

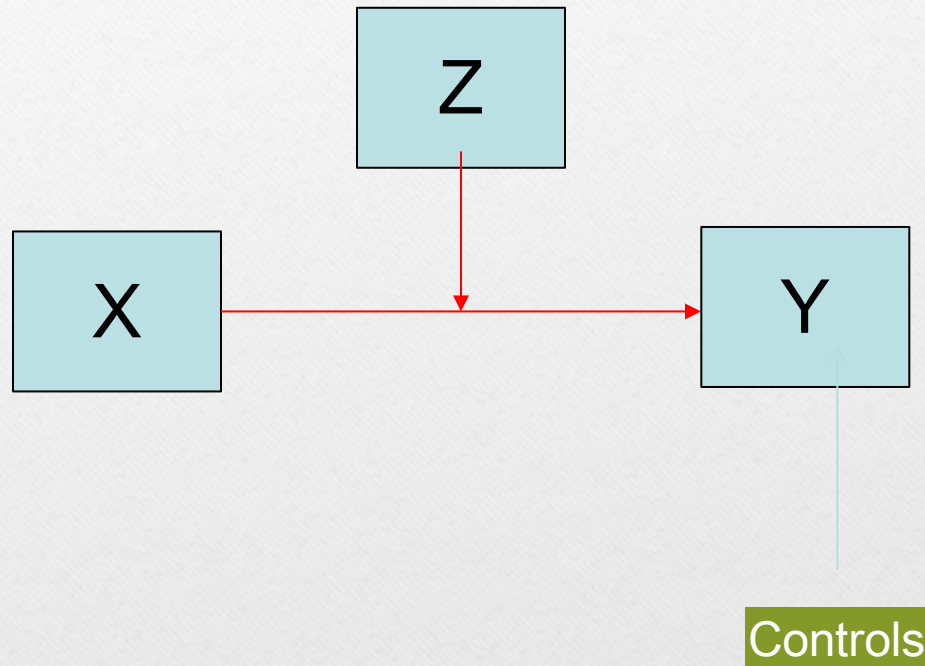
Moderated Mediation or Mediated Moderation

Robert Pavur
University of North Texas

Mediation and Moderation

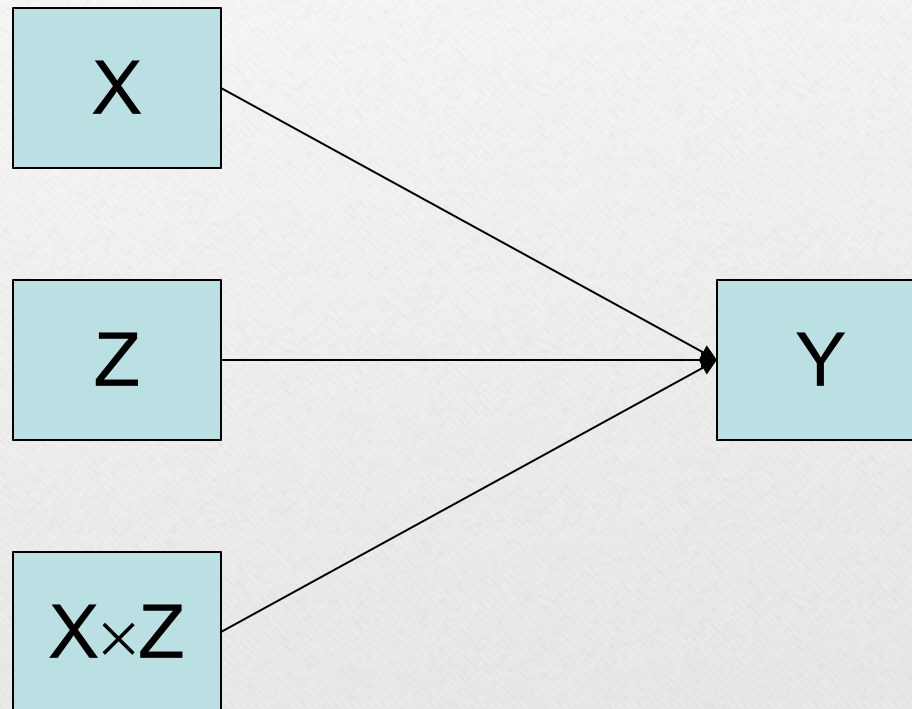
- A moderator variable influences the strength of a relationship between two other variables and is associated with interactions of variables.
- A model of the relationship of X and Y is said to be “conditional” on the value of W if W moderates that relationship
- A mediator variable explains the relationship 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

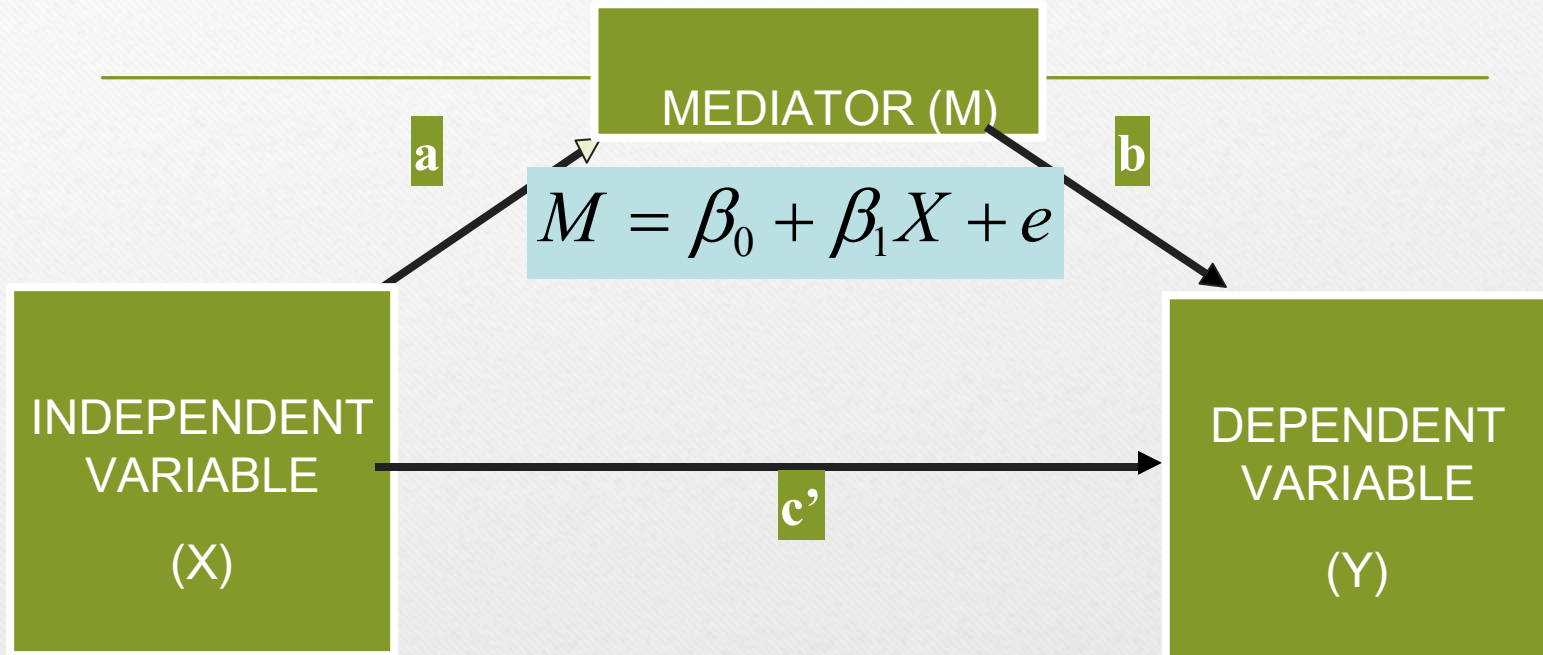
$$Y = B_0 + B_1X + B_2Z + B_3XZ + e$$



Traditional Mediation Model



Control Variables may be included to predict M and Y



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

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 exist (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

