



“Mediation vs. Moderation”

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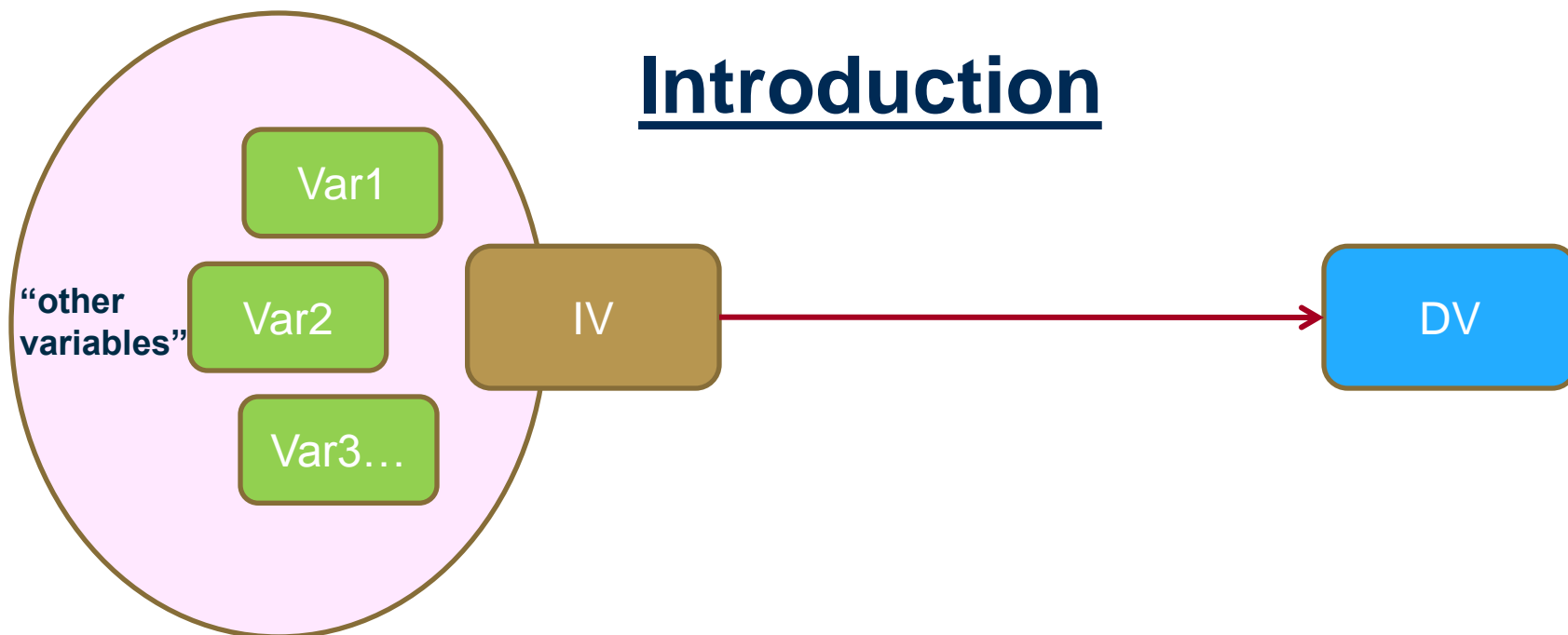
21 November 2008



Outline

- I. Introduction**
- II. Covariates**
- III. Moderators – definitions/explanations**
- IV. Mediators – definitions/explanations**
- V. Moderators – examples [SPSS and Interaction!]**
- VI. Mediators – examples [SPSS and AMOS]**
- VII. References**

Introduction



We want to establish and understand the relationship between the IV and the DV.

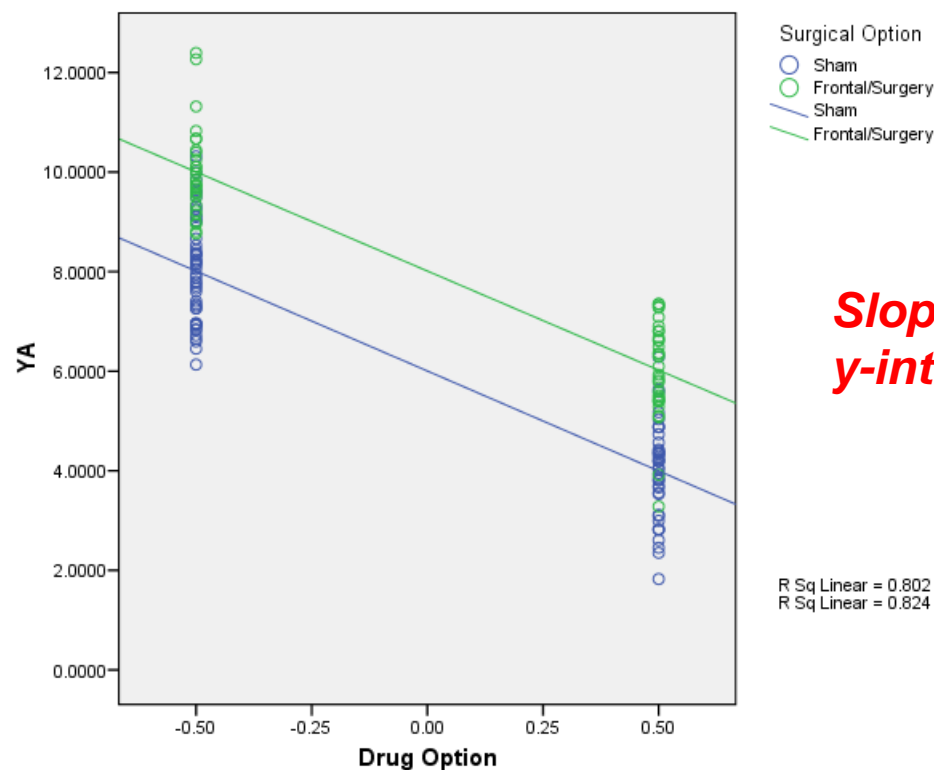
However, there are usually “other variables” that have to be considered which may change/alter the IV→DV relationship:

