

“ Don't ever let someone tell you that you can't do something. Not even me. You got a dream, you gotta protect it. When people can't do something themselves, they're gonna tell you that you can't do it. You want something, go get it. Period.”

~ Will Smith
(The Pursuit of Happiness, film)

Moderators and Mediators: What to Consider



Professor T. Ramayah
Room 118, Level 1,
School of Management,
Universiti Sains Malaysia,
11800 Minden,
Penang, Malaysia.
Tel: 604-653 3888 ext 3889
Fax: 604-657 7448
Email: ramayah@usm.my
ramayah@gmail.com

A screenshot of a Windows Internet Explorer browser window displaying the website for T. Ramayah. The browser's address bar shows the URL http://www.ramayah.com/. The website header features the name "T. RAMAYAH" in large green letters and the subtitle "academician & researcher" in smaller white text. The main content area is a large photograph of an empty lecture hall with rows of green seats and a wooden podium. The Windows taskbar at the bottom shows the Start button, several open applications (Microsoft Office, Vodafone, T. Ram..., untitled...), and the system tray with the time 11:30 AM.

T. Ramayah Online - Windows Internet Explorer

http://www.ramayah.com/

File Edit View Favorites Tools Help

T. Ramayah Online Gmail - Inbox (30) - ramayah...

T. RAMAYAH

academician & researcher

start

Micros... Vodafo... T. Ram... untitled...

11:30 AM

Contribution in Research



Conceptual Contributions

1. improved conceptual definitions of the original constructs;
2. the identification and conceptual definition of additional constructs to be added to the conceptual framework (e.g., additional dependent, independent, mediating, and/or moderator variables);
3. the development of additional theoretical linkages (i.e., research hypotheses) with their accompanying rationale; and
4. the development of improved theoretical rationale for existing linkages.

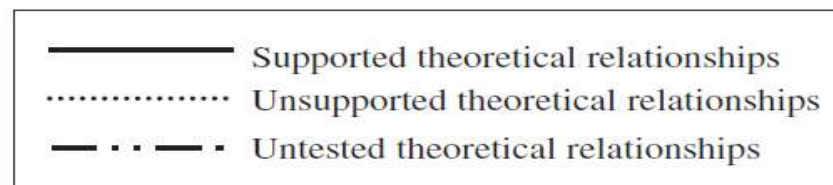
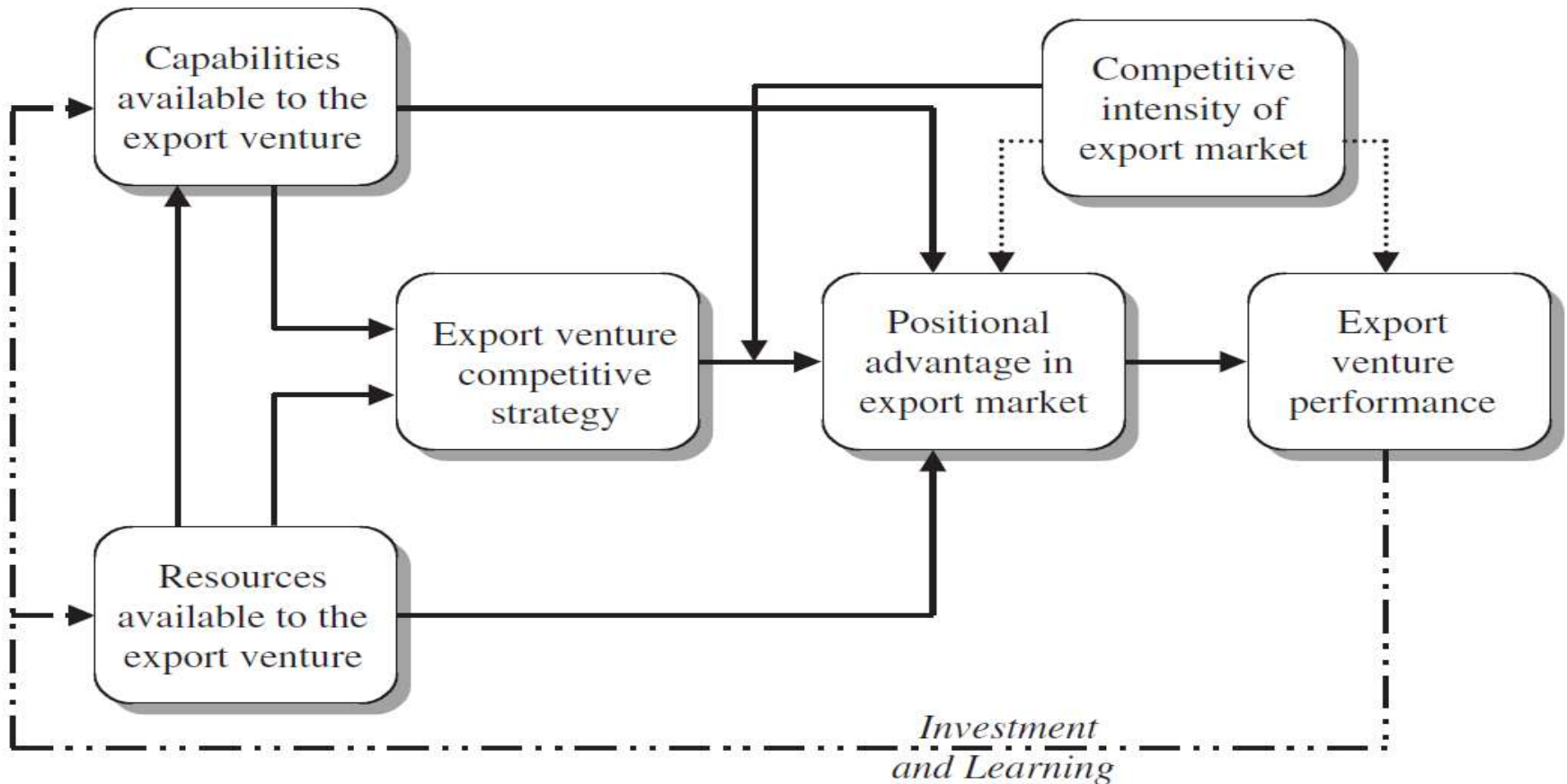
Empirical Contribution

1. testing a theoretical linkage between two constructs that has not previously been tested,
2. examining the effects of a potential moderator variable on the nature of the relationship between two constructs,
3. determining the degree to which a variable mediates the relationship between two constructs, and
4. investigating the psychometric properties of an important scale.

Methodological Contribution - Survey

1. reduce the potential problems with shared method variance through the insightful use of multiple methods of measurement,
2. increase the generalizability of the research through more appropriate sampling procedures,
3. allow the investigation of the plausibility of "third-variable explanations" for the results of past studies, and/or
4. enhance the construct validity of key measures through the use of refined multiple-item measures and/or the use of measurement approaches that do not rely on self-reports.

Example



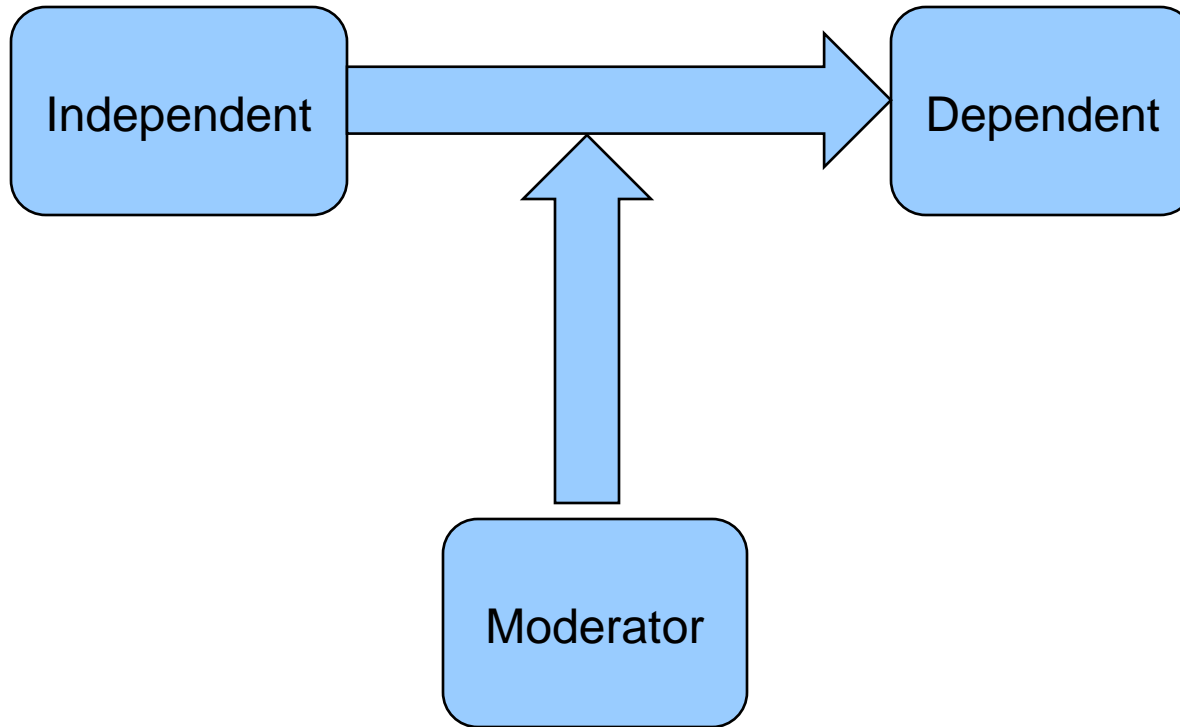
Suggested Reading

- Summers, J. O. (2001). Guidelines for conducting research and publishing in marketing: From conceptualization through the review process. *Journal of the Academy of Marketing Science*, 29(4), 405-415
- Morgan, N. A., Kaleka, A., & Katsikeas, C. S. (2002). Antecedents of Export Venture Performance: A Theoretical Model and Empirical Assessment. *Journal of Marketing*, 68(1), 90–108

Third Variable Role

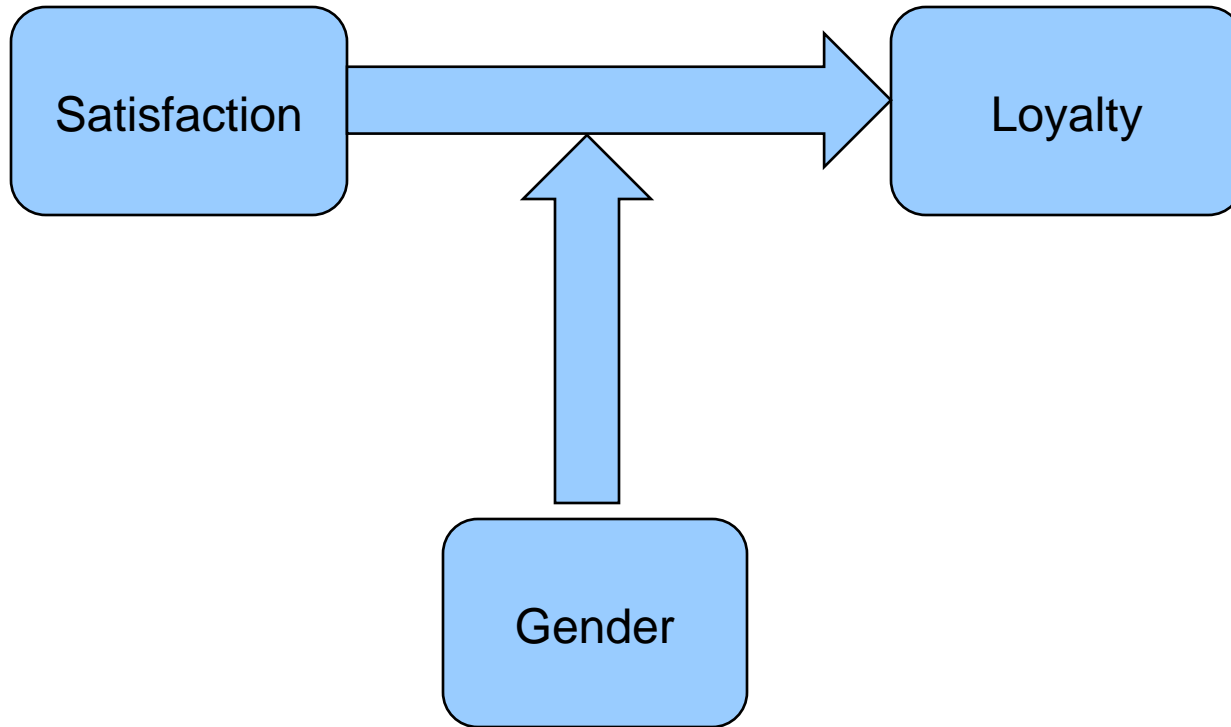
- **Control Variable**
 - A variable that is both unrelated to the predictor and has little or no effect on the relationship between X and Y
 - Is not of primary theoretical interest but is used to account for additional variation in the outcome Y.