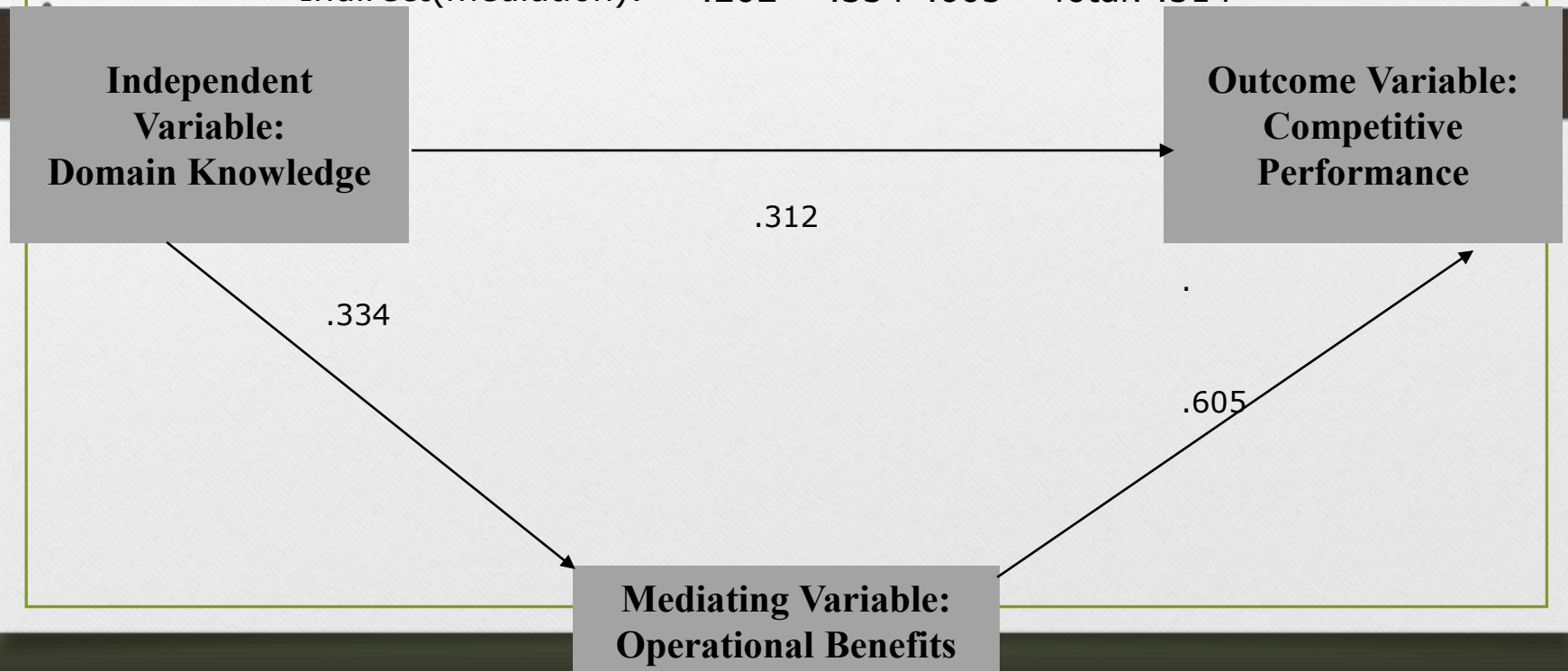
Type of Mediation Partial Mediation of M on relationship of IV & DV

