**Andrew F. Hayes, Ph.D.**

**Macro and Script Rules and Frequently Asked Questions**

**First, some general guidance and rules:**  
  
(1) Read the article corresponding to the macro before you attempt to use it.  I also recommend you download the documentation for the macro, as it may answer many questions you might have.  
  
(2) Download and run the macro definition command set (the .sps file or .sas file)  EXACTLY AS IS from the new page.  **Do not modify the code at all.**  Many users mistakenly change the program by customizing it to their own data or variables.  This will produce an error.  TO REPEAT: **DO NOT MODIFY THE MACRO IN ANY WAY**.  JUST RUN IT EXACTLY AS IS.  IT WILL EITHER DO NOTHING, OR SPSS or SAS WILL PRINT BACK THE COMMANDS IN THE OUTPUT OR LOG WINDOW.  This is good.  After you have done this, you then execute a properly formatted command as described in the syntax reference for the macro you are using.  
  
(3) All macros produce an SPSS or SAS command defined by the macro name.  It is through this command that you get the macro to work.  The syntax structure for the macro can be found in the documentation or, in some cases, in the published article that describes the macro’s functionality.   For lessons on how to run SPSS commands through the syntax system, consult the SPSS help files or an SPSS manual.  
  
(4) You do not need to run the macro command definition set more than once.  Although there is no harm in doing so, the second time you do, you will get a WARNING message from SPSS saying something like  
  
Warning # 6804 in column 3.  
The macro name specified on the DEFINE command duplicates the  
name of a previously defined macro. This instance will take precedence.  
  
This is a harmless warning and need not concern you.   Many users believe they have done something wrong when this warning appears.    
  
(5) Make sure you run the ENTIRE macro command set on the web page.  Many users mistakenly leave off the last line and then try to rerun the command set when nothing happens.  In SPSS, this will produce an error that looks something like  
  
Error # 6805 in column 1.  Text: DEFINE   
There is an instance of a DEFINE command nested within another DEFINE.   
Nested DEFINE's are not permitted.   
  
Typically there is no way out of this.  You’ll have to quit SPSS and start again.  
  
(6) If nothing happens when you run the macro command set on the web page, THAT IS OK.  The macro will do nothing until you then execute the macro command by feeding it the parameters pertinent to your analysis and data set.  The web page describes the acceptable syntax to make the macro do what it can do. Many errors become infinite loops and are nearly impossible to escape.  Quitting SPSS or SAS and starting fresh is usually the only option available in such cases.  
  
(7) My macros were written on SPSS for Windows.  Most of them work on a Mac as well.  If you are using a version of SPSS prior to release 14, you may get nothing but errors.  I recommend you upgrade to a more recent version of SPSS.  
  
(8) For some reason, these macros don’t work with the INCLUDE command.  If you are getting errors and are using the INCLUDE command to execute the macro definition commands from a file, try running the macro definition program manually, without the INCLUDE command.  
  
(9) Users of old versions of SPSS sometimes get the following warning when running the INDIRECT macro:  
  
>Warning # 6813 in column 83.  Text: CONTRAST  
>The DEFINE command includes a parameter with a name of over 7 characters.  
>The limit is 7 before being prefixed with an exclamation point.  The name  
>will be truncated.  
  
This warning is harmless and can be ignored.  Apparently, there was a time when macro variables could not be longer than seven characters, as CONTRAST is.  
  
**Now for answers to some frequently asked questions**  
  
(1) “I am interested in conducting a one-tailed test.  Is there a way of generating a one-tailed test in your macros?”  
  
All *p*-values generated by my procedures are based on the assumption of symmetry in the sampling distribution of the effect.  So if the effect is in the predicted direction, you can cut the *p*-value in half for a one-tailed p-value.  For confidence intervals for indirect effects based on bootstrapping, request a 90% confidence interval to conduct the equivalent of a one-tailed test.  Note that SOBEL prints only 95 and 99% confidence intervals and there is no way of changing that. Use INDIRECT if you want to specify a 90% confidence interval.  
  
(2) “Can your procedures be used with dichotomous outcomes or mediators?”  
  
