random Indire	ct and Total F	- Effects in Mul	tilevel Models		
3			Equations from	n Bauer Pre	acher and Gi	2006		
4			Equations					
5								
6	Fixed Effe	ct and Variar						
7		а	b	c'				
8	Gammas	0.6119077	0.6112021	0.2200085	From GAMV	C.DAT		
9	Covariand	e Matrix of th	e Fixed effec	ts				
10		а	b	c'				
11	а	0.00213537	Х	Х	From GAMV	C.DAT		
12	b	0.00098018	0.00204084	Х				
13	с'	-0.00020142	-0.00047303	0.00136707				
14	Covariand	e Matrix of R	andom Slope	s				
15		a(j)	b(j)	c'(j)				
16	a(j)	0.1181218	Х	Х	From TAUV	D.DAT		
17	b(j)	0.0985146	0.1091824	Х				
18	c'(j)	-0.0218558	0.0061177	0.0311016				
19								
20	Estimated	Sampling Va	riance for Es	timated Cov	ariance Bet	ween a(j) with	b(j) Randorr	)Effects
21	Va	ar[cov(a(j),b(j))]	0.0005209	From TAUV(	DAT			
22								
23	<u>Random In</u>	<u>direct Effect</u>			Random Tot	<u>al 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 In</u>	<u>direct Effect</u>						
31		eq. 5	sqrt(eq. 9)	eq. 11				
32			Standard	95 % Confid	ence 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 To	<u>otal Effect</u>						
38		eq. 7	sqrt(eq.10)	eq. 12				
39			Standard	95 % Confid	ence 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	
12								

The final calculations: