# Moderated Mediation
# or
# Mediated Moderation

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# Mediation and Moderation

- A ***moderator*** variable influences the strength of a relationship between two other variables and is associated with interactions of variables.

- A model of the relationship of X and Y is said to be "conditional" on the value of W if W moderates that relationship

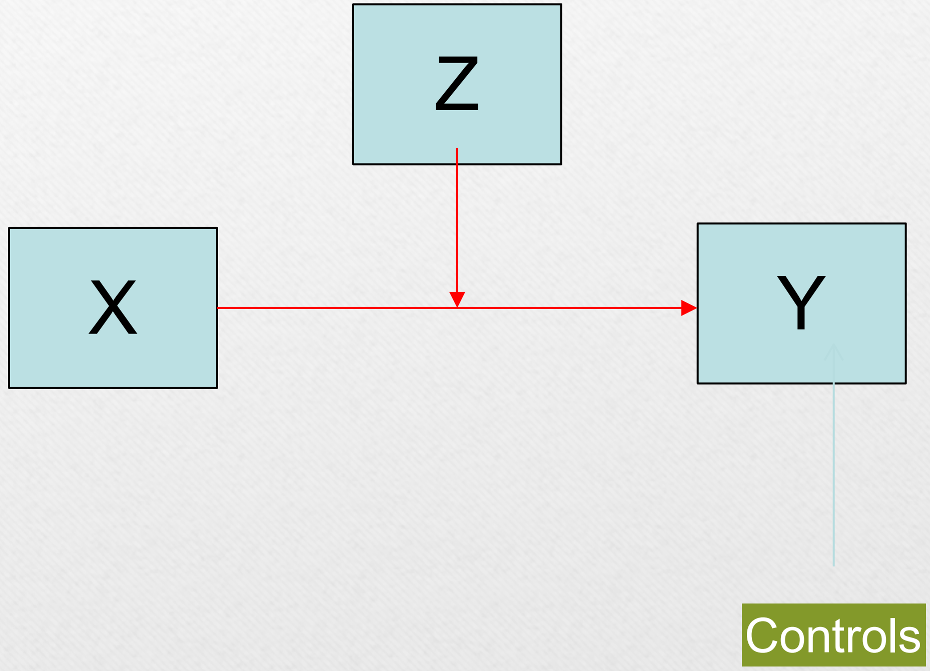
- A ***mediator*** variable explains the relationship between the two other variables and is associated with a path diagram.

- *Mediation is part of a causal chain of events or process*. When the effect of a mediator is in a path model, the strength of the relationship between the independent and dependent variables may decrease.

- Theory and literature support determining variables that are mediators or moderators.

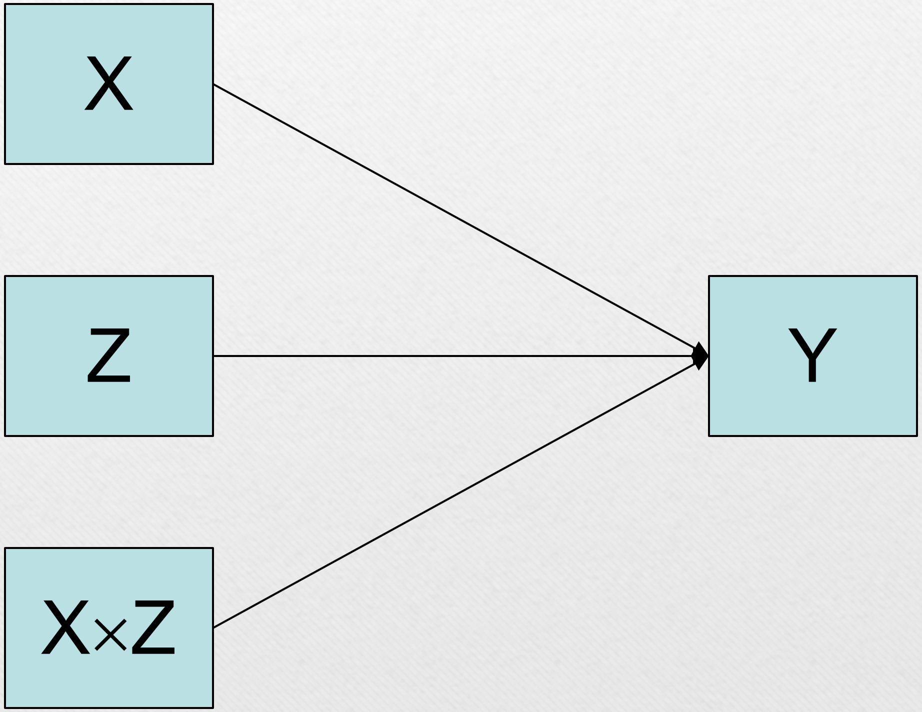
Note: Causal support with cross-sectional data requires additional justification.

# Basic Moderation Model

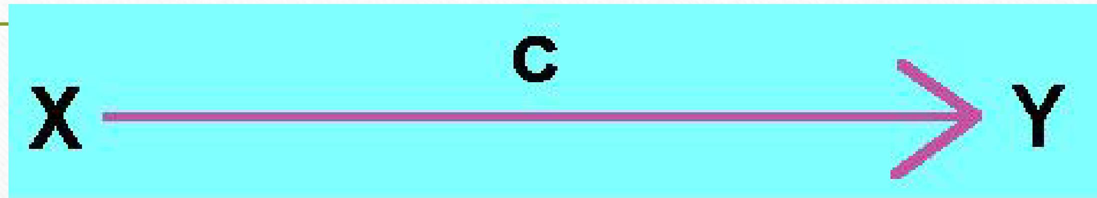


# Moderated Regression Equation

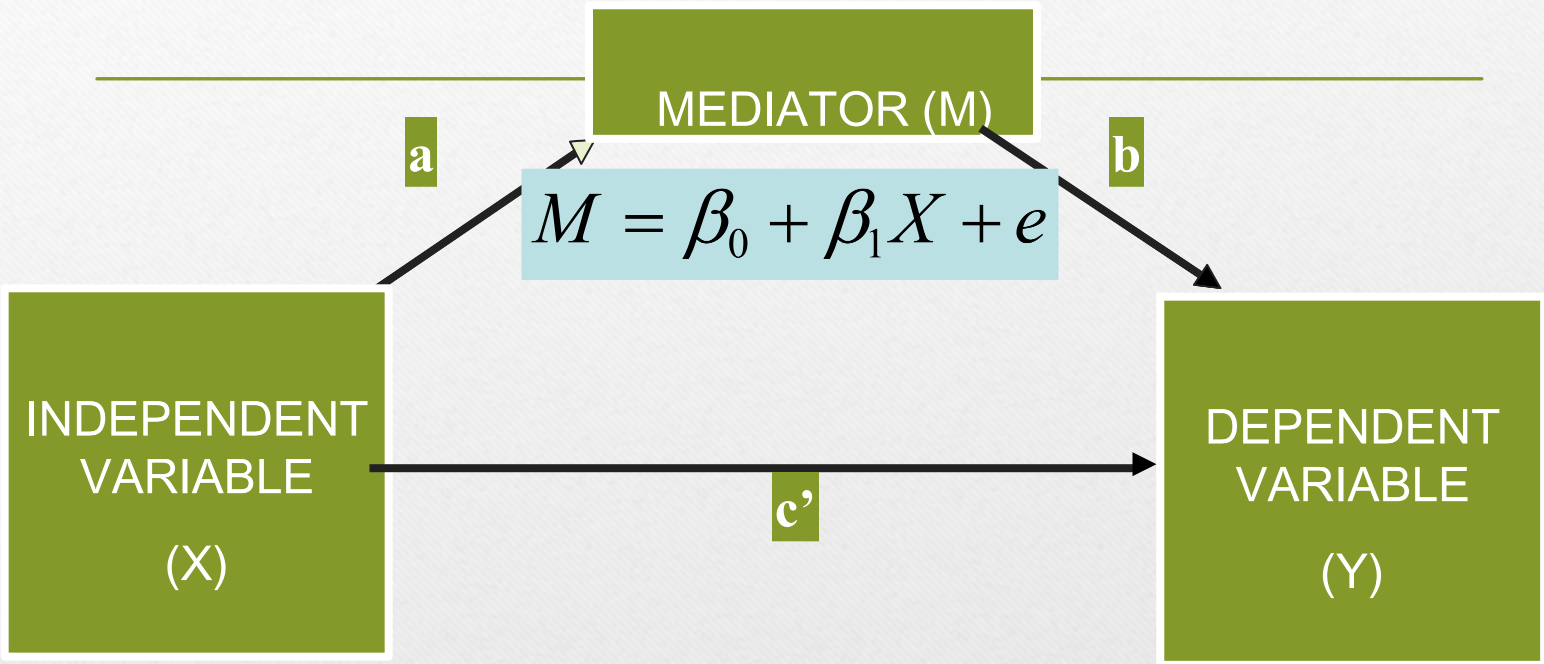
$$Y = B_0 + B_1 X + B_2 Z + B_3 XZ + e$$



# Traditional Mediation Model




Control Variables may be included to predict M and Y




$$M = \beta_0 + \beta_1 X + e$$

$$Y = \beta_0 + \beta_1 M + \beta_2 X + e$$

**Indirect (mediated) effect of X on Y = *a*b***

**Direct (unmediated) effect of X on Y = c'**

# Why Use Bootstrap to test for Significance of Indirect Effect?

- **Test for mediation or indirect effect is $H_0 : ab = 0$.**
- **Sobel Z test is called the "normal theory" test and assumes the indirect effect is normally distributed. Several alternative tests exists (Hayes & Scharkow, 2013 for a review).**
- **The distribution of the indirect effect tends to be skewed, and thus the normal distribution assumption is questionable.**
- **Bootstrapping is a nonparametric approach that can provide bootstrapped confidence intervals for the indirect effect and usually has more power than the "normal theory" tests when data are highly skewed.**

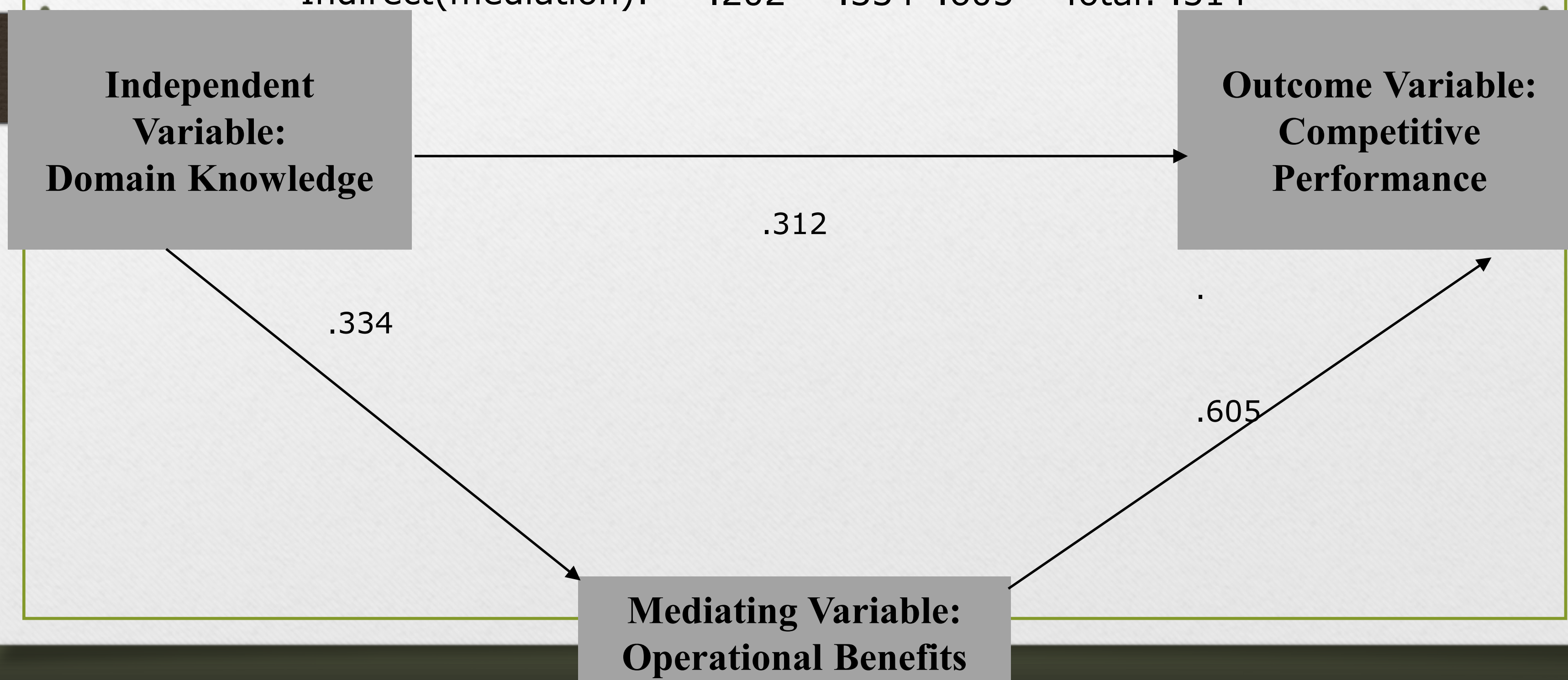
# Example Traditional Mediation Analysis

| Type of Mediation | Partial Mediation of M on relationship of IV & DV |
|---|---|
| **Sobel z-value** | 2.17 significance .015 |

**Results of Regression Analysis and Mediation Computation**

Direct: .312

Indirect(mediation): .202 = .334*.605 Total: .514



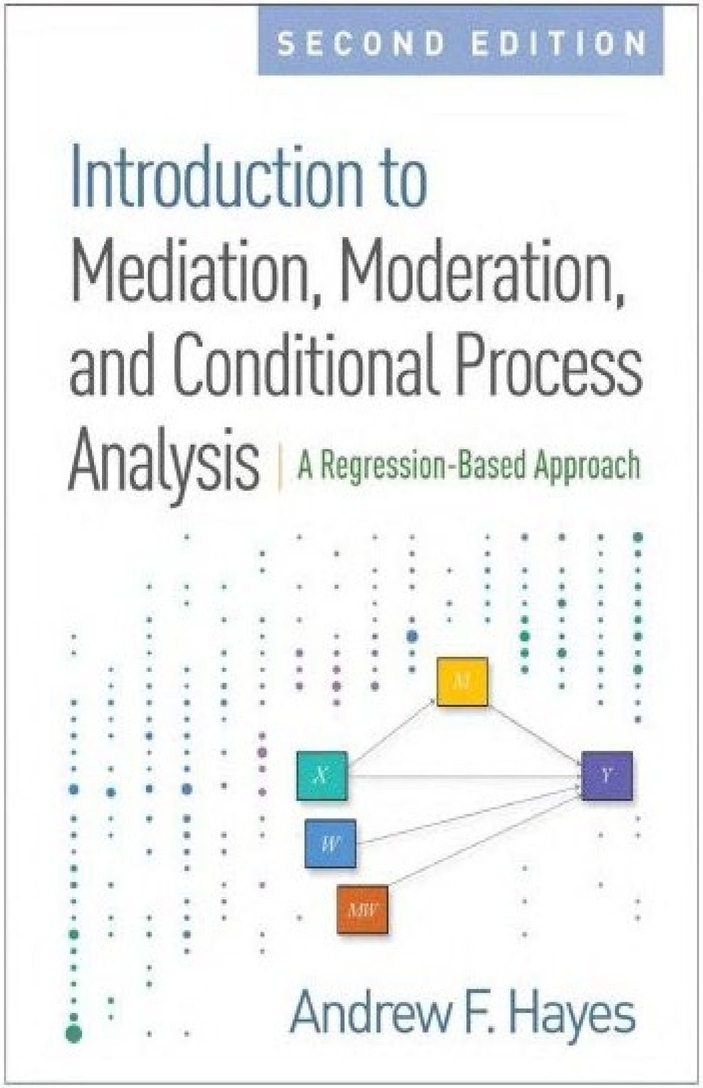
# Baron & Kenny (1986)
# MacKinnon, Hayes, Preacher (2010)