Recently, the SPSS versions of SOBEL and INDIRECT were modified to allow for dichotomous outcomes. However, they are not appropriate when a proposed mediator is dichotomous.  Both SOBEL and INDIRECT have the intelligence to detect whether the outcome is dichotomous, and they estimate the coefficients of the model accordingly using logistic regression.  The MODMED macro should not be used with dichotomous outcomes.  The SAS versions of SOBEL and INDIRECT still assume continuous outcomes.    
  
You will find sources on the web that discuss mediation analysis with a dichotomous mediator or outcome.  I can't recommend approaches that emphasize the Sobel test, which has documented problems.  It is simple to generate bootstrap confidence intervals for an indirect effect with a dichotomous mediator in Mplus, and the free demo version is all you need if your model is fairly simple (see [http://www.statmodel.com](http://www.statmodel.com/)).  Here is some Mplus code that estimates a simple mediation model with a dichotomous mediator (and a dichotomous outcome):  
  
DATA:  
      FILE IS C:\example.txt;  
      FORMAT IS free;  
VARIABLE:  
      NAMES ARE x m y;  
      USEVARIABLES x m y;  
      CATEGORICAL are y m;  
ANALYSIS:  
      bootstrap = 5000;  
MODEL:  
      m on x; y on m x;  
MODEL INDIRECT:  
      y via m x;  
OUTPUT:  
      cinterval(bcbootstrap);  
  
(3) “It appears that I have evidence of an indirect effect of *X* on *Y* through a proposed mediator, but there is no evidence of an association between *X* and *Y*.  Is this possible?  What should I do?”  
  
This is not only possible, but it is probably much more common than people realize.  Modern thinking about intervening variable models do not impose the requirement that there be evidence of a simple association between *X* and *Y* in order to estimate and test hypotheses about indirect effects.  See Hayes, A. F.(2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs*, *76*, 408-420. [[PDF](http://www.informaworld.com/smpp/ftinterface%7Edb=all%7Econtent=a917285720%7Efulltext=713240930)]  
  
(4) “I have a categorical IV with more than two categories.  Can I still use SOBEL or INDIRECT?  
  
It is possible with INDIRECT but not with SOBEL.  The best approach is to dummy code the categorical IV.  If your IV has *k* categories, construct *k*-1 dummy variables and then run INDIRECT *k*-1 times.  With each run, make one dummy variable the IV and the other one(s) the covariate(s).  You will not get a single test of the indirect effect, but you will get indirect effects for each category relative to the reference category in the dummy coding scheme.  
  
(5) “I have more than one IV and I would like to include them in my mediation model simultaneously.  Is this possible?  And what if I have multiple DVs?  
  
Yes, it is possible using INDIRECT.  If you have *k* IVs, run INDIRECT *k* times, each time with one of the IVs as the IV and the others as covariates.  You will not get a single estimate or test of the total indirect effect across all IVs, but you will get estimates and tests for each IV.  This feature of INDIRECT is documented in the last paragraph of Preacher and Hayes (2008).  With multiple DVs, there really is no advantage to trying to estimate the direct and indirect effects simultaneously.  Just run the macro once for each DV.  You will get essentially the same results as you would had you estimated the effects for each DV simultaneously as a structural equation model.  
  
(6) “What if I want to treat one or more of my variables as latent with multiple indicators?”  
  
For latent variable models, we recommend Mplus, for it has the ability to construct bootstrap confidence intervals for specific and total indirect effects in models with latent variables.  
  
(7) “I am getting an error that reads:  
  
>Error # 34 in column 22.  Text: c:\filename.sav  
>SPSS Statistics cannot access a file with the given file specification.  The  
>file specification is either syntactically invalid, specifies an invalid  
>drive, specifies a protected directory, specifies a protected file, or  
>specifies a non-sharable file.  
>This command not executed.”  
  
SPSS is trying to save information that it either saves by default or that you asked it to save.  If you get this error, you are using an old version of the procedure, for newer versions won’t generate this error.  If you get it, the procedure is telling you that it couldn’t save anything during its operation.  This is harmless and won’t otherwise affect computations or output.  It typically occurs when using a computer that is administered by a technical support person who has not given you write access to the “c:\” part of your hard drive in order to protect your computer from viruses, Trojan horses, or other malicious code that you might mistakenly download when using the internet.  See the person who administers your computer to have this protection on your computer disabled.  As long as the protection is enabled, the procedures will not be able to save bootstrap estimates or other information you might ask it to save or that it tries to save on its own in the event you want to look at it.  
  