Model of a Moderator (Condition)



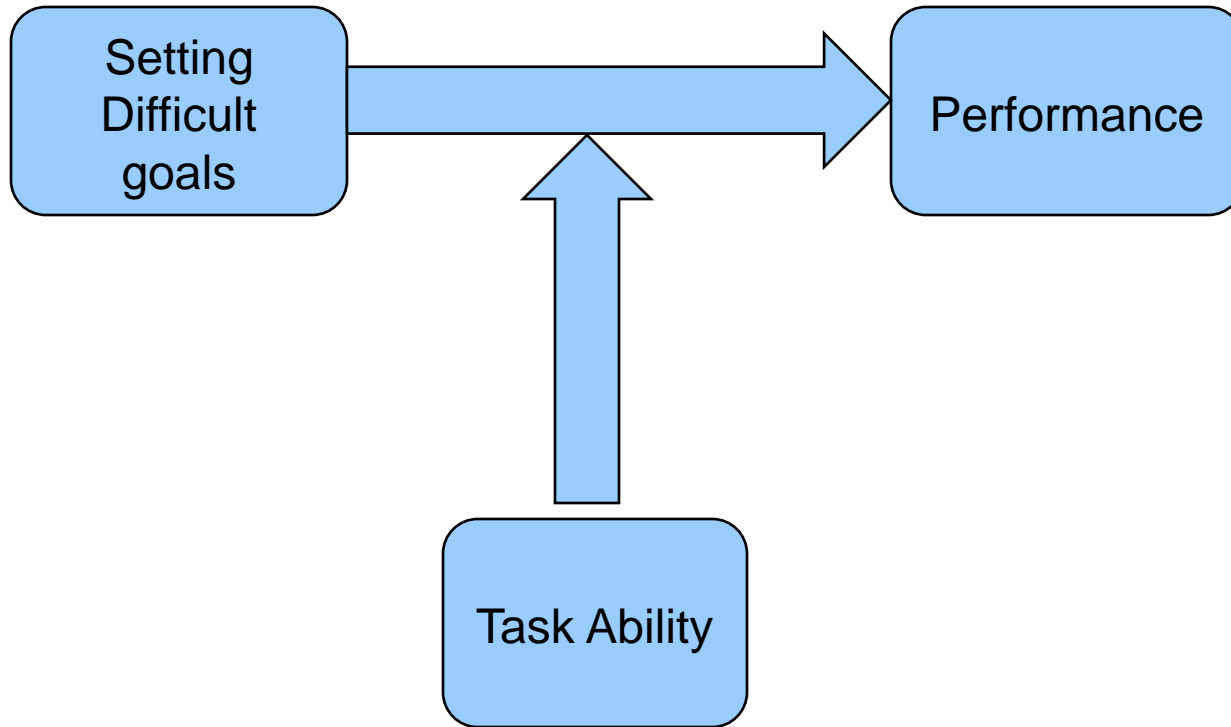
Who it did it work for?
When does it work?

Model of a Moderator (Condition)



Who it did it work for?
When does it work?

Goal Setting Theory (Locke et al., 1981)



Who it did it work for?
When does it work?

Moderator Variable

- A moderator specifies the conditions under which a given effect occurs, as well as the conditions under which the **direction (nature)** or **strength** of an effect vary. Baron and Kenny (1986, pp. 1174, 1178) describe a moderator variable as the following:

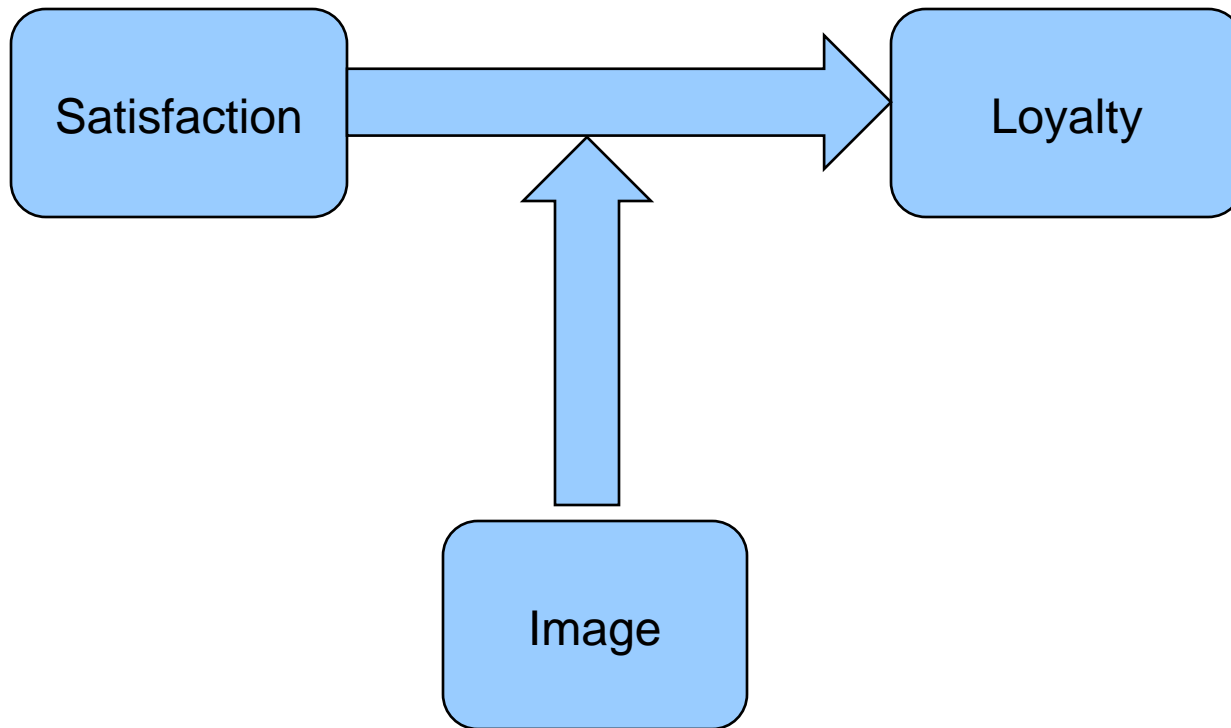
Moderator Variable

- A **qualitative** (e.g., sex, race, class) or **quantitative** variable . . . that affects the direction and/or strength of a relation between an independent or predictor variable and a dependent or criterion variable . . . a basic moderator effect can be presented as an interaction between a focal independent variable and a factor (the moderator) that specifies the appropriate conditions for its operation . . . Moderator variables are typically introduced when there is an **unexpectedly weak or inconsistent relation between a predictor and a criterion variable.**

Moderator Variable

- A moderator variable is one that affects the relationship between two variables, so that the nature of the impact of the predictor on the criterion varies according to the level or value of the moderator (Holmbeck, 1997).
- A moderator interacts with the predictor variable in such a way as to have an impact on the level of the dependent variable.

Model of a Moderator (Condition)



Hypothesis

- Should I Hypothesize the form of **My Interactions** in Advance?
 - **YES**, not only should the existence of an interaction effect be predicted, but also its form. In particular, whether a moderator increases or decreases the association between two other variables should be specified as part of the a priori hypothesis (Dawson, 2013).

Hypothesis

H1: The positive relationship between satisfaction and loyalty will be **stronger** when **perceived image is high**.

H2: The positive relationship between satisfaction would be stronger for male compared to female.

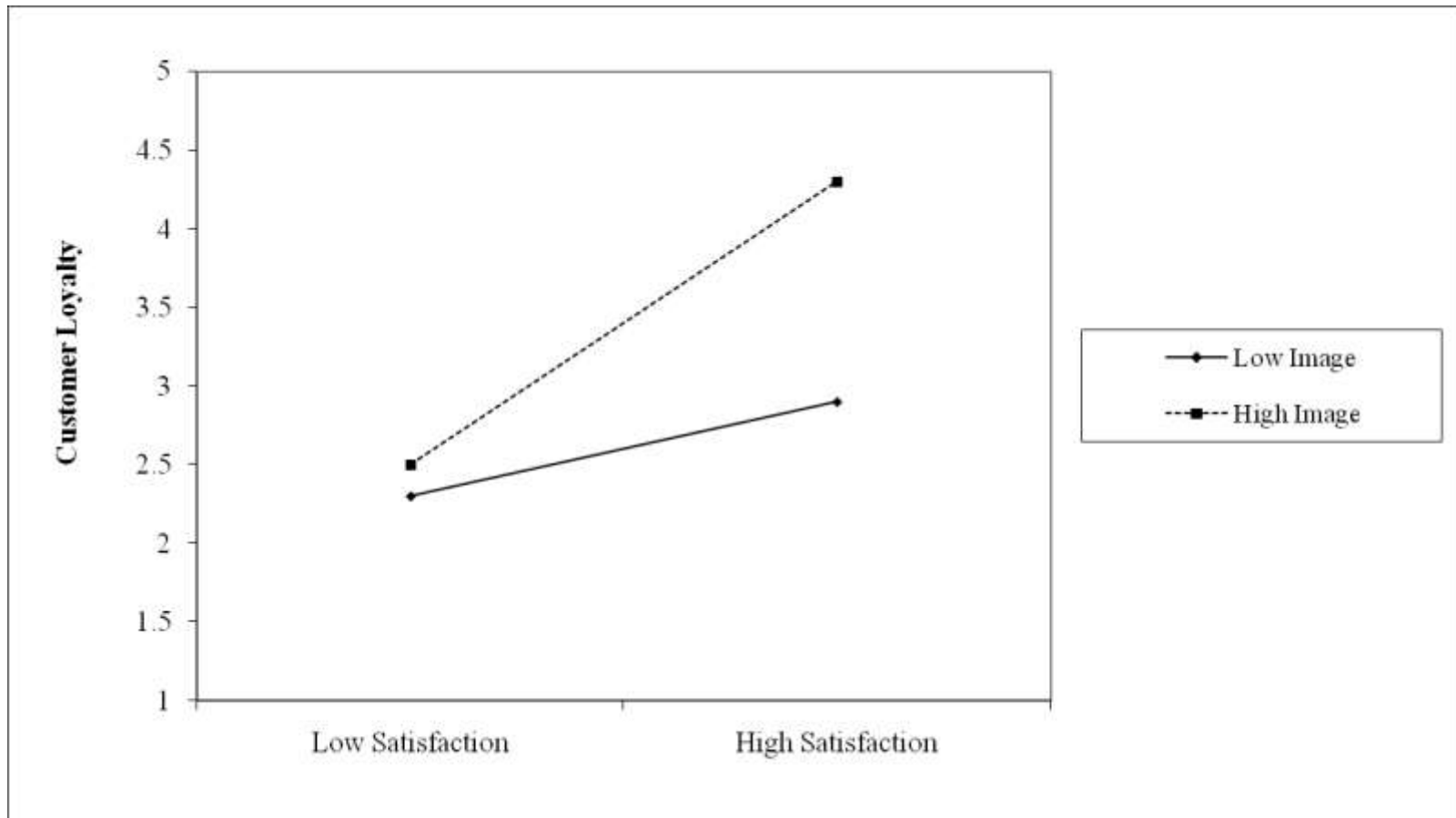
Hypothesis

H3: Body Mass Index (BMI) moderates the relationship between exercise and weight loss, such that for those with a low BMI, the effect is negative (i.e., you gain weight - muscle mass), and for those with a high BMI, the effect is positive (i.e., exercising leads to weight loss)