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**



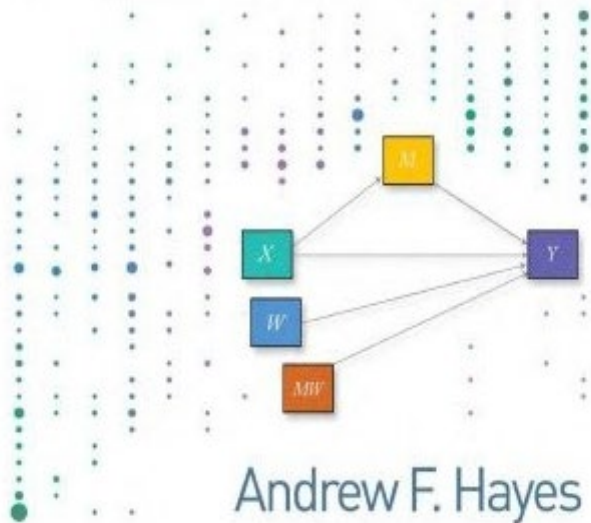
Hayes Provides Process Macros

- 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

SECOND EDITION

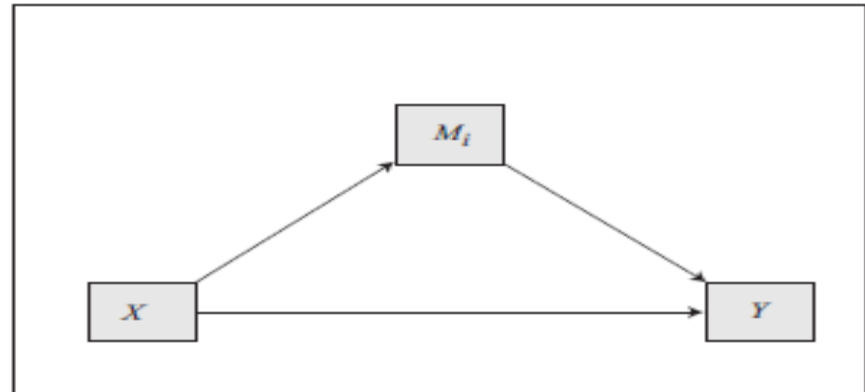
Introduction to
Mediation, Moderation,
and Conditional Process
Analysis | A Regression-Based Approach



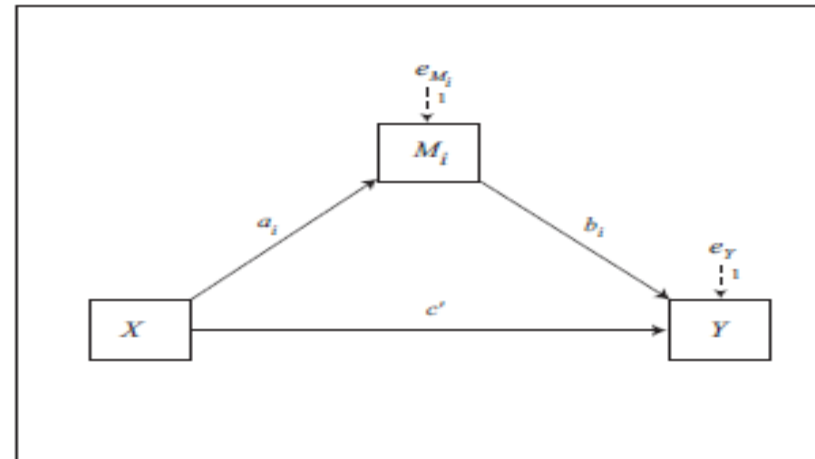
Andrew F. Hayes

Model 4

Conceptual Diagram



Statistical Diagram



Indirect effect of X on Y through $M_i = a_1 b_1$

Direct effect of X on $Y = c'$



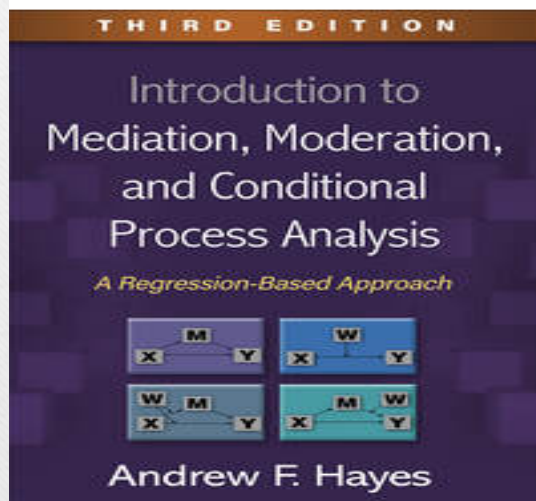
Mediation, Moderation and Conditional Process Analysis

Online and in-person courses by
Andrew F. Hayes in July 2023

Enroll at ccramsessions.com

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



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

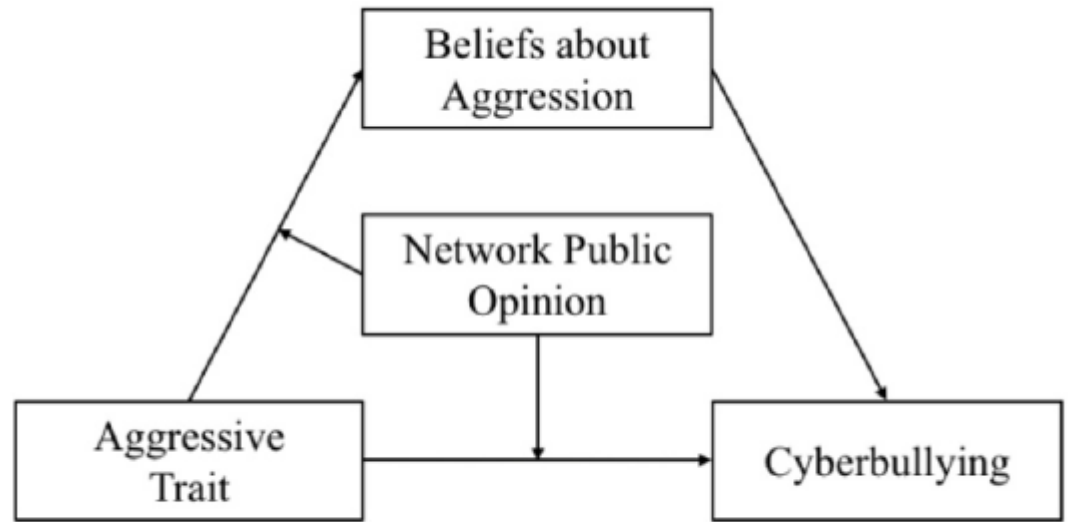


Fig. 1. The mediated moderation model.

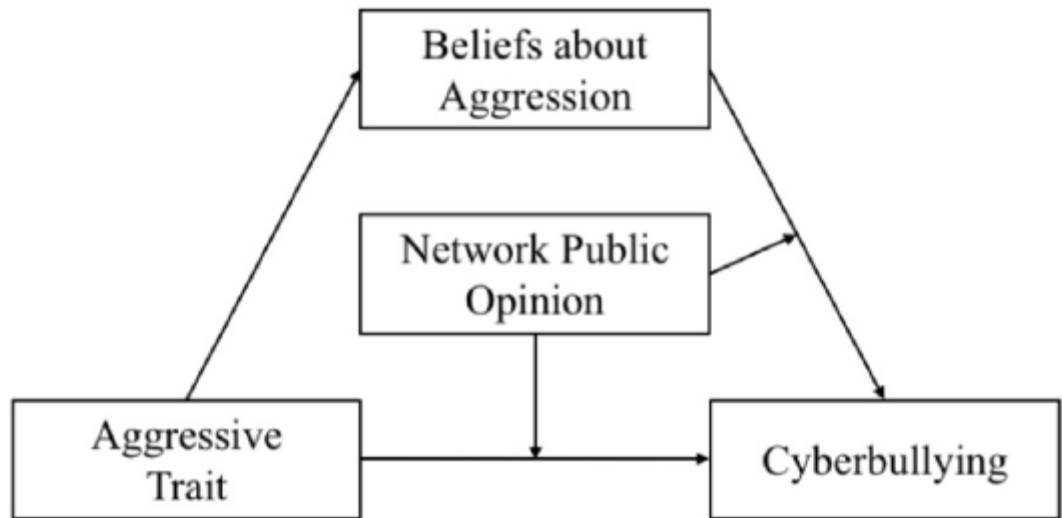


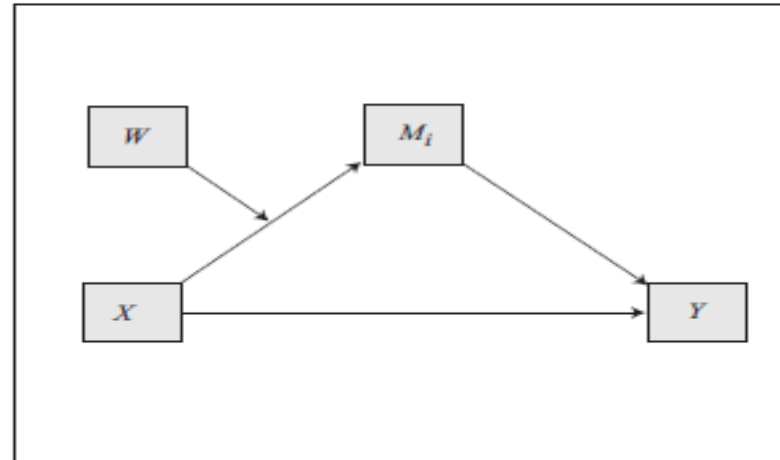
Fig. 2. The moderated mediation model.