(8) “I am getting an error that reads:  
  
>Error # 12417  
>Source operand is singular for INV.  
>This command not executed.  
  
This is usually a fatal error.  Do not interpret output if you see this.  It occurs when one or more of the predictor variables in a model is constant or is a perfect linear combination of the other predictors.   This error typically occurs when bootstrapping a small dataset with one or more dichotomous predictors that heavily favors one category or another.   Sometimes reducing the number of bootstrap samples will make the problem go away temporarily, but it will reappear at some point, as such a singularity will occur now and then just by chance during resampling.   
  
(9) “I don’t know how to use SPSS syntax.  Can you help me?”  
  
If you aren’t familiar with SPSS syntax, you may find the scripts or custom dialogs for SOBEL, MODPROBE, INDIRECT, and MEDCURVE  easier to use.  These programs, once run or installed, construct a windows dialog box that you can use to set up the model.  The scripts can be downloaded from the same location the macros can be found.  Otherwise, I recommend you find a local expert and ask them for assistance on the use of syntax.  Once you become familiar with using syntax, I’d be happy to help you out on matters directly related to my macros.  
  
(10) “I have evidence that one of the paths in my simple mediation model is not linear.  Can I use the SOBEL macro anyway?”  
  
If you have reason to believe that one of the paths is nonlinear (e.g., exponential, quadratic), whether you should use a model that assumes linearity will depend on how comfortable you are with misspecifying the nature of the association by making the simplifying assumption of linearity.  I recently published a paper with Kris Preacher on the computation of indirect effects in models with nonlinear paths: Hayes, A. F., & Preacher, K. J. (2010). Quantifying and testing indirect effects in simple mediation models when the constituent paths are nonlinear.  *Multivariate Behavioral Research*, *45*, 627-660.  You can find the macro discussed in this paper [here](http://www.afhayes.com/spss-sas-and-mplus-macros-and-code.html#medcurve).  
  
(11) “I find the results from your SOBEL, INDIRECT, MODMED, or MODPROBE procedures produce results for the individual paths differ from what I get in SPSS’s regression procedure.  Is there something wrong with your macro?”  
  
No.  The coefficients and tests of significance you get from my procedures will be exactly the same as what you get from SPSS’s regression procedure when you analyze exactly the same data.  99% of the time, discrepancies are the result of users not acknowledging missing data.  The macros use listwise deletion based on all variables in the model.  So, for example, if some cases are missing data on *Y*, it will throw all those cases out of the analysis estimating the effect of *X* on *M*, even if those cases are complete on *X* and *M*.  And cases missing on *M* will be thrown of the computation of the total effect of *X* on *Y* even though *M* is not relevant to the estimation of the total effect.  This is standard practice in the estimation of models such as these.  Indeed, one could argue that it would be inappropriate to piece together a causal model using tests of significance when the analyses for different paths are based on different subsets of the data.  You can determine whether missing data is producing the discrepancies by comparing the sample sizes in your regression analysis versus what the macro is using.  
  
(12) “Some of the regression coefficients in the output are larger than 1.  How is this possible?”  
  
My SPSS and SAS procedures produce regression or path coefficients in unstandardized form.  The scale of unstandardized coefficients is determined by the scale of measurement of the variables in the model.   As often as not, the coefficients will be greater than 1 in absolute value.  This question typically is asked by people who think the output displays standardized coefficients.  But even standardized coefficients can be greater than 1.  See <http://epm.sagepub.com/content/38/4/873.abstract>  
  
(13) “My advisor tells me I should use the Baron and Kenny strategy for assessing mediation.  But my reading of the literature tells me this isn’t recommended these days.  What should I do?”  
  
You have counted on your advisor for guidance and support.  Now return the favor.  All but the most stubborn of advisors are open to new ideas, and many are too busy or just don’t care enough to stay informed on recent developments.  Give him or her a copy of the relevant literature, and make your case.  Try my Beyond Baron and Kenny paper for a start (*Communication Monographs*, 2009, vol 76, p. 408-420).  [[PDF](http://www.informaworld.com/smpp/ftinterface%7Edb=all%7Econtent=a917285720%7Efulltext=713240930)]  
  
(14) "I am interested in moderated mediation rather than mediated moderation.  Do you have a macro for that?"  
  