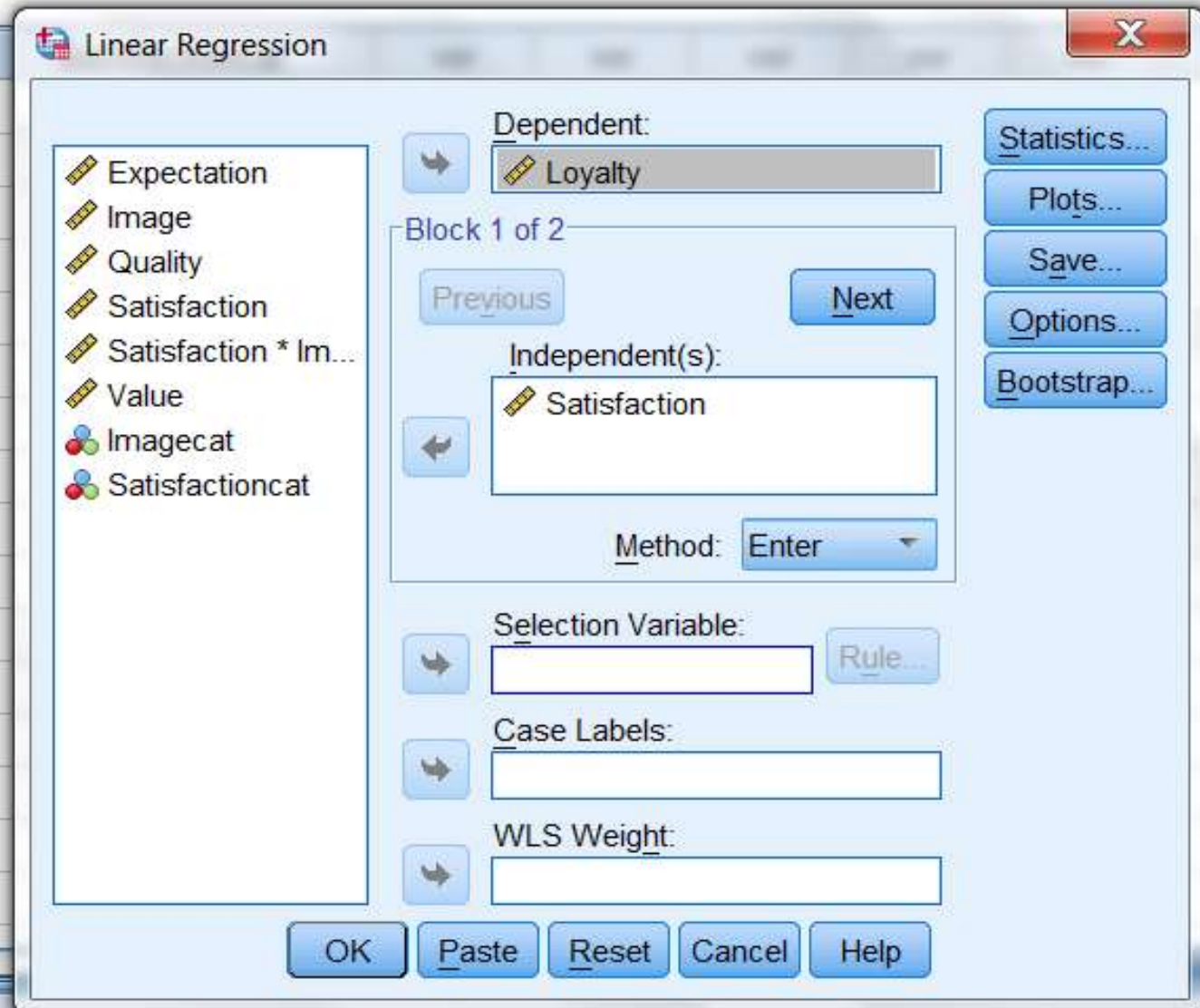
Why Plot?

- However, it is not entirely clear how it differs. If the you get a positive coefficient, the positive coefficient of the interaction term suggests that it becomes more positive as **Image** increases; however, the **size and precise nature** of this effect is not easy to divine from examination of the coefficients alone, and becomes even more so when one or more of the coefficients are negative, or the standard deviations of X and Z are very different (Dawson, 2013).

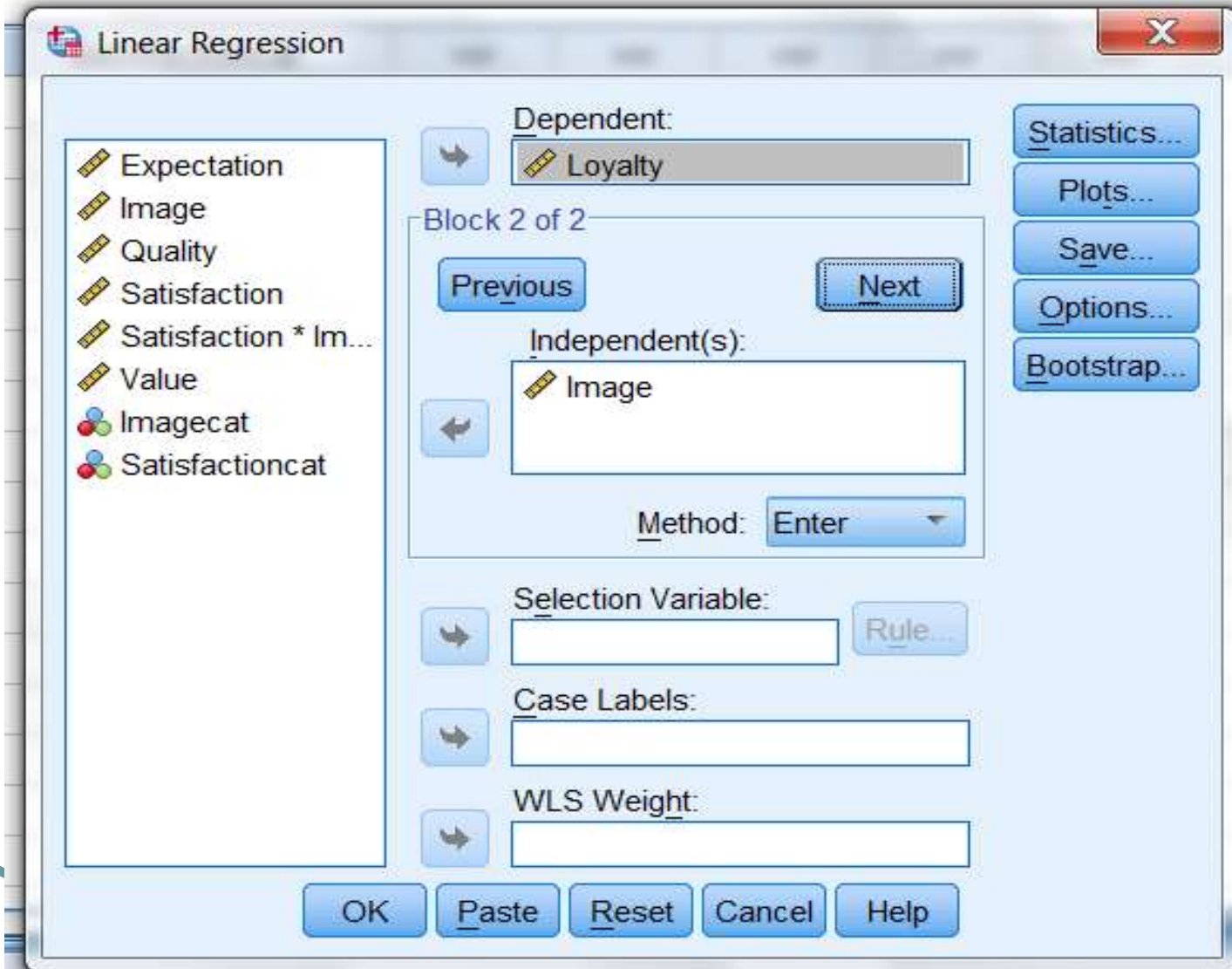
Interaction Plot



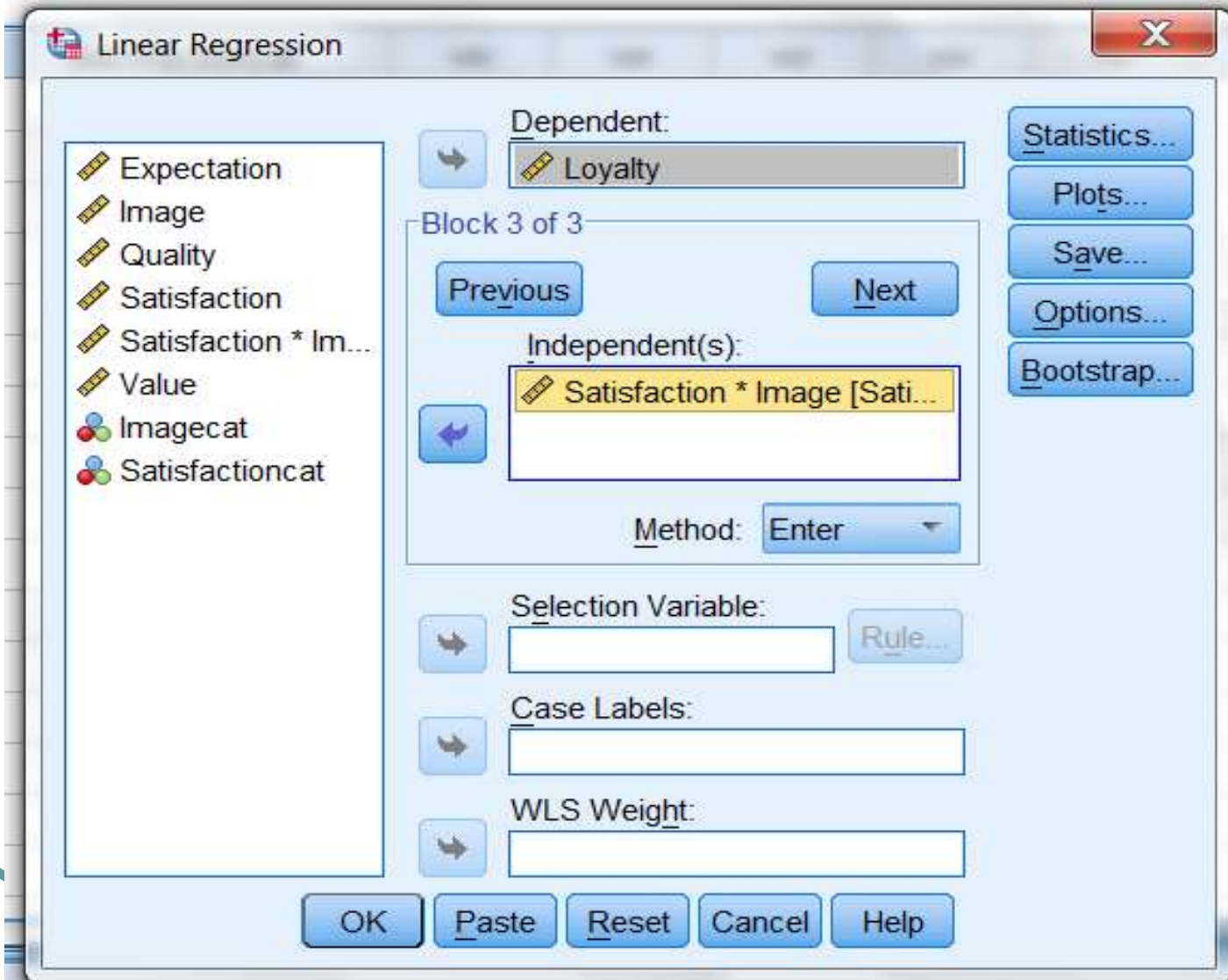
Testing in SPSS (Block 1)



Testing in SPSS (Block 2)

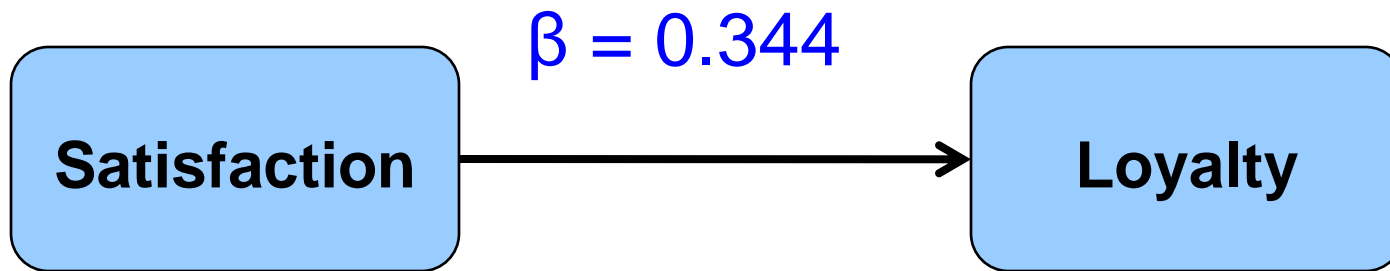


Testing in SPSS (Block 3)

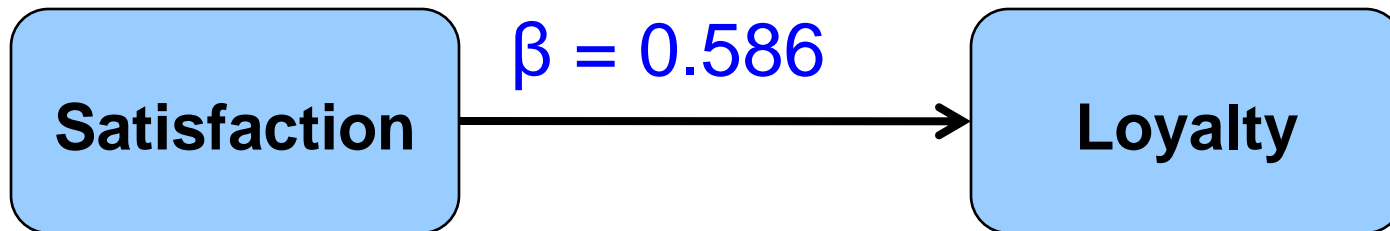


Testing in AMOS (Unconstrained)

- Low Image

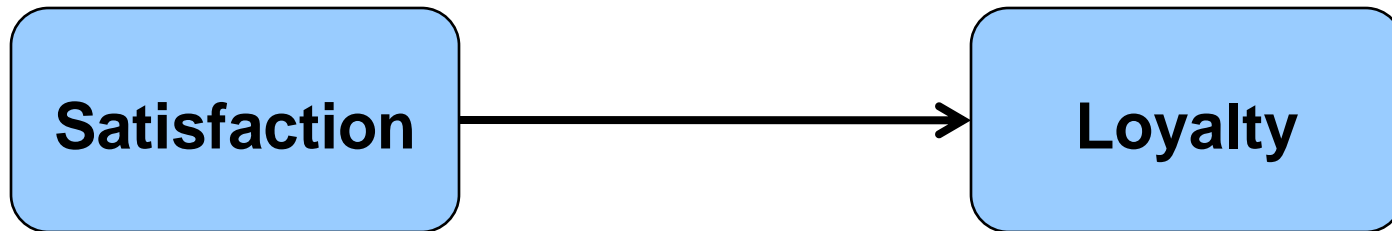


- High Image



Testing in AMOS (Constrained)

- Beta (Low Image = High Image)
- Look at the Chi Squared difference Test



Caveat

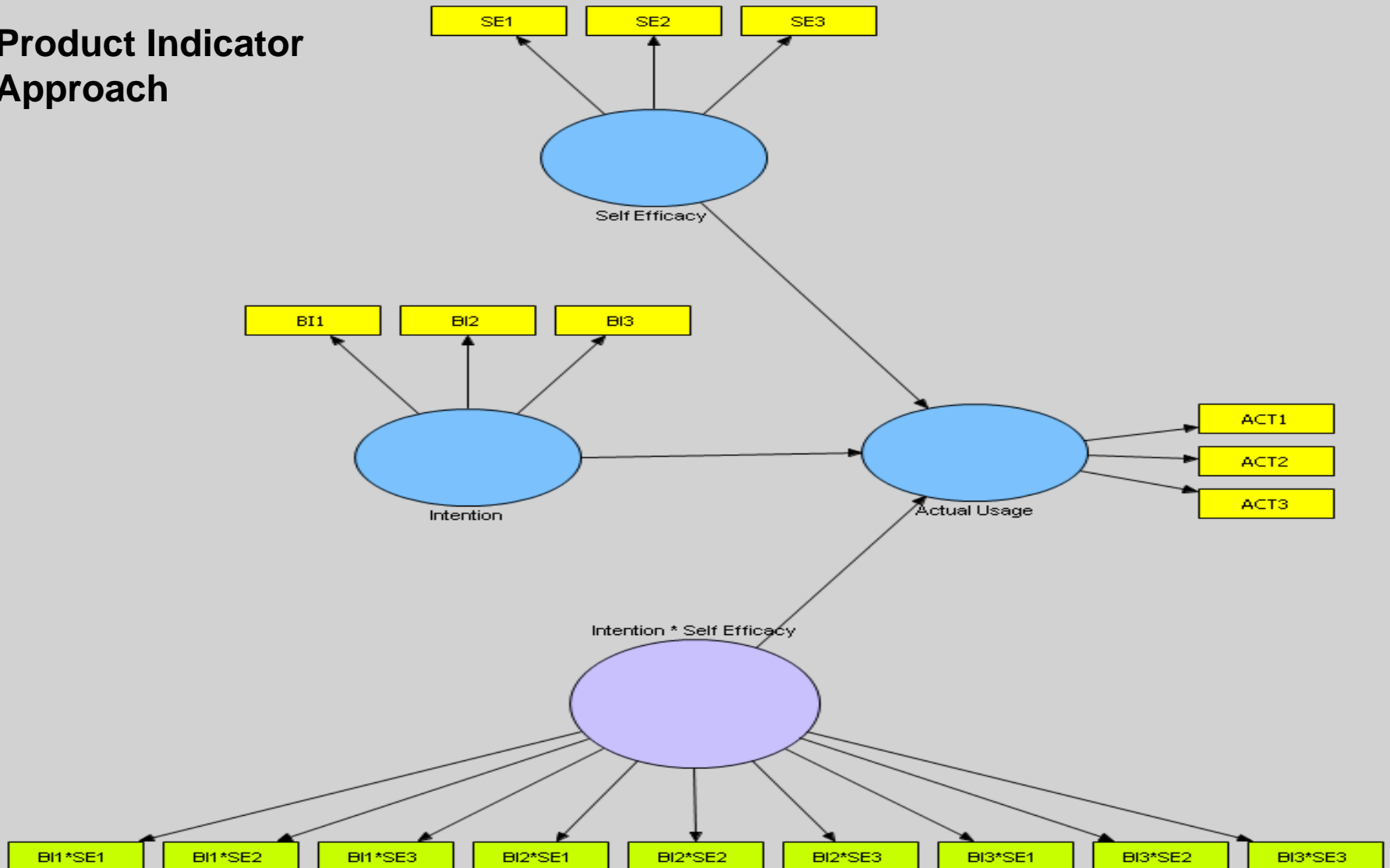
- An important consideration about categorical moderators is that they should only be used when the variable was originally measured as categories. **Continuous variables should never be converted to categorical variables for the purpose of testing interactions.** Doing so **reduces the statistical power** of the test, making it more difficult to detect significant effects (Stone-Romero and Anderson 1994; Cohen et al. 2003), as well as **throwing up theoretical questions about why particular dividing points should be used** (Dawson, 2013).

Procedure

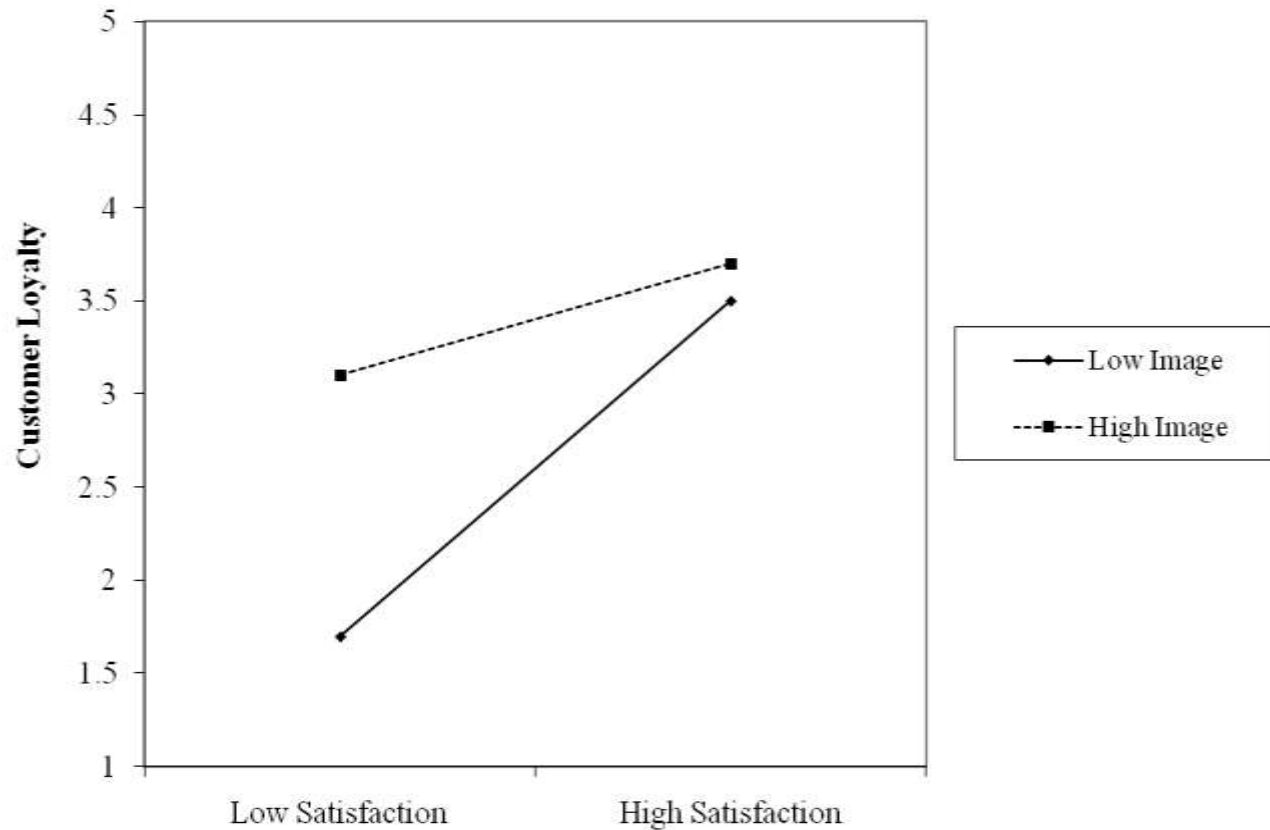
- Ideally, the regression should include all independent variables, the moderator, and interactions between the moderator and each independent variable.
- It is important in this situation that all predictors are mean-centered or z-standardized before the calculation of interaction terms and the regression analysis.

Testing in PLS

Product Indicator Approach



Interaction Plot



Interaction Plot

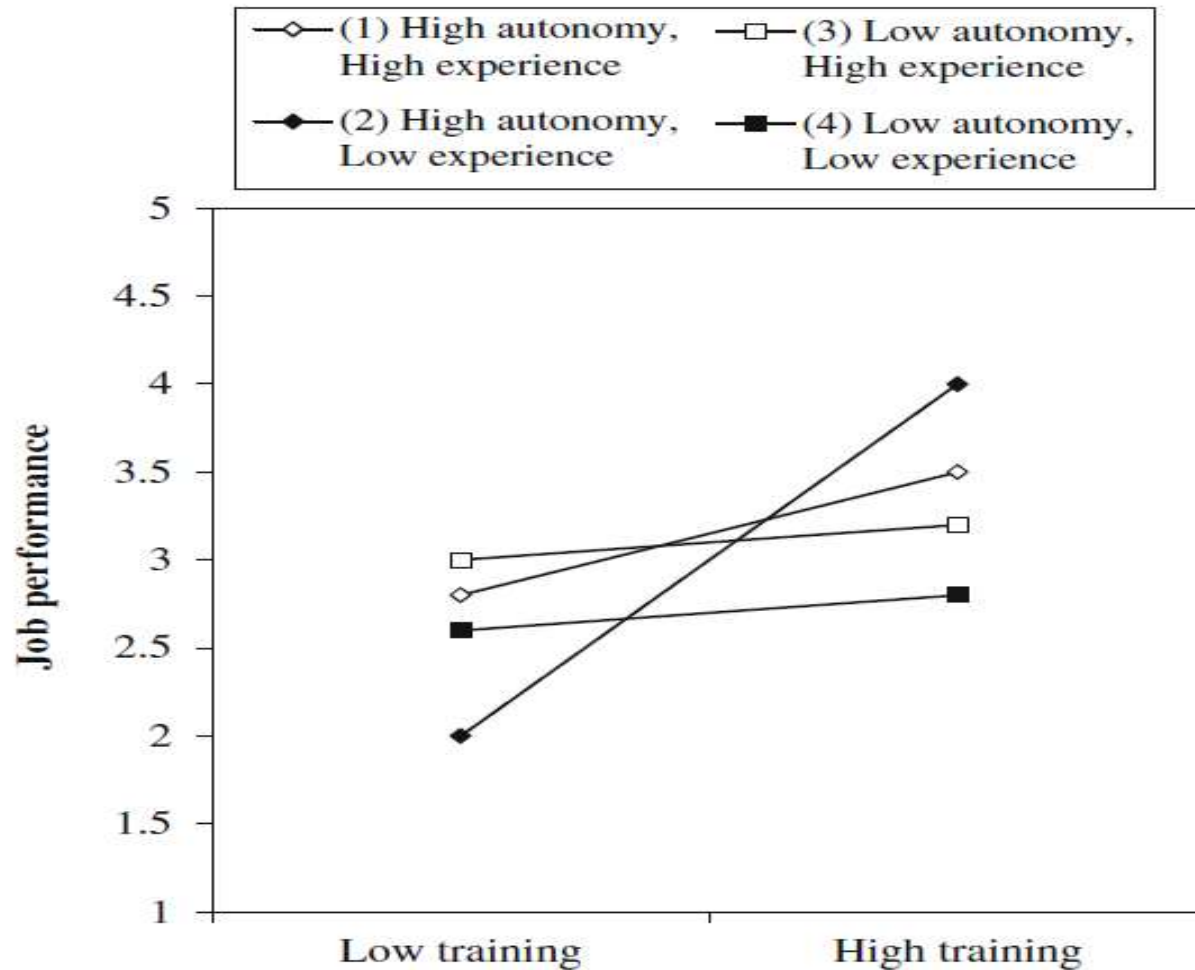


Fig. 2 Moderating effect of autonomy and experience on the training provision-job performance relationship (three-way interaction with continuous moderators)

Online Resources

- <http://www.jeremydawson.com/slopes.htm>
- <http://danielsoper.com>
- <http://quantpsy.org/interatc/index.html>

Moderator Effect Assessment

$$f^2 = \frac{R_i^2 - R_m^2}{1 - R_i^2} = \frac{0.664 - 0.659}{1 - 0.664} = 0.015$$

(Here, i = *interaction model*, m = *main effect model*)

- According to **Cohen (1988)**, f^2 is assessed as:
 - **0.02** **small**
 - **0.15** **medium**
 - **0.35** **large**

Suggested Reading

- Sharma, S., Durand, R. M., & Gur-Arie, O. (1981). “Identification and analysis of moderator variables”. *Journal of Marketing Research*, 18(3), 291-300.
- Dawson, J. F. (2013). Moderation in Management Research: What, Why, When, and How. *Journal of Business and Psychology*, DOI 10.1007/s10869-013-9308-7

Mediation



Research Model

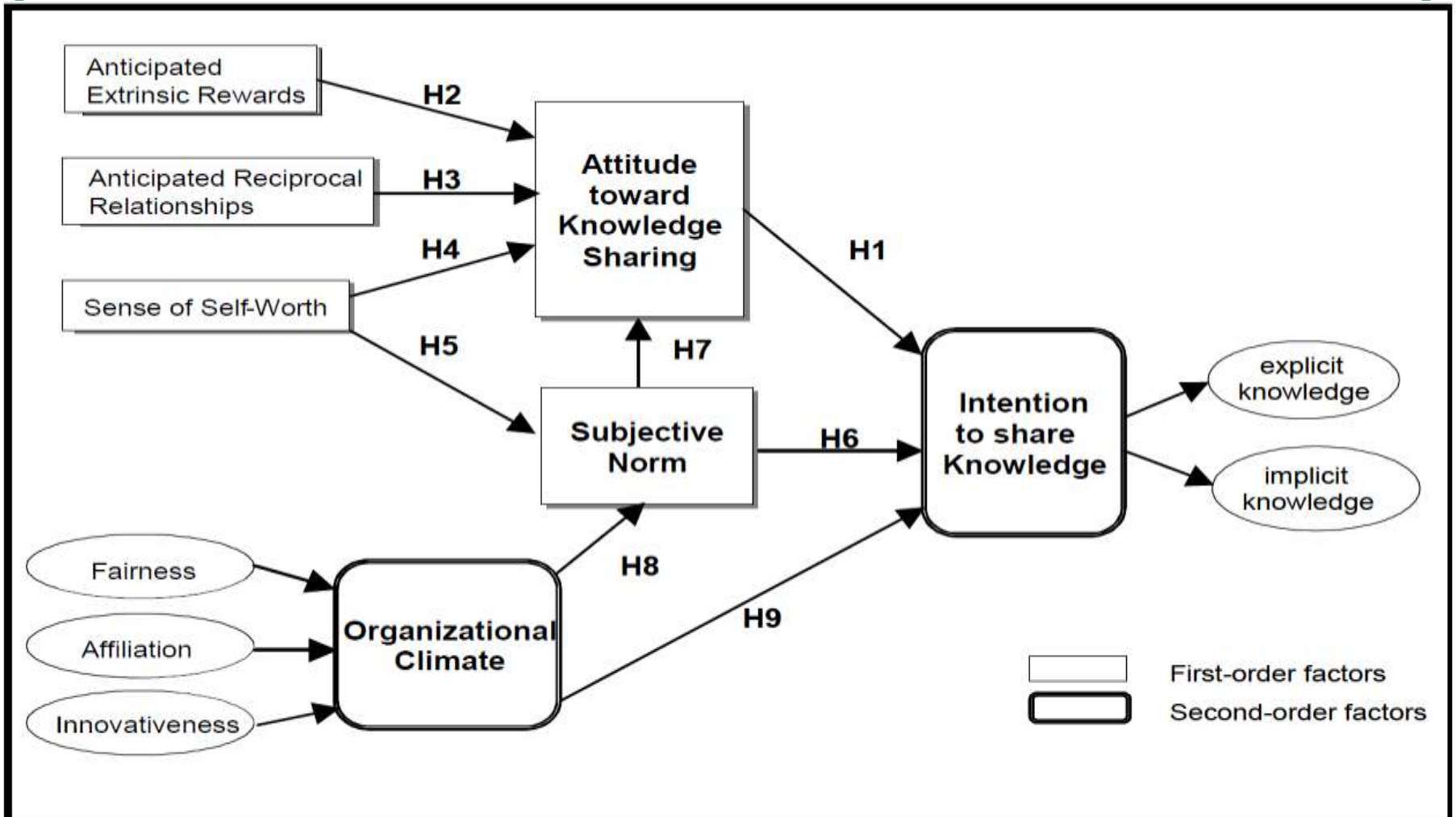


Figure 1. Research Model

Basic Requirement

- Despite the extensive use of complex statistical modeling in the behavioral sciences, the quality of a research project is largely determined by the design decisions that are made before any analysis is done and even before the study is conducted.
- The conceptualization of a mediation analysis requires forethought about the relationships between the variables of interest and the theoretical meaning behind those relationships. (McKinnon et al., 2012)

Mediator Variable (Mechanism)

- A mediator specifies how (or the mechanism by which) a given effect occurs (Baron & Kenny, 1986; James & Brett, 1984). Baron and Kenny (1986, pp. 1173, 1178) describe a mediator variable as the following:

Mediator Variable

- *The generative mechanism through which the focal independent variable is able to influence the dependent variable of interest . . . (and) Mediation . . . is best done in the case of a strong relation between the predictor and criterion variable.*
- **How did it work?**
- **Why did it work?**

Mediator Variable

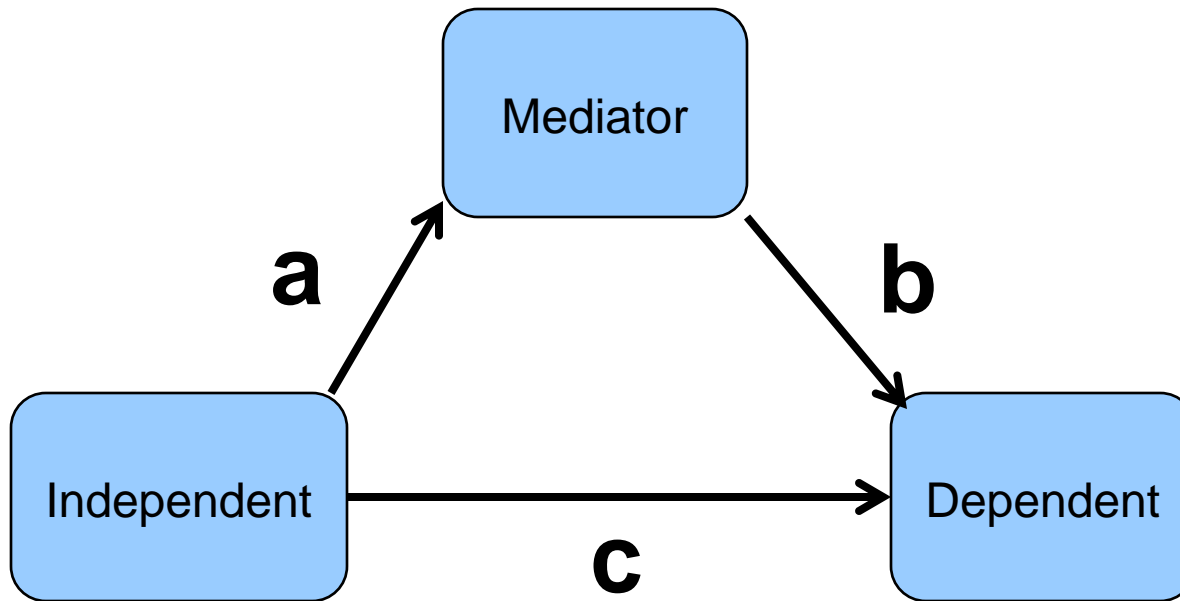
- Shadish and Sweeney (1991) stated that **“the independent variable causes the mediator which then causes the outcome”**.
- Also critical is the prerequisite that there be a significant association between the independent variable and the dependent variable before testing for a mediated effect.

Mediator Effect

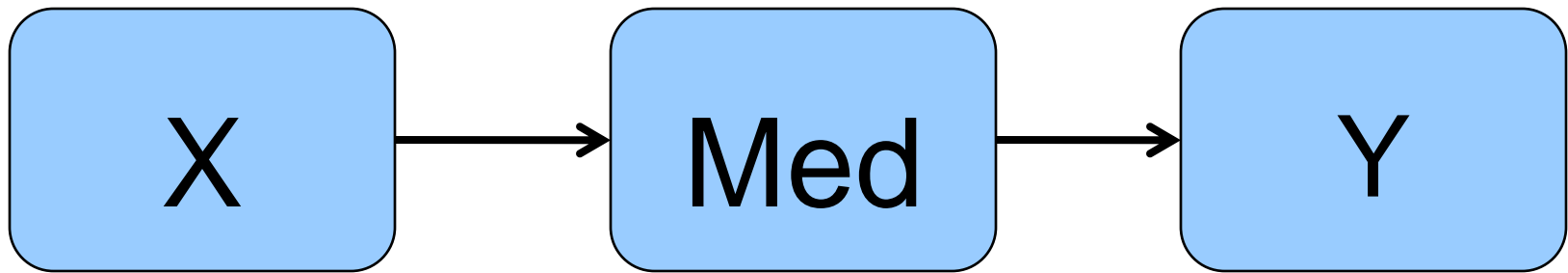
- According to McKinnon et al, (1995), mediation is generally present when:
 1. the IV significantly affects the mediator,
 2. the IV significantly affects the DV in the absence of the mediator,
 3. the mediator has a significant unique effect on the DV, and
 4. the effect of the IV on the DV shrinks upon the addition of the mediator to the model.

Mediator Variable

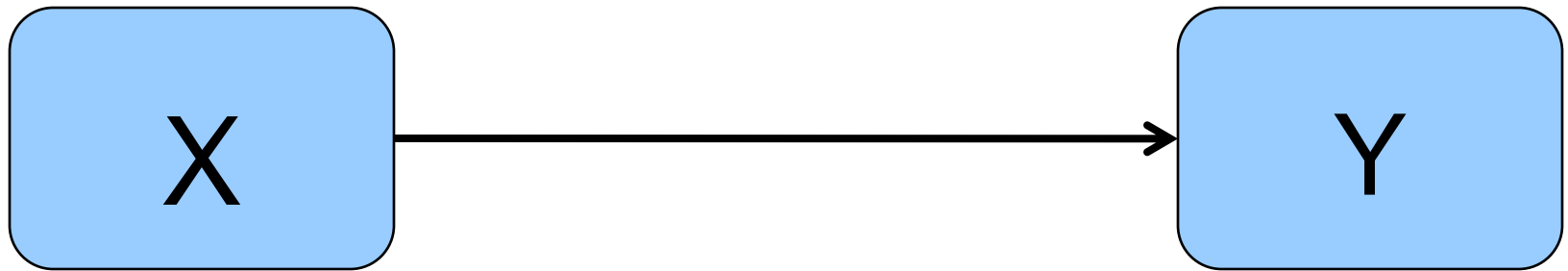
- Baron & Kenny (1986) has formulated the steps and conditions to ascertain whether full or partial mediating effects are present in a model.



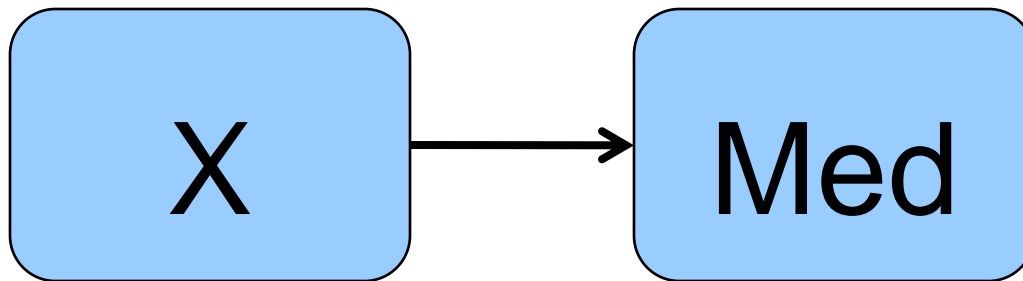
Mediation



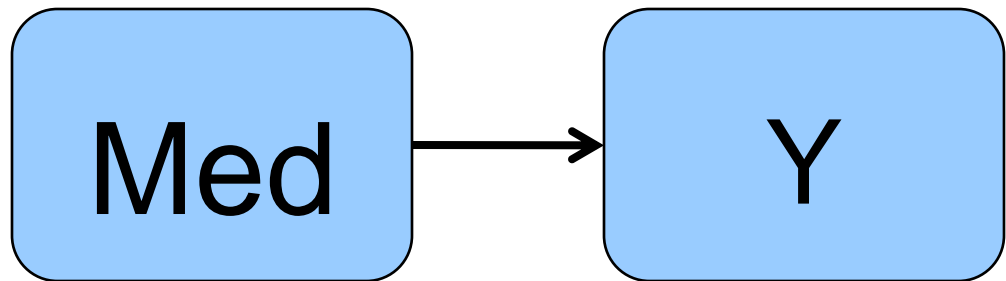
Mediation – Step 1



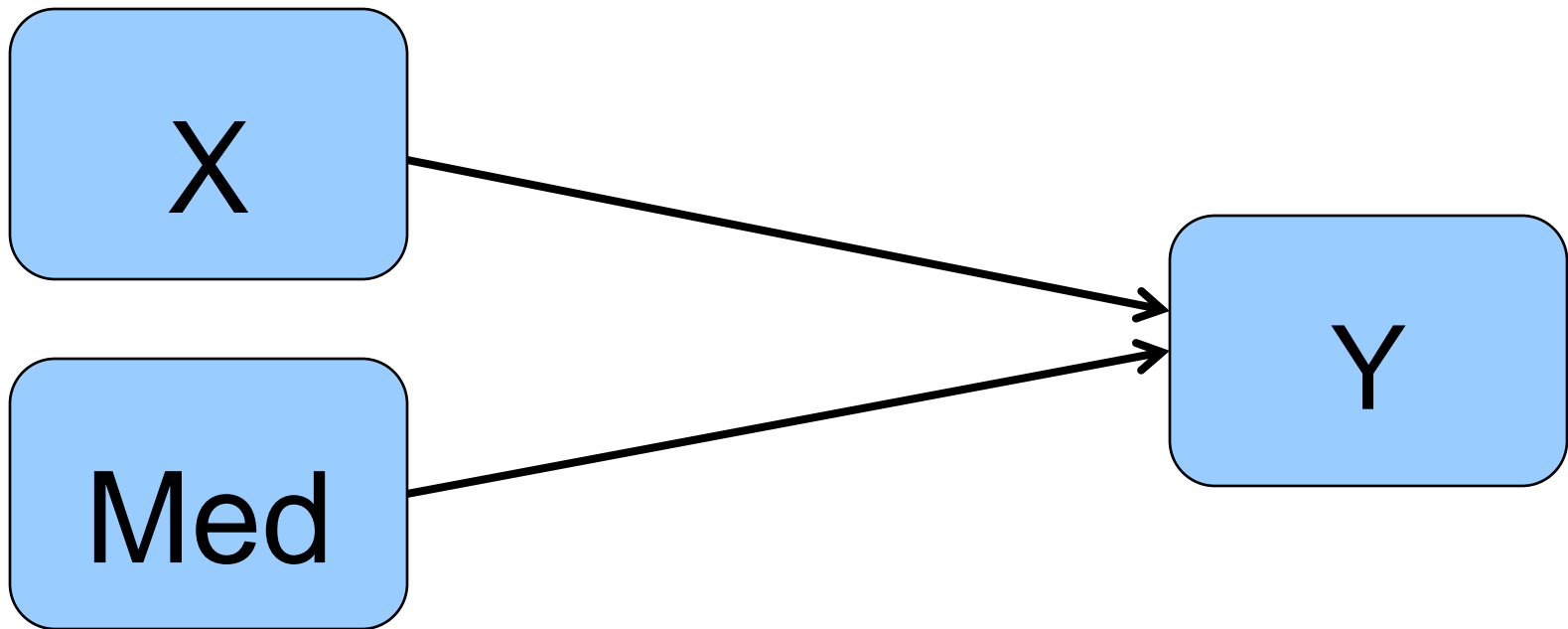
Mediation – Step 2



Mediation – Step 3



Mediation – Step 4



Mediator Analysis

- Judd and Kenny (1981), a series of regression models should be estimated. To test for mediation, one should estimate the three following regression equations:
 1. regressing the mediator on the independent variable;
 2. regressing the dependent variable on the independent variable;
 3. regressing the dependent variable on both the independent variable and on the mediator.

Mediator Analysis

- 1) variations in levels of the independent variable significantly account for variations in the presumed mediator (i.e., Path *c*),
- 2) variations in the mediator significantly account for variations in the dependent variable (i.e., Path *b*), *and*
- 3) when Paths *a* and *b* are controlled, a previously *significant* relation between the independent and dependent variables is no longer significant, with the strongest demonstration of mediation occurring when Path *c* is zero.

Mediator Analysis

- Separate coefficients for each equation should be estimated and tested.
- There is no need for hierarchical or stepwise regression or the computation of any partial or semipartial correlations.

<http://quantpsy.org/sobel/sobel.htm>

Input:		Test statistic:	Std. Error:	p -value:
a	<input type="text"/>	Sobel test:	<input type="text"/>	<input type="text"/>
b	<input type="text"/>	Aroian test:	<input type="text"/>	<input type="text"/>
s_a	<input type="text"/>	Goodman test:	<input type="text"/>	<input type="text"/>
s_b	<input type="text"/>	<input type="button" value="Reset all"/> <input type="button" value="Calculate"/>		

a and b = **path coefficient**

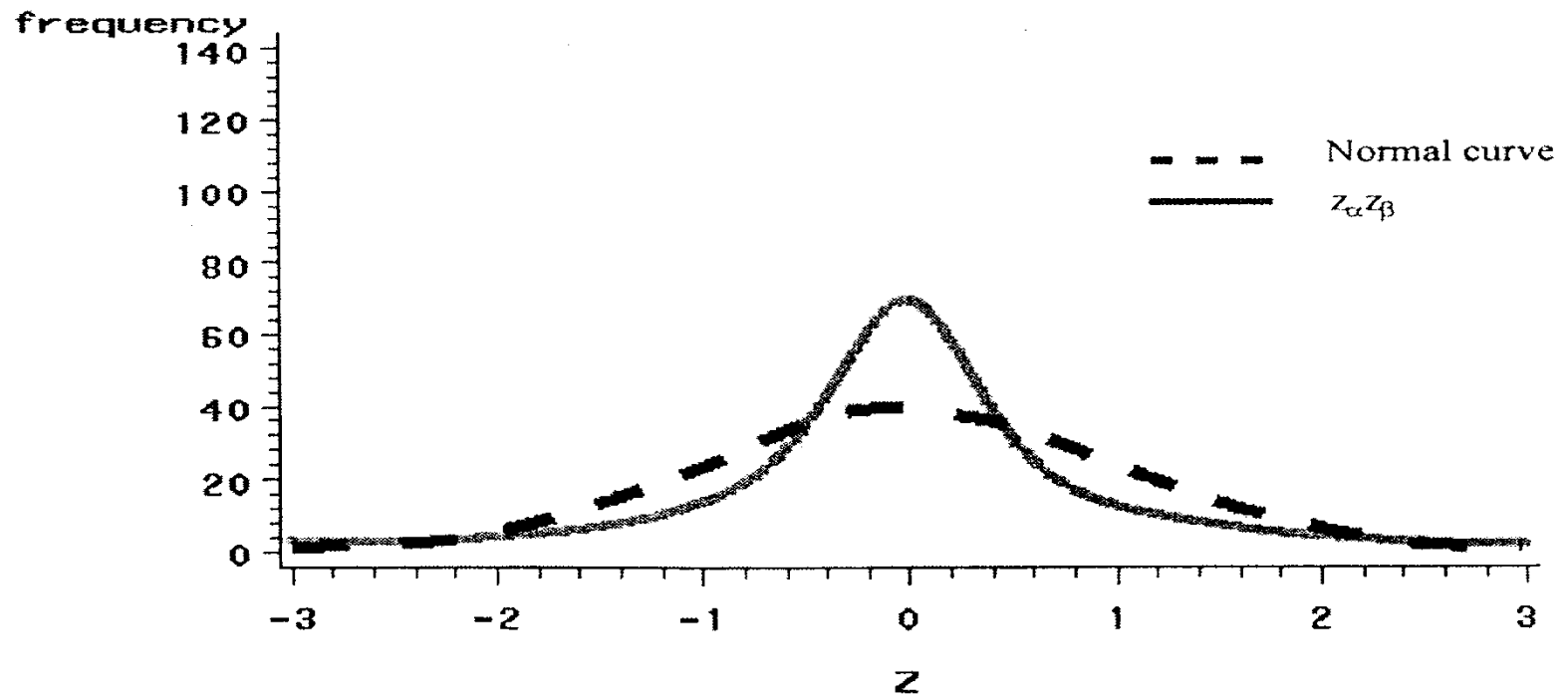
s_a and s_b = **standard errors**

Input:		Test statistic:	p -value:
t_a	<input type="text"/>	Sobel test:	<input type="text"/>
t_b	<input type="text"/>	Aroian test:	<input type="text"/>
		Goodman test:	<input type="text"/>
		<input type="button" value="Reset all"/> <input type="button" value="Calculate"/>	

t_a and t_b = **t-values for a and b path coefficients generated from bootstrapping**

Distribution of Indirect Effect

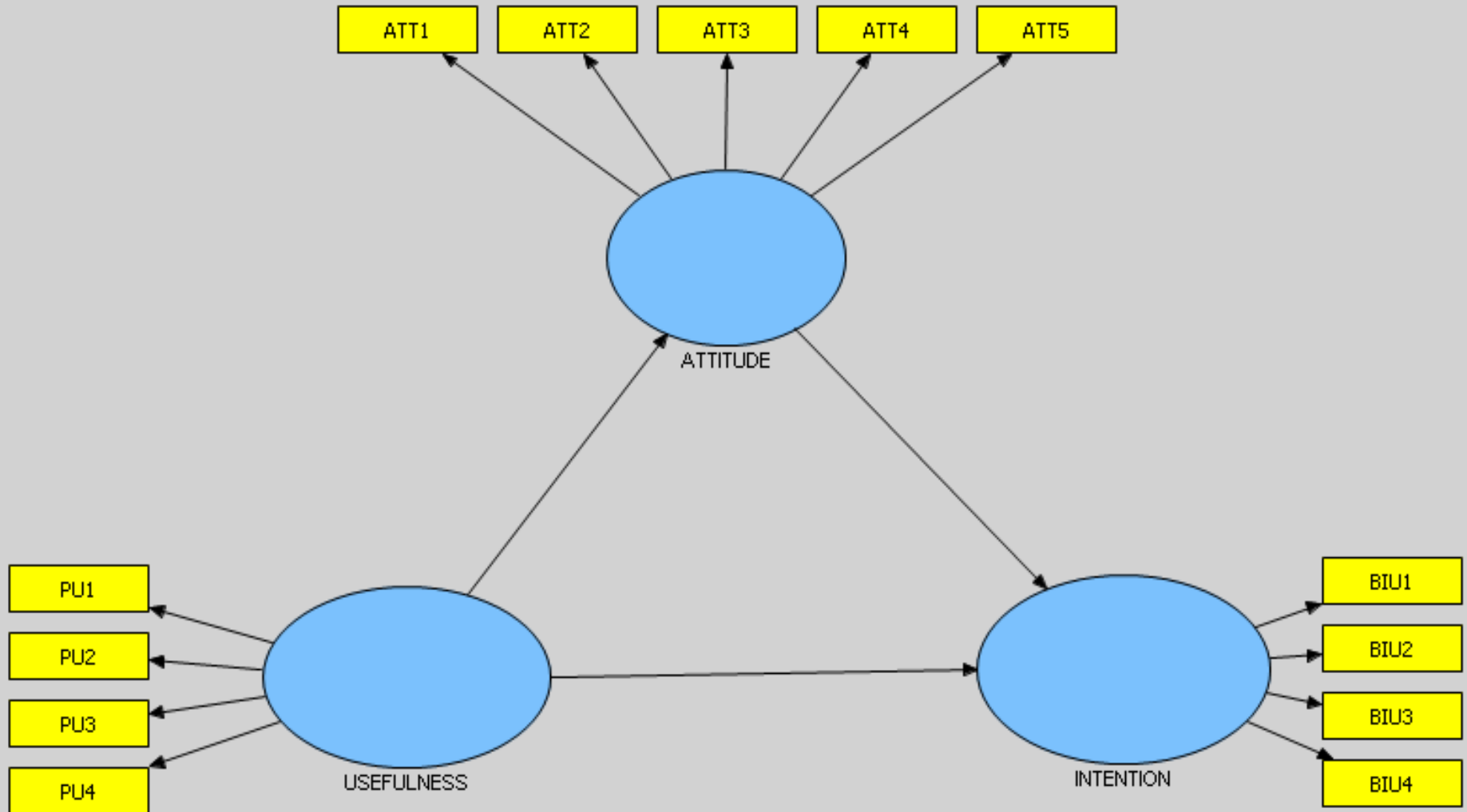
Distribution of $z_\alpha z_\beta$ vs. the normal curve
 $\alpha\beta = 0, n=1000$



Suggested Test for Mediator

- Based on Preacher and Hayes (2008)
- Bootstrap the indirect effect

Testing Mediation in PLS



Testing Mediation in PLS

Book12 - Microsoft Excel

Home Insert Page Layout Formulas Data Review View Acrobat

Clipboard Font Alignment Number Styles

Normal Bad Good Neutral Calculat

Check Cell Explanatory... Input Linked Cell Note

E2 =STDEV(D2:D192)

	A	B	C	D	E	F
1		ATTITUDE -> INTENTION	SN -> ATTITUDE	a*b	Std Error	
2	Sample 0	0.837223	0.721428	0.603996114	0.040246283	
3	Sample 1	0.822793	0.682056	0.561190902		
4	Sample 2	0.793366	0.660204	0.523783407		
5	Sample 3	0.793476	0.698009	0.553853389		
6	Sample 4	0.822039	0.688098	0.565643392		
7	Sample 5	0.796256	0.669747	0.533290067		
8	Sample 6	0.839571	0.70682	0.593425574		
9	Sample 7	0.83994	0.747936	0.628221364		
10	Sample 8	0.822785	0.67188	0.552812786		

$$t = \frac{a*b}{sd(a_i*b_i)}$$

Testing in SPSS

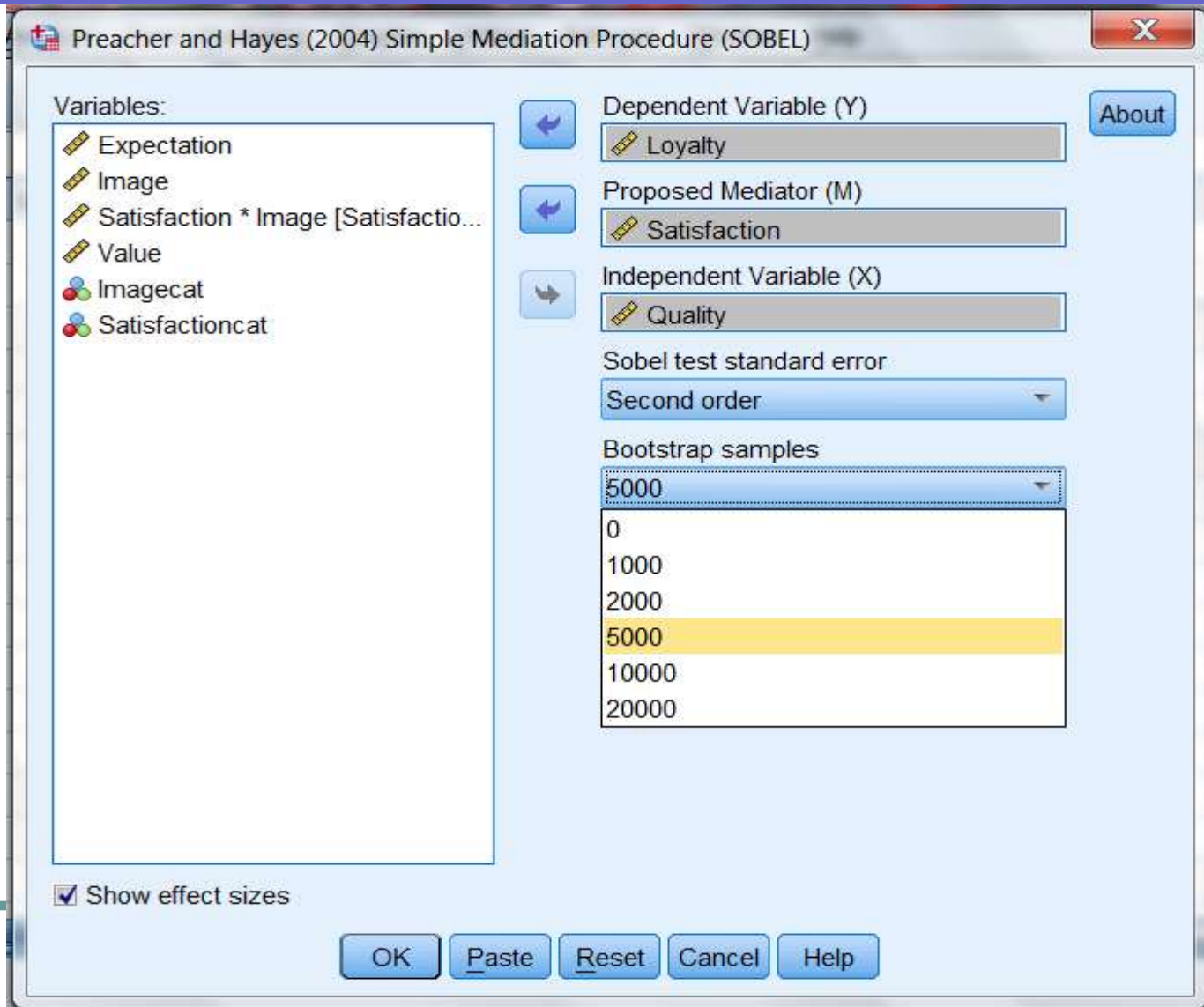
SPSS Statistics Data Editor window showing a dataset with 30 rows and 9 variables. The 'Analyze' menu is open, highlighting the 'Regression' option, which has opened a sub-menu. The 'Preacher and Hayes (2004) Simple Mediation Procedure (SOBEL)' option is selected in the sub-menu.