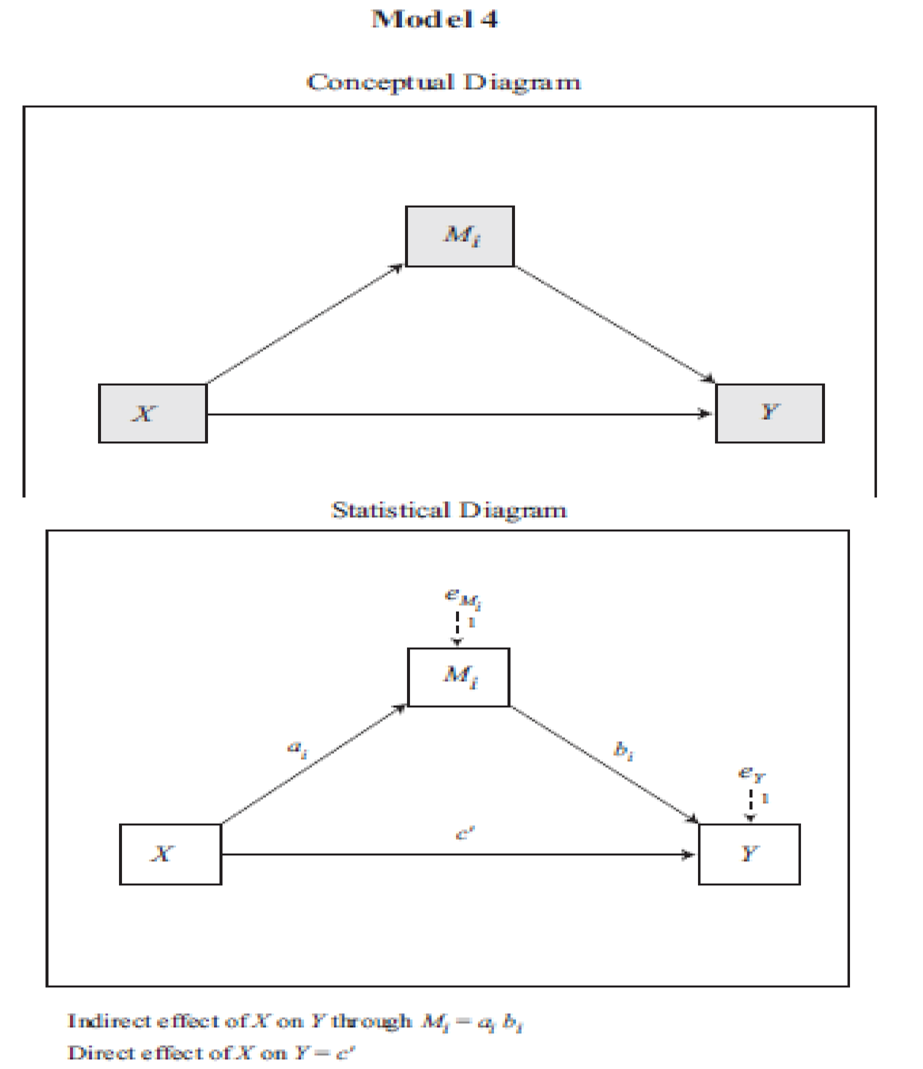
Traditional and Modern Mediation Pioneers

# Hayes Provides Process Macros

- **Many software packages compute the indirect effects. If it is significant, then mediation is supported.** **(Whether it is consistent mediation may be another problem.)**
- **Hayes created Process Macros in 2012 to use bootstrapping to test significance of the indirect effect in path models using regression analysis.**
- **His contribution is that he has a template of models that can be selected and indirect effects and their contrasts can be analyzed.**
- **Template allows multiple mediators and moderators.**

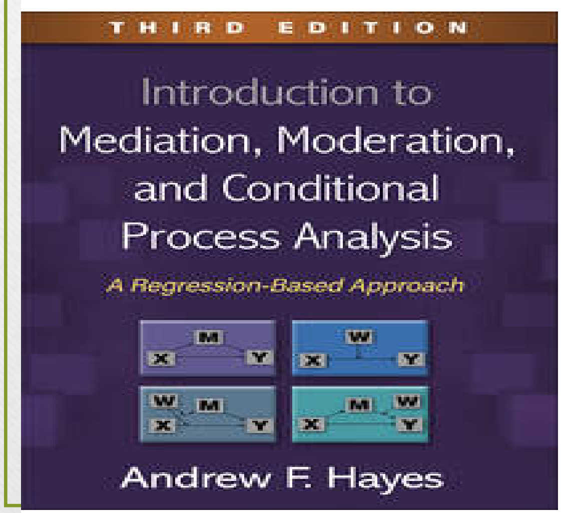
# Hayes Process Textbook & Templates




Take a class from me on the topic of this book.

## Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach Third Edition

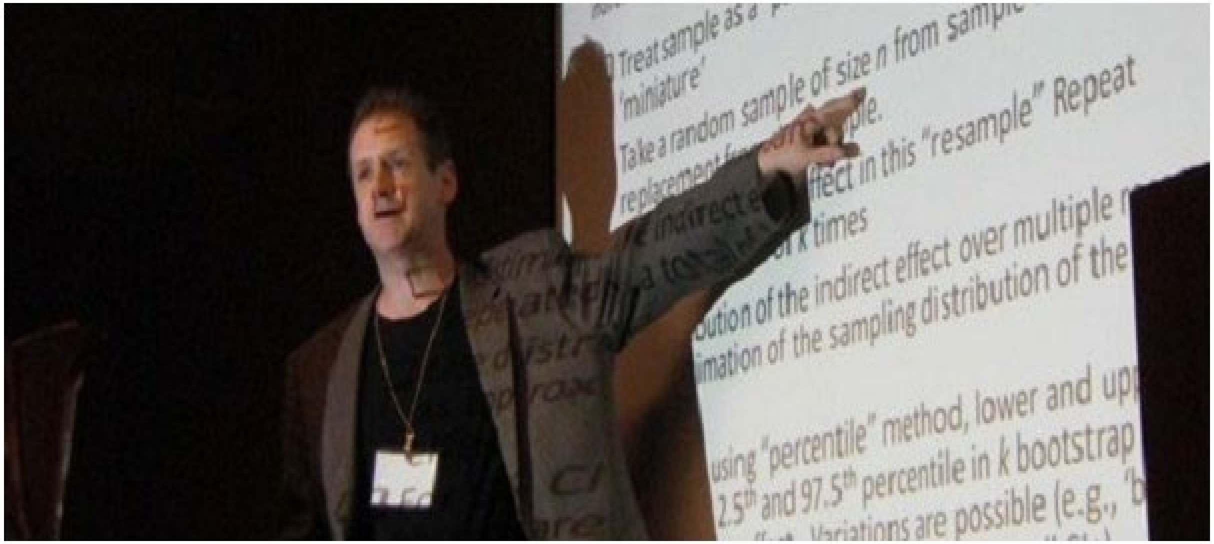



*Introduction to Mediation, Moderation, and Conditional Process Analysis* describes the foundation of mediation and moderation analysis as well as their analytical integration in the form of "conditional process analysis", with a focus on PROCESS for SPSS SAS, and R (#processmacro) as the tool for implementing the methods discussed. Available as both an e-book and in print form, it is published by The Guilford Press.