If you are interested in knowing whether an interaction's effect on an outcome is mediated, use INDIRECT.    If your IV is X and your moderator is W (and X and W are either dichotomous or continuous), create a variable XW that is the product of X and W.  Then use XW as your IV and X and W as covariates.  A bootstrap confidence interval for the indirect effect that INDIRECT produces can be used to test whether the "moderation is mediated."    
  
(15) "In my mediation analysis examining the direct and indirect effects of X on Y through M, the path from X to M is not statistically significant.  Does this mean there is no way that M could mediate the relationship between X and Y.  According to Baron and Kenny (1986), it cannot.  Should I bother estimating the indirect effect in this case?"  
  
These days, we don't rely on statistical significance criteria for the individual paths in a mediation model in order to assess whether M functions as a mediator.  The pattern of significance or nonsignificance for individual paths in a mediation model is not pertinent to whether the indirect effect is significant.  You absolutely should estimate the indirect effect.  See Hayes (2009) for a brief discussion [[PDF](http://www.informaworld.com/smpp/ftinterface%7Edb=all%7Econtent=a917285720%7Efulltext=713240930)].  
  
(16) “Do you have any examples of how to report the results of the analyses you advocate in your articles?”5  
  
Here are a few examples:  
  
**INDIRECT and SOBEL**  
  
  
Wiltermuth, S. S. (2011). Cheating more when the spoils are split. *Organizational Behavior and Human Decision Processes, 115*. 157-168.  
  
Brauer, M., & Er-rafiy (2011). Increasing perceived variability reduces prejudice and discrimination. *Journal of Experimental Social Psychology, 47*, 871-881.  
  
Giesbrecht, G. F., Miller, M. R., & Muller, U. (2010). The anger-distress model of temper tantrums: Associations with emotional reactivity and emotional competence.  *Infant and Child Development, 19*, 478-497.  
  
Kong, G., & Bergman, A. (2010). A motivational model of alcohol misuse in emerging adulthood.  *Addictive Behaviors, 35*, 855-860.  
  
Teixiera, P. J., Silva, M. N., Coutinho, S. R. et al. (2010). Mediators of weight loss and weight loss maintenance in middle-aged women.  *Obesity, 18*, 725-735.  
  
Anagnostopoulos, F., Slater, J., & Fitzsimmons, D. (2010). Intrusive thoughts and psychological adjustment to breast cancer: Exploring the moderating and mediating role of global meaning and emotional expressivity.  *Journal of* *Clinical Psychology in Medical Settings, 17*, 137-149.   
  
Brandt, M. J., & Reyna, C. (2010). The role of prejudice and the need for closure in religious fundamentalism. *Personality and Social Psychology Bulletin, 36*, 715-725.  
  
Barnhofer, T., & Chittka, T. (2010)*.* Cognitive reactivity mediates the relationship between neuroticism and depression*. Behaviour Research and Therapy, 48*,275-281.   
  
Thimm, J. C. (2010).Mediation of early maladaptive schemas between perceptions of parental rearing style and personality disorder symptoms. *Journal of Behavior Therapy and Experimental Psychiatry, 41*, 52-59.  
  
Birnie, C., McClure, M. J., Lydon, J. E., & Holmberg, D. (2009). Attachment avoidance and commitment aversion: A script for relationship failure. *Personal Relationships, 16,* 79-97.  
  
Stillman, T. F., Baumeister, R. F.,. Lambert, N. M. et al. (2009). Alone and without purpose: Life loses meaning following social exclusion. *Journal of Experimental Social Psychology, 45*, 686-694.  
  
Pua, Y. H., Wrigley, T. V., Cowan, S. M., et al. (2009). Hip flexion range of motion and physical function in hip osteoarthritis: Mediating effects of hip Extensor strength and pain. *Arthritis & Rheumatism-Arthritis Care and Research, 61*, 633-640.  
  
Hamer, M., Molloy, G. J., de Oliveira, C., et al. (2009). Persistent depressive symptomology and imflammation: To what extent to health behaviors and weight control mediate this relationship? *Brain, Behavior, and Immunity, 23*, 413-418.  
  
Alloy, L. B., Bender, R. E., Wagner, C. A. et al. (2009). Bipolar spectrum-substance use co-occurrence: Behavioral apporach system (BAS) sensitivity and impulsiveness as shared personality vulnerabilities. *Journal of Personality and Social Psychology, 97*, 549-565.  
  