The dataset contains the following variables: Expectation, Quality, Satisfaction, SatisfactionImage, Value, Imagecat, Satisfactioncat, and three unlabeled variables (V8F, V8F, V8F).

Row	Expectation	Quality	Satisfaction	SatisfactionImage	Value	Imagecat	Satisfactioncat	V8F	V8F	V8F	V8F	V8F	V8F
1	7.000												
2	10.000												
3	7.000												
4	8.354												
5	7.549												
6	9.549												
7	7.646												
8	5.451												
9	7.000												
10	7.549												
11	6.549												
12	10.000												
13	7.097												
14	10.000												
15	5.000												
16	5.903												
17	8.000												
18	5.903												
19	8.000												
20	5.903												
21	5.354												
22	7.354												
23	6.097	7.000	7.000	6.882	6.398	.671	6.105	Low	Low				
24	7.000	7.486	8.588	7.721	8.000	-.073	9.000	Low	High				
25	7.549	6.611	1.864	5.991	4.900	2.690	4.105	Low	Low				
26	8.903	10.000	10.000	10.000	9.405	4.526	8.000	High	High				
27	8.000	8.329	7.000	7.868	6.806	-.583	7.000	High	Low				
28	8.000	3.791	8.864	5.000	6.806	2.810	10.000	Low	Low				
29	6.451	7.179	8.432	7.441	7.401	.059	7.552	Low	Low				
30	8.354	9.643	10.000	9.573	9.699	4.601	9.105	High	High				

SPSS Statistics Processor is ready

Testing in SPSS



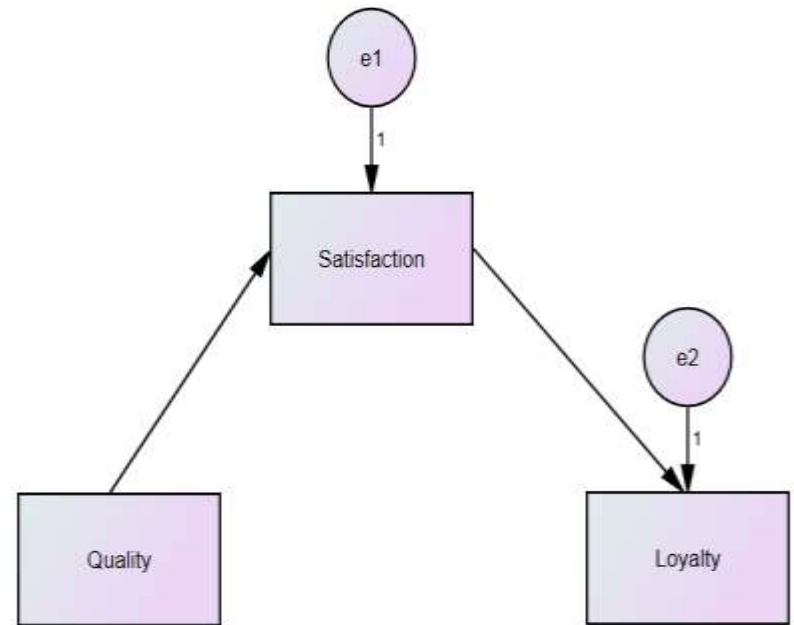
Testing in AMOS

One : Group number 1 : Input

File Edit View Diagram Analyze Tools Plugins Help

The screenshot displays the AMOS software interface. On the left is a toolbar with various icons for model building. The main workspace shows a path diagram with three latent variables: Satisfaction, Quality, and Loyalty. Satisfaction is the central variable, with arrows pointing to Quality and Loyalty. Error terms e1 and e2 are shown with arrows pointing to Satisfaction and Loyalty, respectively, both with a path coefficient of 1. Overlaid on the workspace is the 'Analysis Properties' dialog box, which is currently on the 'Bootstrap' tab. The dialog box contains the following settings:

Option	Value	Description
<input checked="" type="checkbox"/> Perform bootstrap	5000	Number of bootstrap samples
<input checked="" type="checkbox"/> Percentile confidence intervals	95	PC confidence level
<input checked="" type="checkbox"/> Bias-corrected confidence intervals	95	BC confidence level
<input type="checkbox"/> Bootstrap ADF		
<input type="checkbox"/> Bootstrap ML		
<input type="checkbox"/> Bootstrap GLS		
<input type="checkbox"/> Bootstrap SLS	1	Bootfactor
<input type="checkbox"/> Bootstrap ULS		
<input type="checkbox"/> Monte Carlo (parametric bootstrap)		
<input type="checkbox"/> Report details of each bootstrap sample		
<input checked="" type="checkbox"/> Bollen-Stine bootstrap		



Reporting

- The bootstrapping analysis showed that the indirect effect $\beta = 0.159$ (0.546×0.291) was significant with a t-value of 3.682. Also as indicated by Preacher and Hayes (2008) the indirect effect 0.159, 95% Boot CI: [LL = 0.074, UL = 0.243] does not straddle a 0 in between indicating there is mediation. Thus we can conclude that the mediation effect is statistically significant.

Suggested Reading

- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51*, 1173-1182.
- Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical Mediation Analysis in the New Millennium. *Communication Monographs, 76*(4), 408-420.

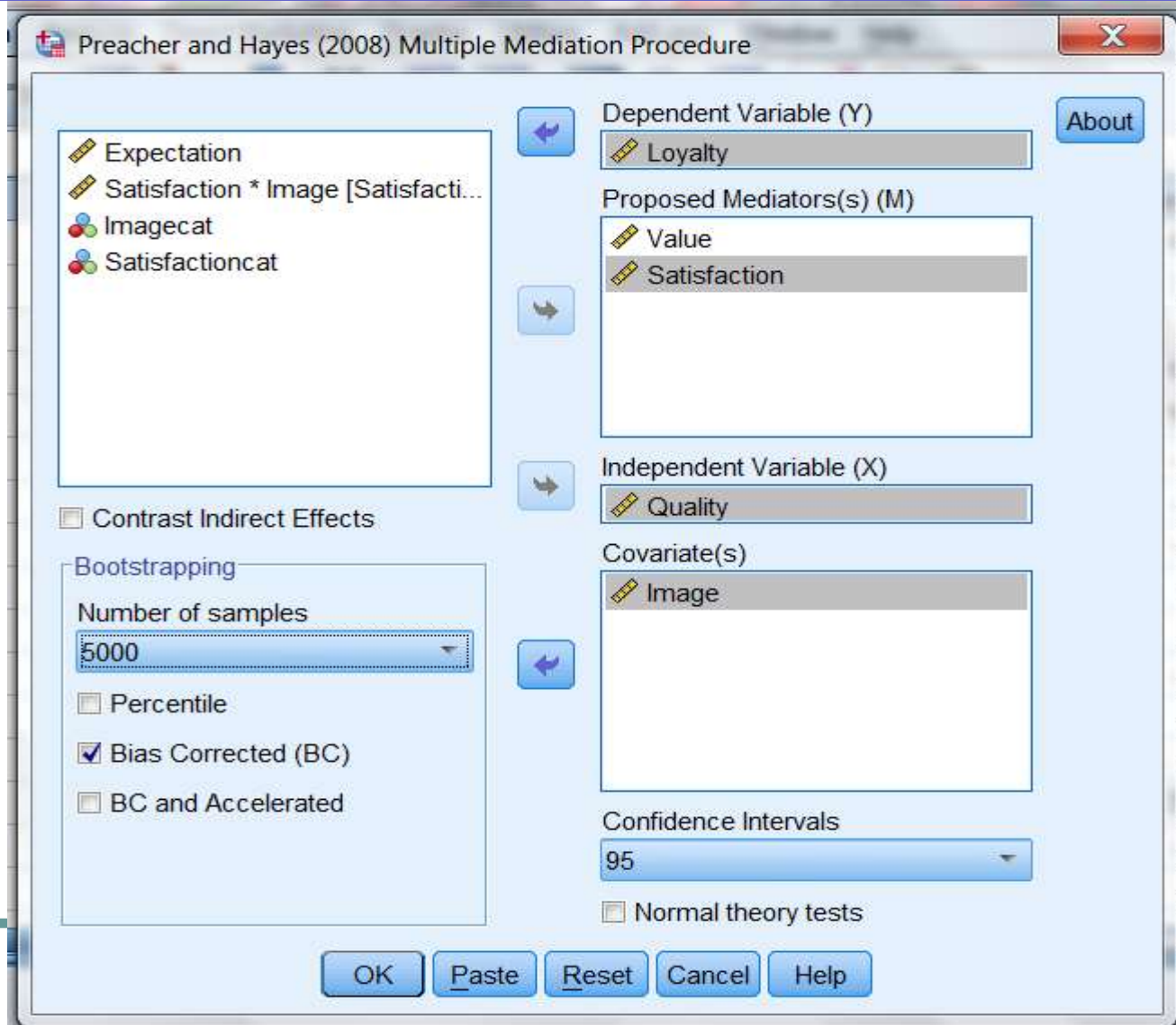
Suggested Readings

- Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40(3), 879-891.
- Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, 36(4), 717-731.

Suggested Readings

- Hayes, A. F. (2013). Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. New York: Guilford Press.
- MacKinnon, D. P., Coxe, S., & Baraldi, A. N. (2012). Guidelines for the Investigation of Mediating Variables in Business Research. *Journal of Business and Psychology*, 27(1), 1-14.

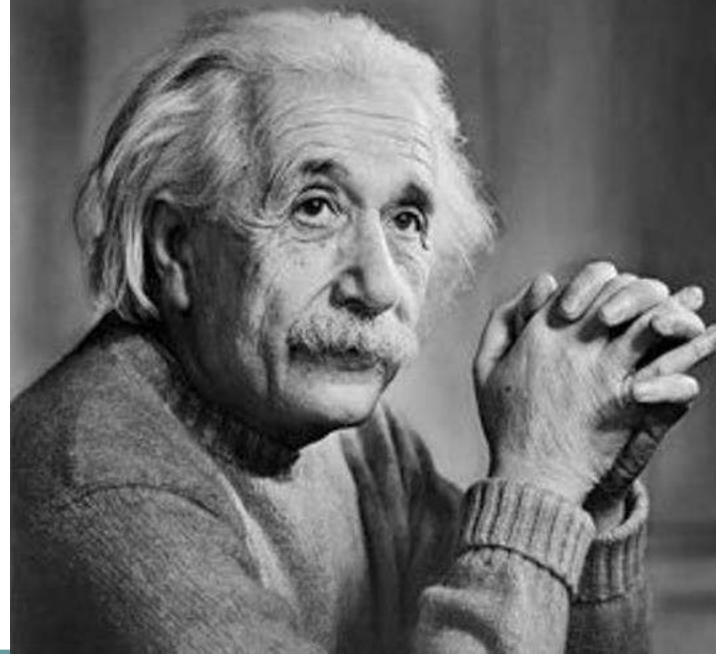
Testing in SPSS



Thank you for listening

If you can't explain it **simply**, you don't understand it well enough.

– Albert Einstein



Persevere 1

Success 2