Here are the data files and code used in this third edition of the book.
Here is the errata for the third edition.

# Andrew F. Hayes, Ph.D.

- Home
- My C.V.
- My Books
- Teaching and Speaking
- Mechanisms and Contingencies Lab
- PROCESS macro for SPSS, SAS, and R
- SPSS, SAS, and R Macros and Code
- Video
- Tweets




GLOBAL SCHOOL EMPIRICAL RESEARCH METHODS

STATISTICAL HORIZONS

**Take a workshop from me in 2021 on the topic of this book.**

**Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach Second Edition**

# **Effects of Aggressive Traits on Cyberbullying**: Mediated moderation or moderated mediation?

By Song, Zhu, Liu, Fan, Zhu, and Zhang (2019)

***Computers in Human Behavior***

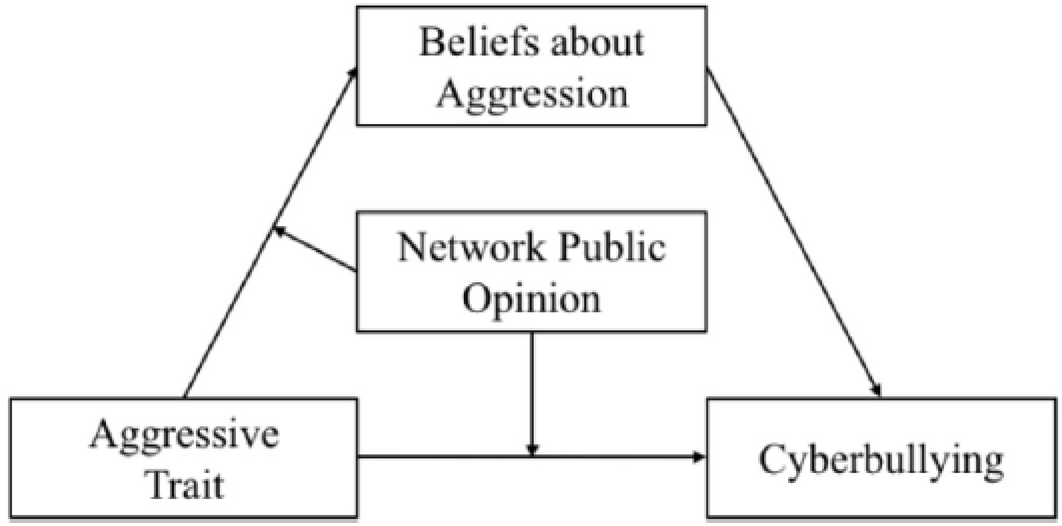



Fig. 1. The mediated moderation model.

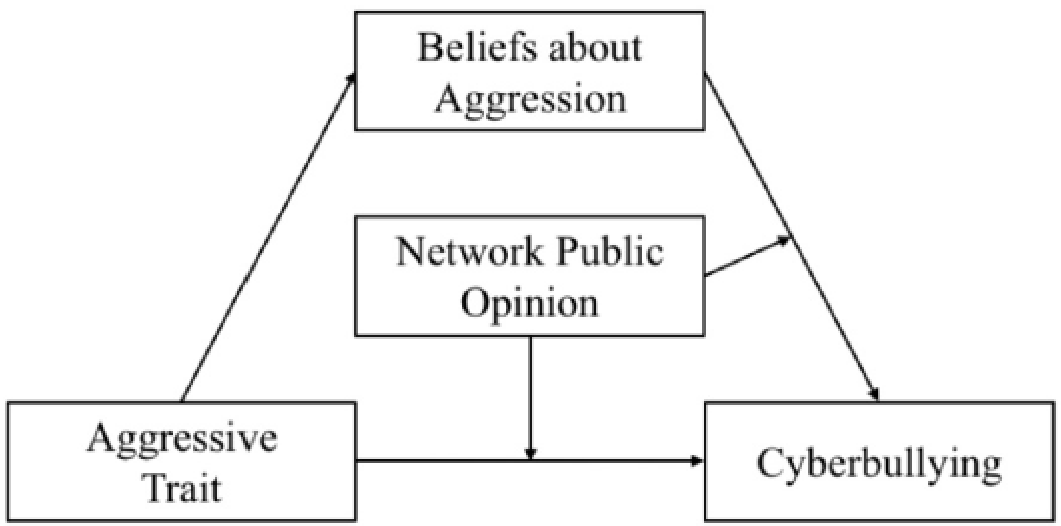


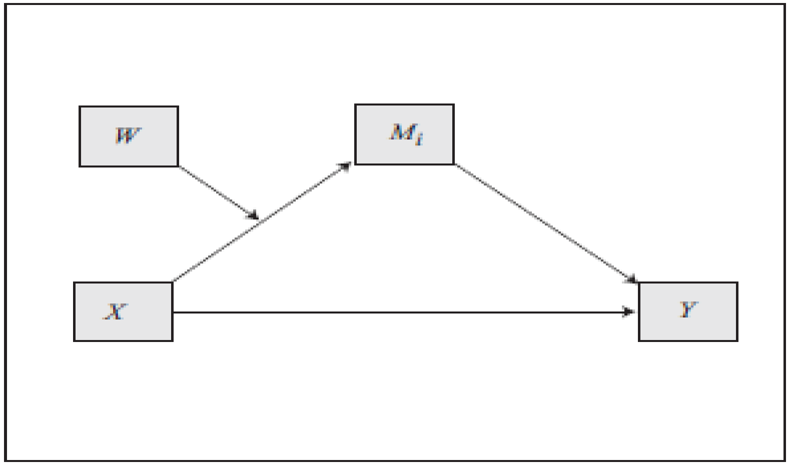

Fig. 2. The moderated mediation model.

# Hayes Model 7

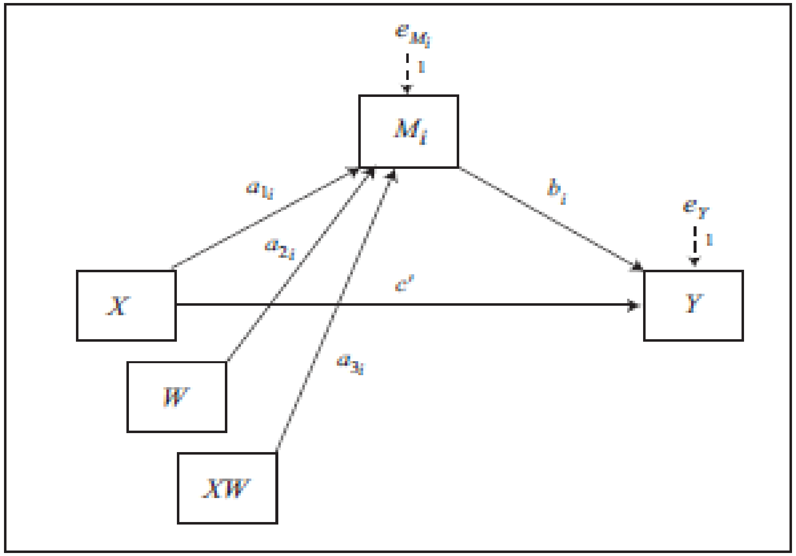
Moderating Relationship of IV and Mediator