Hayes Model 7

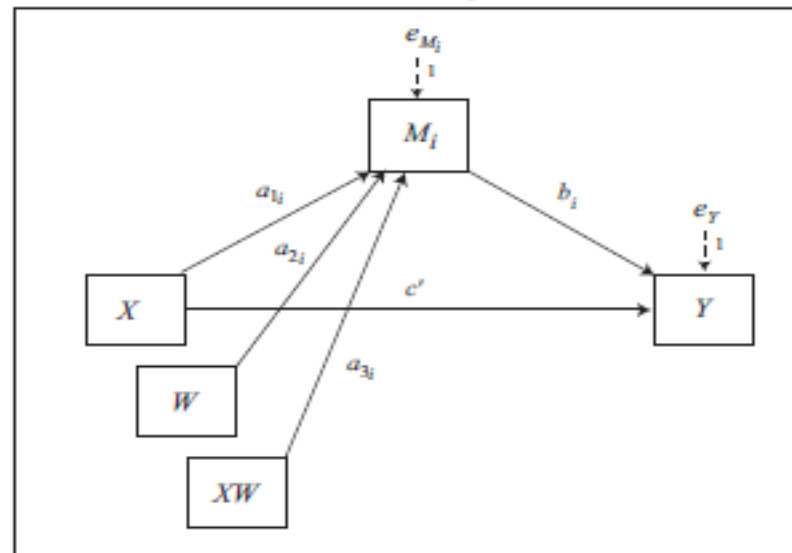
Moderating Relationship of IV and Mediator