Huber, A., Suman, A. L., Biasi, G., & Carli, C. (2009). Alexithymia in fibromyalgia syndrome: Associations with ongoing pain, experimental pain sensitivity, and illness behavior. *Journal of Psychosomatic Research, 66*, 425-433.  
  
Roelofs, J., Huibers, M., Peeters, F., Arntz, A. & van Os, J. (2008). Ruminating and worrying as possible mediators in the relation between neuroticism and symptoms of depression and anxiety in clinically depressed individuals. *Behaviour Research and Therapy, 48*, 1283-1289.  
  
Danaher, B. G., Smolkowski, K., Seeley, J. R., & Severson, H. H. (2008). Mediators of a successful web-based smokeless tobacco sensation program. *Addiction, 103*, 1706-1712.  
  
Buffardi, L. E., & Campbell, W. K. (2008). Narcissism and social networking web sites.  *Personality and Social Psychology Bulletin, 34*, 1303-1314.  
  
Ruva, C. L., & McEvoy, C. (2008). Negative and positive pretrial publicity affect juror memory and decision making. *Journal of Experimental Psychology: Applied, 14*, 226-235.  
  
**MODMED**  
  
Model 1  
  
Oei, N. Y. L., Tollenaar, M. S., Elzinga, B. M., & Spinhoven, P. (2010). Propranolol reduces emotional distraction in working memory: A partial mediating role of propranolol-induced cortisol increases?  *Neurobiology of Learning and Memory, 93*, 388-395.  
  
Wiedemann, A. U., Schuz, B., Sniehotta, F., Scholtz, U., & Schwarzer, R. (2010). Disentangling the relation between intentions, planning, and behaviour: A moderated mediation analysis.  *Psychology and Health, 24*, 67-79.  
  
Model 2  
  
Cole, M. S., Bedeian, A. G., & Bruch, H. (2011). Linking leader behavior and leadership consensus to team performance: Integrating direct consensus and dispersion models of group composition. *Leadership Quarterly, 22*, 383-398.  
  
Naumann, J., Richter, T., Christmann, U., & Groeben, N. (2008). Working memory capacity and reading skill moderate the effectiveness of strategy training in learning from hypertext. *Learning and Individual Differences, 18*, 197-213.  
  
Jensen, J. D. (2008). Scientific uncertainty in news coverage of cancer research: Effects of hedging on scientists' and journalists' credibility. *Human Communication Research, 34*, 347-369.  
  
Rees, T., & Freeman, P. (2009). Social support moderates the relationship between stressors and task performance through self-efficacy. *Journal of Social and Clinical Psychology, 28*, 244-263.  
  
Goodin, B. R., McGuire, L. M., Stapleton, L. M. et al. (2009). Pain catastrophizing mediates the relationship between self-reported strenuous exercise involvement and pain ratings: Moderating role of anxiety sensitivity. *Psychosomatic Medicine, 71*, 1018-1025.   
  
Sibley, C. G., & Perry, R. (2010). An opposing process model of benevolent sexism. *Sex Roles, 62*, 438-452.  
  
Model 3  
  
Cole, M. S., Walter, F., & Bruch, H. (2008). Affective mechanisms linking dysfunctional behavior to performance in work teams: A moderated mediation study. *Journal of Applied Psychology, 93*, 945-958.  
  
Palomares, N. A. (2008). Explaining gender-based language use: Effects of gender identity salience on references to emotion and tentative language in intra- and intergroup contexts. *Human Communication Research, 34*, 263-286.  
  
Goodin, B. R., McGuire, L., Allshouse, M., et al. (2009). Associations between catastrophizing and endogenous pain-inhibitory processes: Sex differences. *Journal of Pain, 10,* 180-190.  
  
Antheunis, M. L., Valkenberg, P. M., & Peter, J. (2010). Getting acquainted through Social network sites: Testing a model of online uncertainty reduction and social attraction. *Computers in Human Behavior, 26*, 100-109.    
  
Model 5  
  
Parade, S. H., Leerkes, E. M., Blankson, A. N. (2010).  Attachment to parents, social anxiety, and close relationships  
of female students over the transition to college. *Journal of Youth and Adolescence, 39*, 127-137.