**Model 7**

Conceptual Diagram



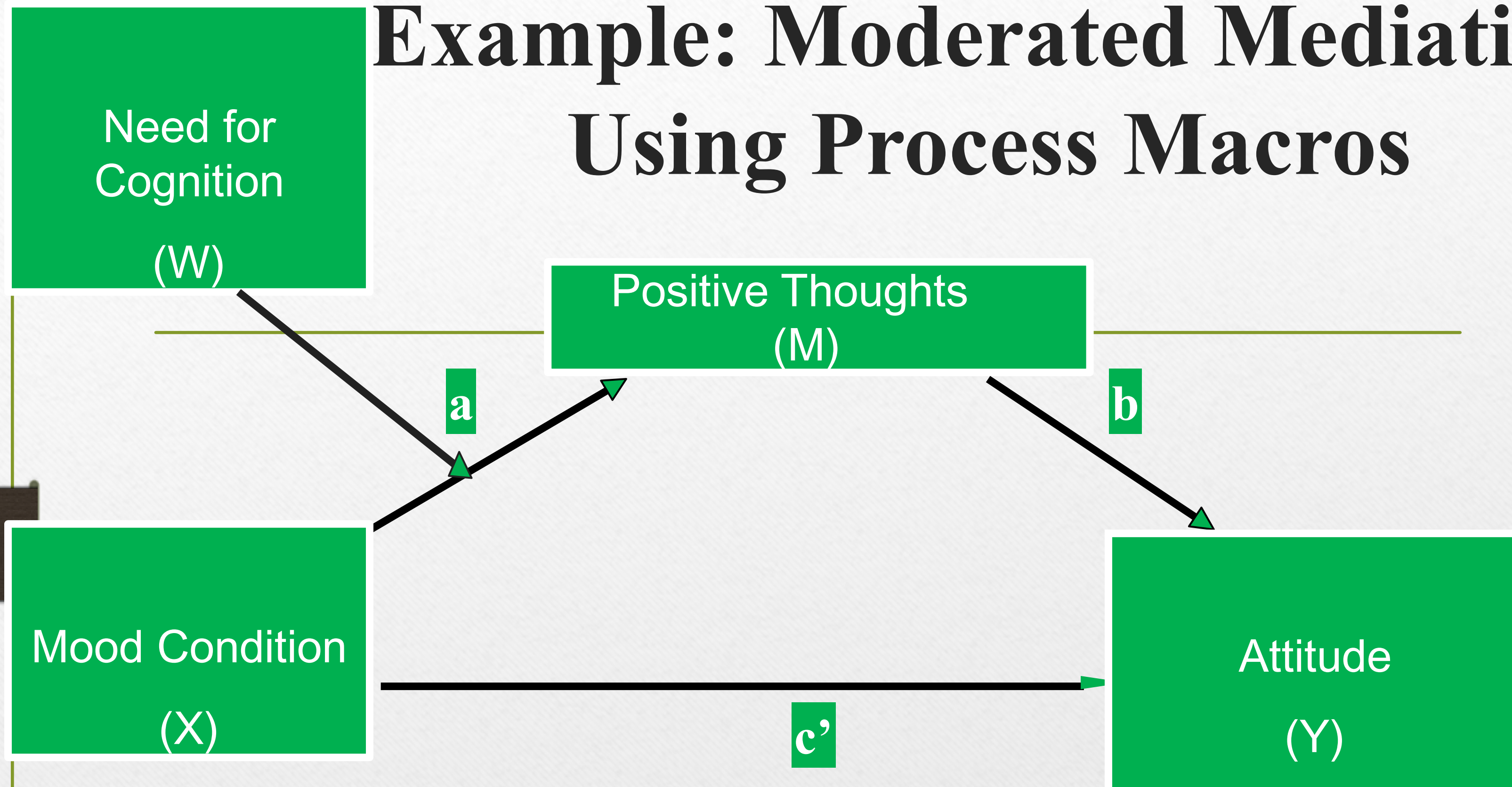

Statistical Diagram




Conditional indirect effect of $X$ on $Y$ through $M_i = (a_{1i} + a_{3i}W)b_i$

Direct effect of $X$ on $Y = c'$

# Example: Moderated Mediation Using Process Macros




$$Y = \beta_0 + \beta_1 M + \beta_2 X + e$$

**Indirect (mediated) effect of X on Y = *a*b***
**Direct (unmediated) effect of X on Y = c’**

# Example of MODMED Data

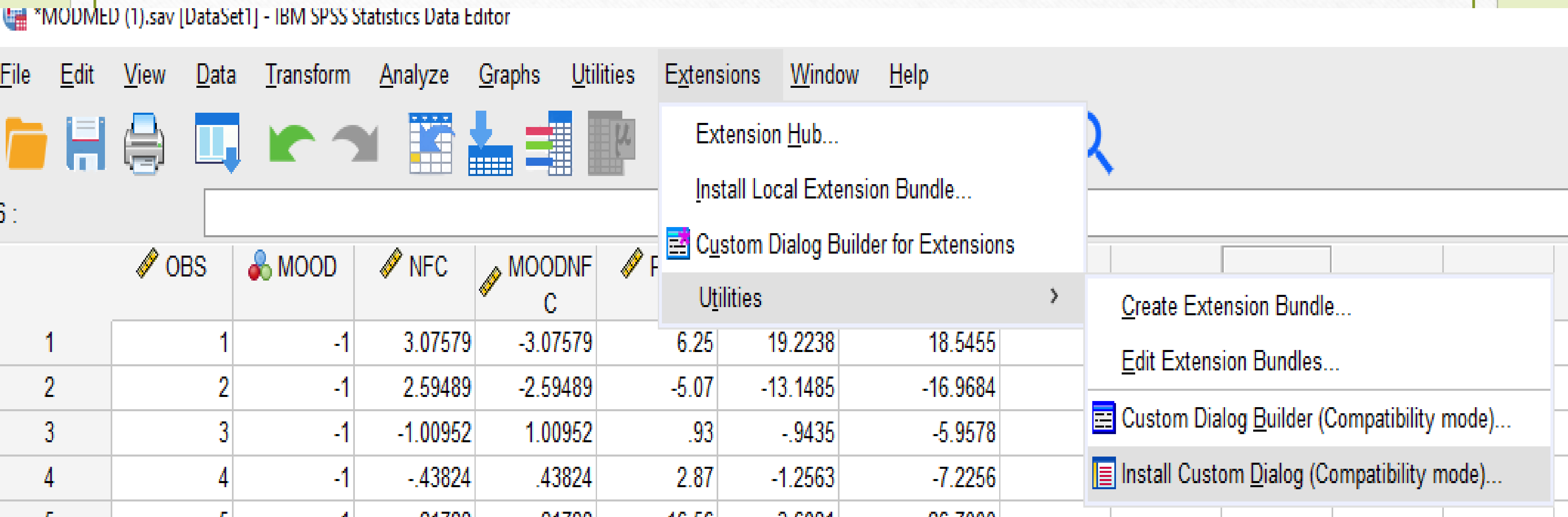
*MODMED (1).sav [DataSet1] - IBM SPSS Statistics Data Editor