Model 7

Conceptual Diagram



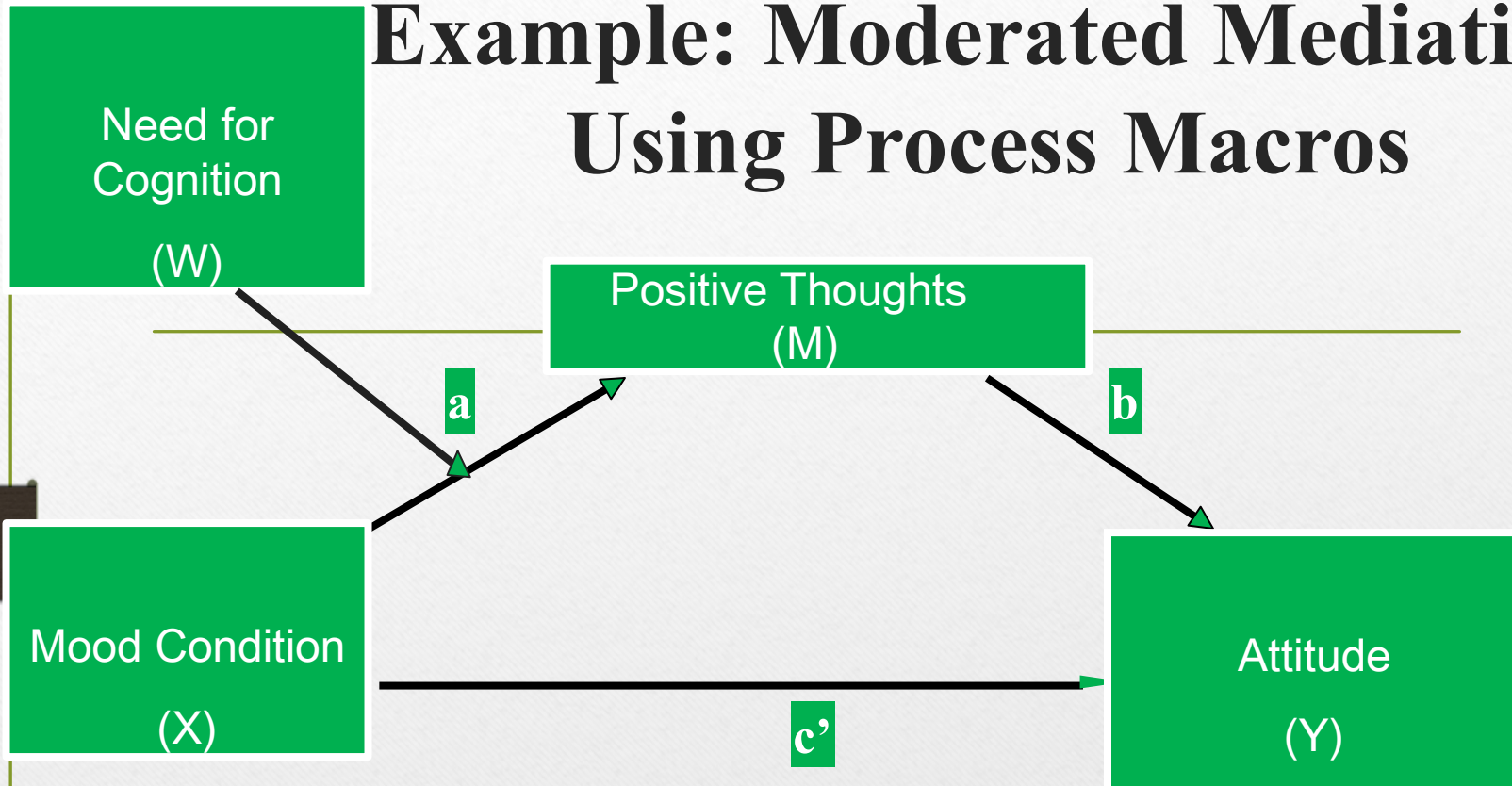
Statistical Diagram



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	MOODNF C	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

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

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help



Extension Hub...
Install Local Extension Bundle...
Custom Dialog Builder for Extensions
Utilities >

Create Extension Bundle...
Edit Extension Bundles...
Custom Dialog Builder (Compatibility mode)...
Install Custom Dialog (Compatibility mode)...

	OBS	MOOD	NFC	MOODNFC	F			
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	0.1700	0.1700	10.50	0.0004	00.7000	

Open a Dialog Specification

Look in: Moderated Med or Med Moderation

- Hayes Downloads
- Papers using Moderated Med or Process
- Presentations
- SWDSI Presentation
- process.spd

File name: process.spd

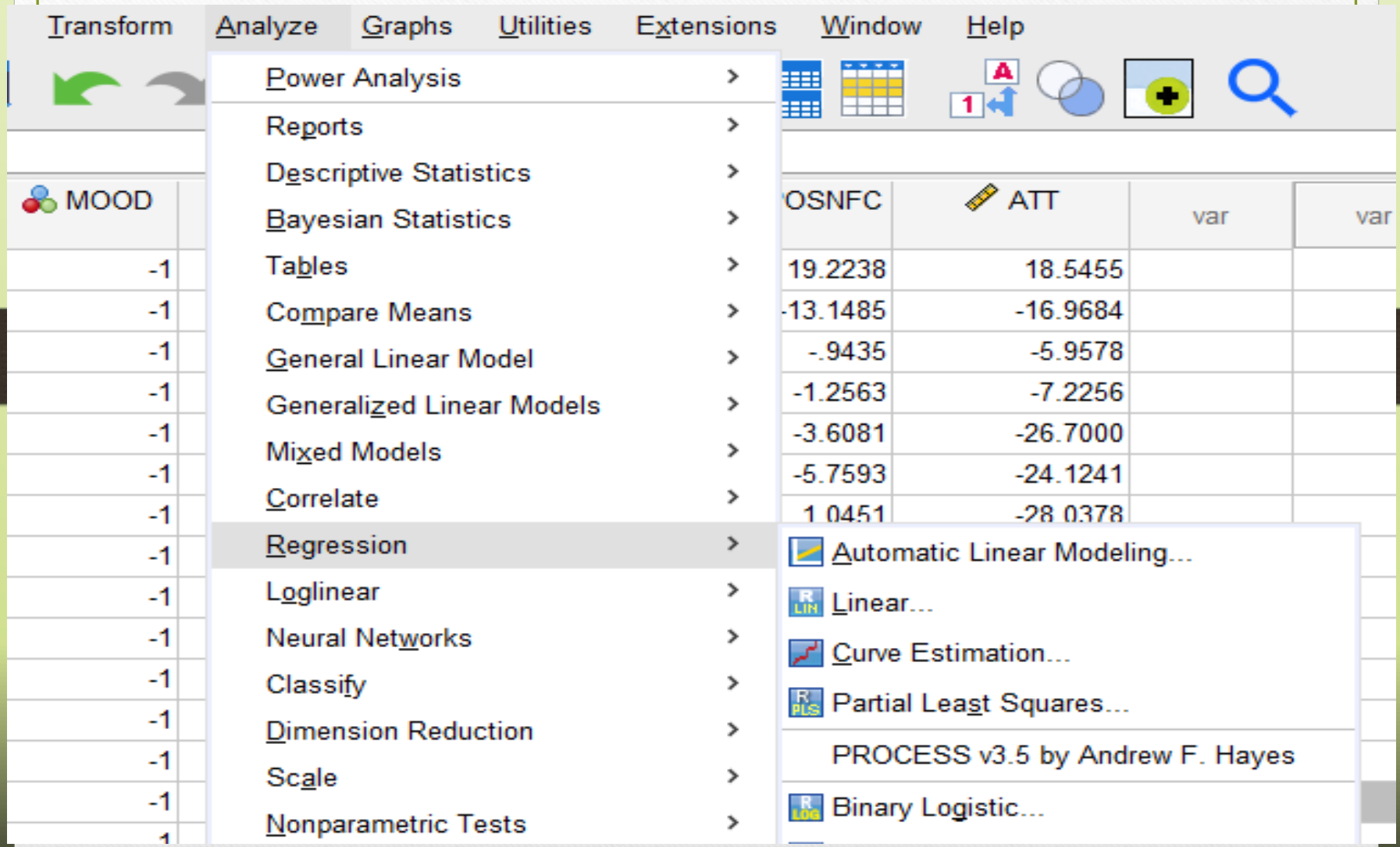
Files of type: Compatible custom dialog package files (*.spd)