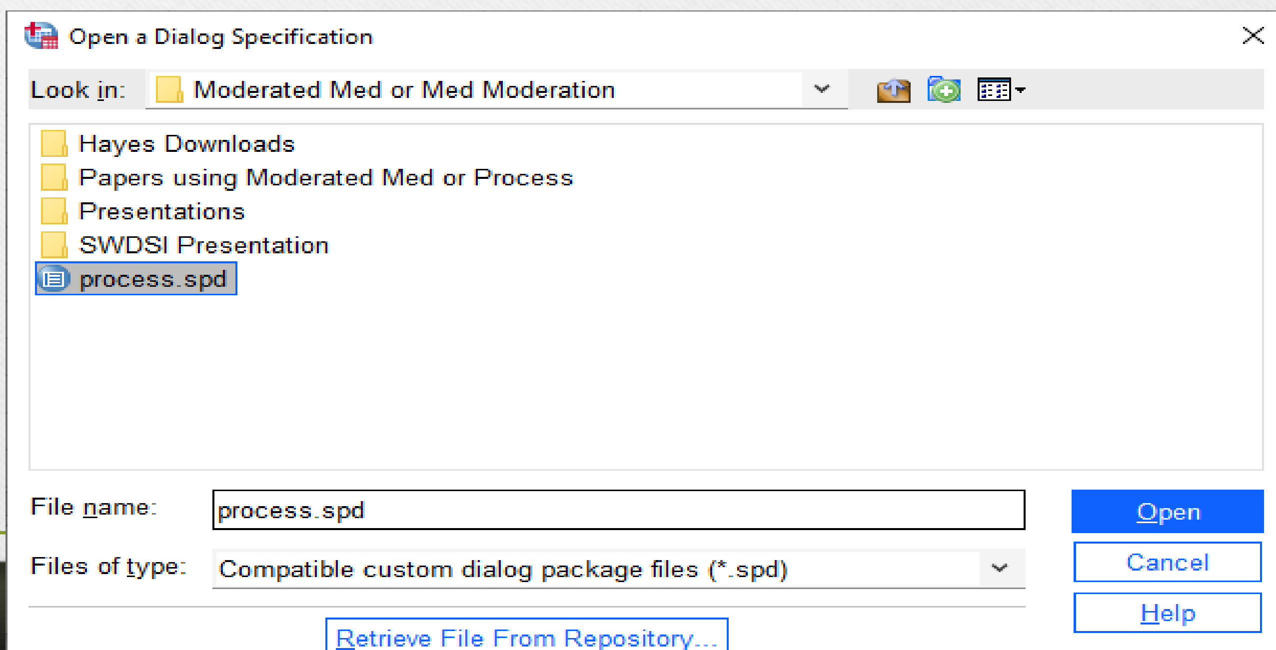
File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

16 :

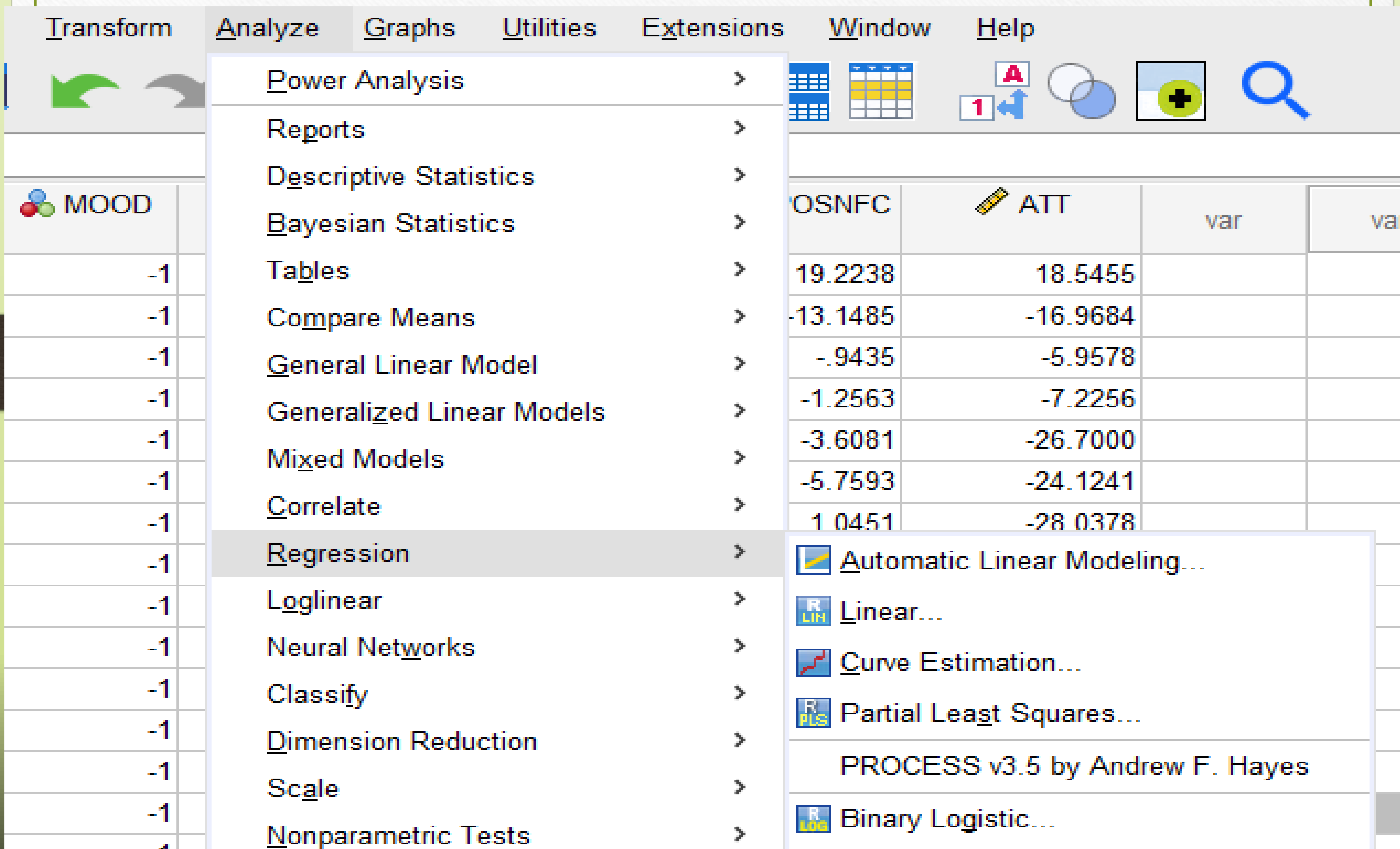
| | OBS | MOOD | NFC | MOODNFC | POS | POSNFC | ATT | var |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | -1 | 3.07579 | -3.07579 | 6.25 | 19.2238 | 18.5455 | |
| 2 | 2 | -1 | 2.59489 | -2.59489 | -5.07 | -13.1485 | -16.9684 | |
| 3 | 3 | -1 | -1.00952 | 1.00952 | .93 | -.9435 | -5.9578 | |
| 4 | 4 | -1 | -.43824 | .43824 | 2.87 | -1.2563 | -7.2256 | |
| 5 | 5 | -1 | .21788 | -.21788 | -16.56 | -3.6081 | -26.7000 | |
| 6 | 6 | -1 | .43842 | -.43842 | -13.14 | -5.7593 | -24.1241 | |
| 7 | 7 | -1 | -1.09646 | 1.09646 | -.95 | 1.0451 | -28.0378 | |
| 8 | 8 | -1 | -.57737 | .57737 | -13.77 | 7.9523 | -9.4845 | |
| 9 | 9 | -1 | 1.75978 | -1.75978 | -5.82 | -10.2359 | 10.8746 | |

# Hayes SPSS Add-ins

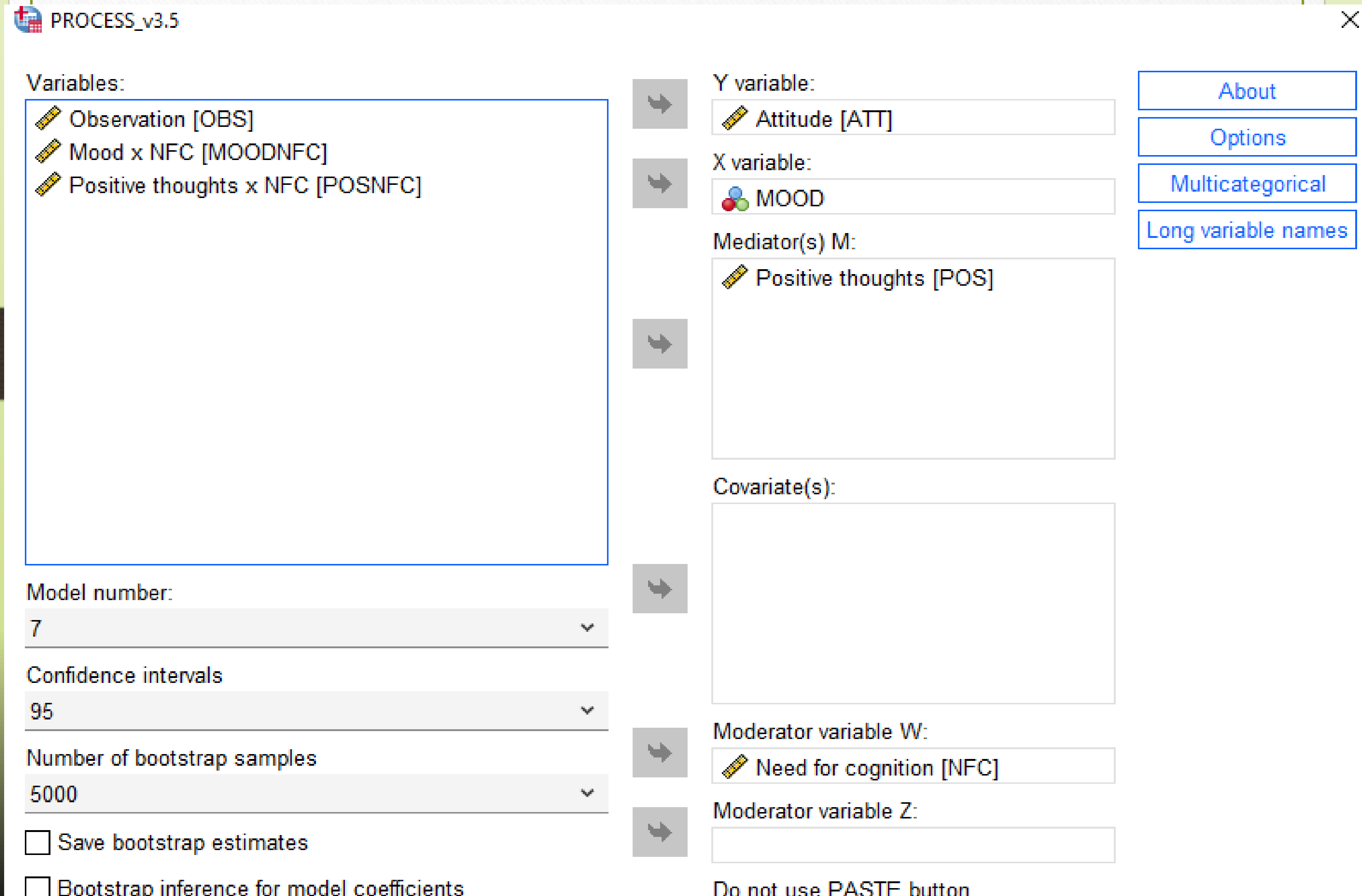


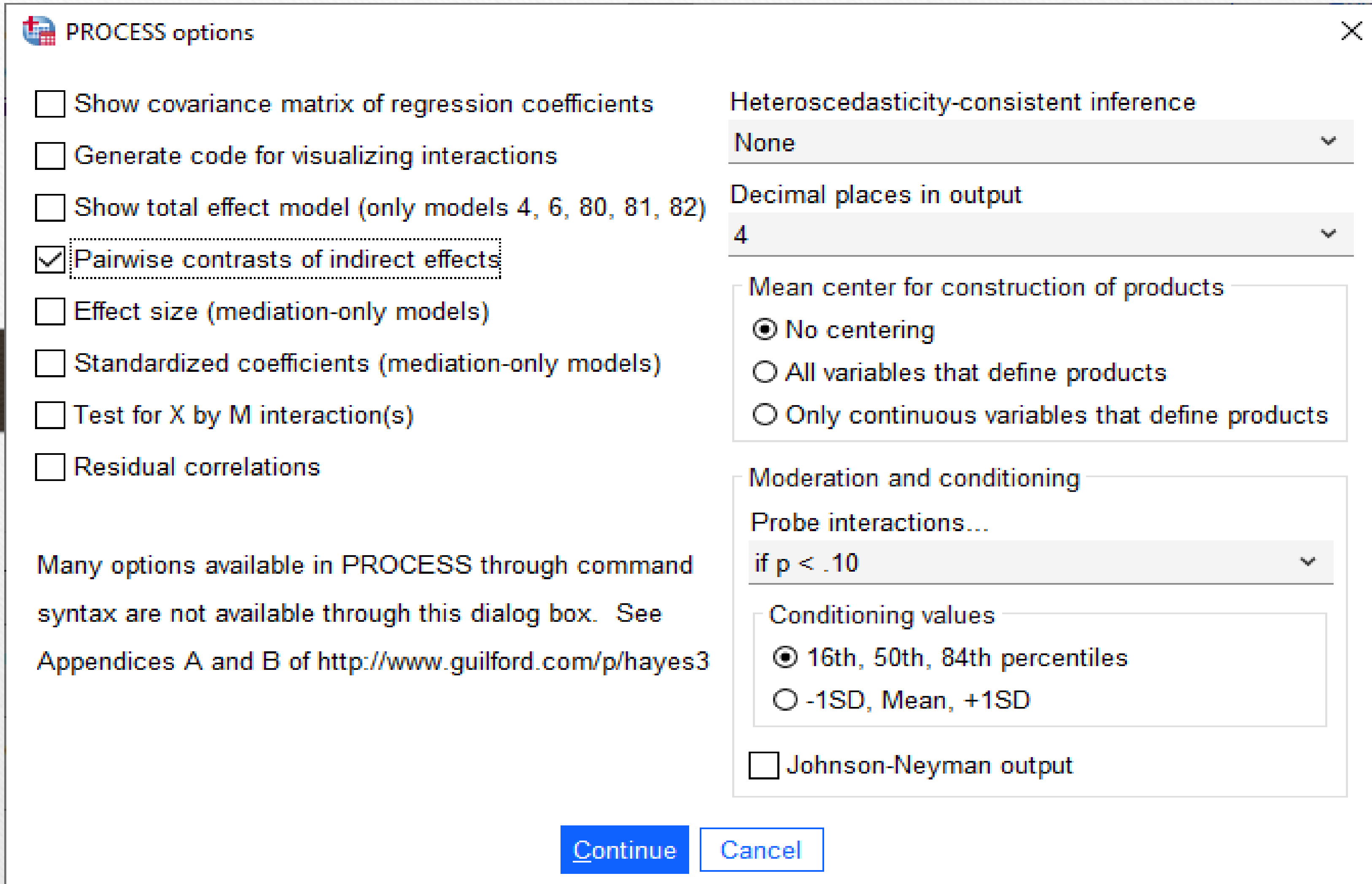
# Add-in under Regression in SPSS Analyze DropDown



# Specify Model 7 for this Analysis



# Process Options



# SPSS Output

```
Run MATRIX procedure:

**************** PROCESS Procedure for SPSS Version 3.5.3 ****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2018). www.guilford.com/p/hayes3

**************************************************************************
Model  : 7
    Y  : ATT
    X  : MOOD
    M  : POS
    W  : NFC

Sample
Size:  100
```