Open Cancel Help

Retrieve File From Repository...

Add-in under Regression in SPSS

Analyze DropDown



The screenshot shows the SPSS software interface. The 'Analyze' menu is open, and the 'Regression' option is selected, which has opened a sub-menu. The sub-menu contains the following options:

- Automatic Linear Modeling...
- Linear...
- Curve Estimation...
- Partial Least Squares...
- PROCESS v3.5 by Andrew F. Hayes
- Binary Logistic...

The background shows a data editor window with a table containing the following data:

OSNFC	ATT	var	var
19.2238	18.5455		
-13.1485	-16.9684		
-.9435	-5.9578		
-1.2563	-7.2256		
-3.6081	-26.7000		
-5.7593	-24.1241		
1.0451	-28.0378		

Specify Model 7 for this Analysis

PROCESS_v3.5



Variables:

- Observation [OBS]
- Mood x NFC [MOODNFC]
- Positive thoughts x NFC [POSNFC]

Model number:

7

Confidence intervals

95

Number of bootstrap samples

5000

Save bootstrap estimates

Bootstrap inference for model coefficients



Y variable:

Attitude [ATT]



X variable:

MOOD



Mediator(s) M:

Positive thoughts [POS]



Covariate(s):



Moderator variable W:

Need for cognition [NFC]



Moderator variable Z:

Do not use PASTE button


About

Options

Multicategorical

Long variable names

Process Options

 PROCESS options



- Show covariance matrix of regression coefficients
- Generate code for visualizing interactions
- Show total effect model (only models 4, 6, 80, 81, 82)
- Pairwise contrasts of indirect effects
- Effect size (mediation-only models)
- Standardized coefficients (mediation-only models)
- Test for X by M interaction(s)
- Residual correlations

Many options available in PROCESS through command syntax are not available through this dialog box. See Appendices A and B of <http://www.guilford.com/p/hayes3>

Heteroscedasticity-consistent inference

None

Decimal places in output

4

Mean center for construction of products

- No centering
- All variables that define products
- Only continuous variables that define products

Moderation and conditioning

Probe interactions...

if $p < .10$

Conditioning values

- 16th, 50th, 84th percentiles
- 1SD, Mean, +1SD

Johnson-Neyman output

Continue

Cancel

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	
		Effect	BootSE	BootLLCI	BootULCI
NFC					
		3.4406	1.2170	1.3189	6.0246
		5.0195	1.1817	2.9481	7.5305
		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!

Questions?



Comments?