# Standard Regression Analysis

```
**************************************************************************
OUTCOME VARIABLE:
 POS

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      .5656      .3200    48.5739    15.0557     3.0000    96.0000      .0000

Model
              coeff         se          t          p       LLCI       ULCI
constant      .0404      .6971      .0579      .9540    -1.3435     1.4242
MOOD         4.3357      .6971     6.2193      .0000     2.9519     5.7196
NFC           .7672      .5130     1.4956      .1380     -.2510     1.7854
Int_1        1.2565      .5130     2.4496      .0161      .2383     2.2747

Product terms key:
 Int_1    :        MOOD     x        NFC

Test(s) of highest order unconditional interaction(s):
       R2-chng          F        df1        df2          p
X*W      .0425     6.0005     1.0000    96.0000      .0161
```

# Conditional Effects of X(Mood) at values of W(Need for Cognition)

Focal predict: MOOD (X)

Mod var: NFC (W)

Conditional effects of the focal predictor at values of the moderator(s):

| NFC | Effect | se | t | p | LLCI | ULCI |
|---|---|---|---|---|---|---|
| -1.0841 | 2.9735 | .8894 | 3.3434 | .0012 | 1.2081 | 4.7389 |
| .0018 | 4.3380 | .6972 | 6.2225 | .0000 | 2.9542 | 5.7219 |
| 1.4457 | 6.1523 | 1.0206 | 6.0281 | .0000 | 4.1264 | 8.1782 |

# Predictors of Attitude

OUTCOME VARIABLE:
ATT

Model Summary

| R | R-sq | MSE | F | df1 | df2 | p |
|---|---|---|---|---|---|---|
| .6356 | .4039 | 171.5940 | 32.8662 | 2.0000 | 97.0000 | .0000 |

Model

| | coeff | se | t | p | LLCI | ULCI |
|---|---|---|---|---|---|---|
| constant | 1.9807 | 1.3099 | 1.5121 | .1338 | -.6192 | 4.5806 |
| MOOD | 1.7844 | 1.5343 | 1.1631 | .2477 | -1.2607 | 4.8295 |
| POS | 1.1571 | .1853 | 6.2450 | .0000 | .7894 | 1.5248 |

# Significance of Direct Effect and Conditional Indirect Effects

```
****************** DIRECT AND INDIRECT EFFECTS OF X ON Y *****************

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI
     1.7844     1.5343     1.1631      .2477    -1.2607     4.8295

Conditional indirect effects of X on Y:

INDIRECT EFFECT:
 MOOD        ->    POS          ->    ATT

        NFC     Effect     BootSE   BootLLCI   BootULCI
    -1.0841     3.4406     1.2170     1.3189     6.0246
      .0018     5.0195     1.1817     2.9481     7.5305
     1.4457     7.1187     1.6595     4.1985    10.6781
```

# Conditional Indirect Effects, Contrasts, and Index of Moderated Mediation

```
Conditional indirect effects of X on Y:

INDIRECT EFFECT:
 MOOD         ->    POS          ->    ATT

        NFC      Effect     BootSE   BootLLCI   BootULCI
    -1.0841      3.4406     1.2170     1.3189     6.0246
      .0018      5.0195     1.1817     2.9481     7.5305
     1.4457      7.1187     1.6595     4.1985    10.6781

      Index of moderated mediation:
          Index      BootSE   BootLLCI   BootULCI
NFC      1.4539       .6344      .3471     2.8462

 Pairwise contrasts between conditional indirect effects (Effect1 minus Effect2)
    Effect1     Effect2   Contrast      BootSE   BootLLCI   BootULCI
     5.0195      3.4406     1.5789       .6889      .3769     3.0908
     7.1187      3.4406     3.6781      1.6048      .8781     7.2003
     7.1187      5.0195     2.0992       .9159      .5012     4.1095
```

# Johnson-Neyman Option

Moderator value(s) defining Johnson-Neyman significance region(s):

| Value | % below | % above |
|---|---|---|
| -1.6949 | 10.0000 | 90.0000 |

Conditional effect of focal predictor at values of the moderator:

| NFC | Effect | se | t | p | LLCI | ULCI |
|---|---|---|---|---|---|---|
| -4.8265 | -1.7288 | 2.5683 | -.6731 | .5025 | -6.8270 | 3.3693 |
| -4.4314 | -1.2324 | 2.3739 | -.5191 | .6049 | -5.9446 | 3.4798 |
| -4.0363 | -.7359 | 2.1810 | -.3374 | .7365 | -5.0651 | 3.5933 |
| -3.6411 | -.2394 | 1.9900 | -.1203 | .9045 | -4.1896 | 3.7107 |
| -3.2460 | .2570 | 1.8016 | .1427 | .8868 | -3.3191 | 3.8331 |
| -2.8509 | .7535 | 1.6166 | .4661 | .6422 | -2.4554 | 3.9624 |
| -2.4558 | 1.2500 | 1.4364 | .8702 | .3864 | -1.6012 | 4.1012 |
| -2.0607 | 1.7464 | 1.2630 | 1.3828 | .1699 | -.7606 | 4.2535 |
| -1.6949 | 2.2061 | 1.1114 | 1.9850 | .0500 | .0000 | 4.4122 |
| -1.6656 | 2.2429 | 1.0997 | 2.0395 | .0441 | .0600 | 4.4258 |
| -1.2705 | 2.7394 | .9517 | 2.8785 | .0049 | .8503 | 4.6285 |
| -.8753 | 3.2358 | .8271 | 3.9121 | .0002 | 1.5940 | 4.8777 |
| -.4802 | 3.7323 | .7381 | 5.0566 | .0000 | 2.2672 | 5.1974 |
| -.0851 | 4.2288 | .6983 | 6.0561 | .0000 | 2.8427 | 5.6148 |
| .3100 | 4.7253 | .7159 | 6.6004 | .0000 | 3.3042 | 6.1463 |
| .7051 | 5.2217 | .7872 | 6.6337 | .0000 | 3.6592 | 6.7842 |
| 1.1002 | 5.7182 | .8994 | 6.3581 | .0000 | 3.9330 | 7.5034 |
| 1.4953 | 6.2147 | 1.0393 | 5.9794 | .0000 | 4.1516 | 8.2778 |
| 1.8904 | 6.7111 | 1.1974 | 5.6047 | .0000 | 4.3343 | 9.0880 |
| 2.2856 | 7.2076 | 1.3673 | 5.2714 | .0000 | 4.4935 | 9.9217 |
| 2.6807 | 7.7041 | 1.5451 | 4.9861 | .0000 | 4.6370 | 10.7711 |
| 3.0758 | 8.2005 | 1.7284 | 4.7446 | .0000 | 4.7697 | 11.6314 |

# Links & References

**http://www.afhayes.com/introduction-to-mediation-moderation-and-conditional-process-analysis.html**

**http://www.processmacro.org/index.html**


Hayes, A. (2013). *Introduction to mediation, moderation, and conditional process analysis.* New York: Guilford Press

- Hayes, A. F., & Scharkow, M. (2013). The relative trustworthiness of inferential tests of the indirect effect in statistical mediation analysis: Does method really matter? *Psychological Science*. 24. 1918-1927
- Preacher, K. J., & Kelley, K. (2011). Effect size measures for mediation models: Quantitative strategies for communicating indirect effects. *Psychological Methods,* 16, 93-115.
- Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Assessing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research,* 42, 185-227.
- Hayes, A. (2015). An index and test of linear moderated mediation. *Multivariate Behavioral Research,* 50, 1-22.

# Thanks for your attendance!