**Covariates
Moderators
Mediators**



Covariates

- We discussed Covariates in the last lecture – we put these into the model first (“control for”), but assume no further involvement (i.e. assume NO INTERACTIONS).

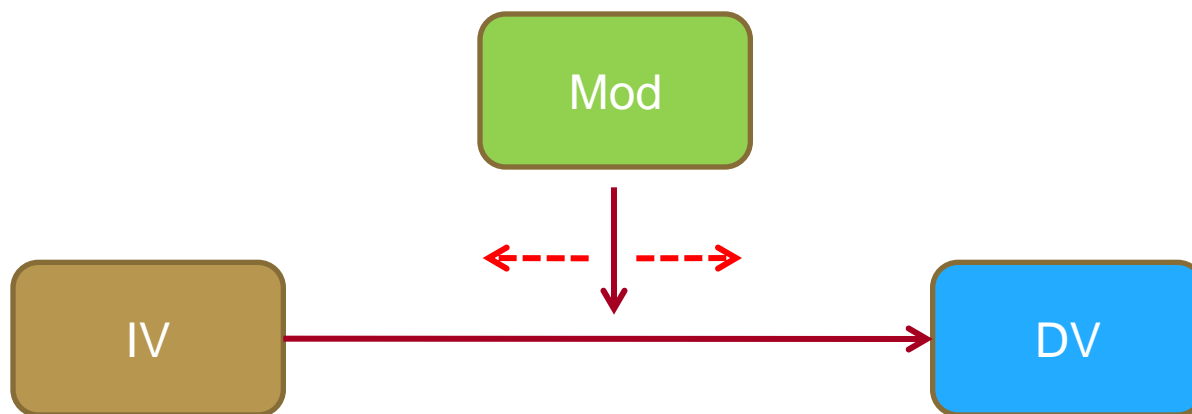


*Slopes are parallel,
y-intercept changes*



Moderators

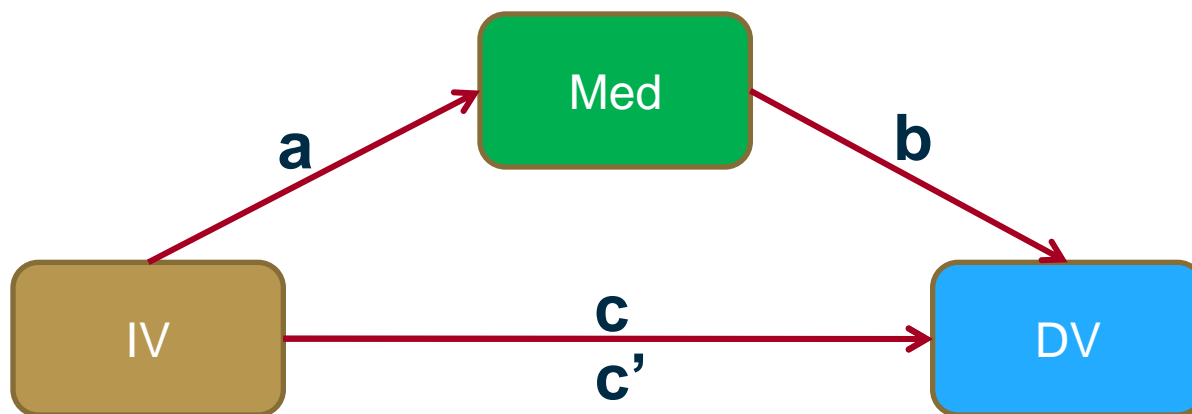
- “A moderator is an independent variable that affects the strength or direction of the association between another independent variable and an outcome variable. [Bennett]”
- “A moderator is a 3rd variable that modifies a causal effect.”
- “A moderation effect is a causal model that postulates “when” or “for whom” an independent variable most strongly (or weakly) causes a dependent variable (i.e. modifying the strength or direction). ...
- “A simple analogy is a dimmer that adjusts the strength of a switch on the lighting.”
- “... the moderation effect is more commonly known as the statistical term “interaction” effect [Wu, Zumbo]”





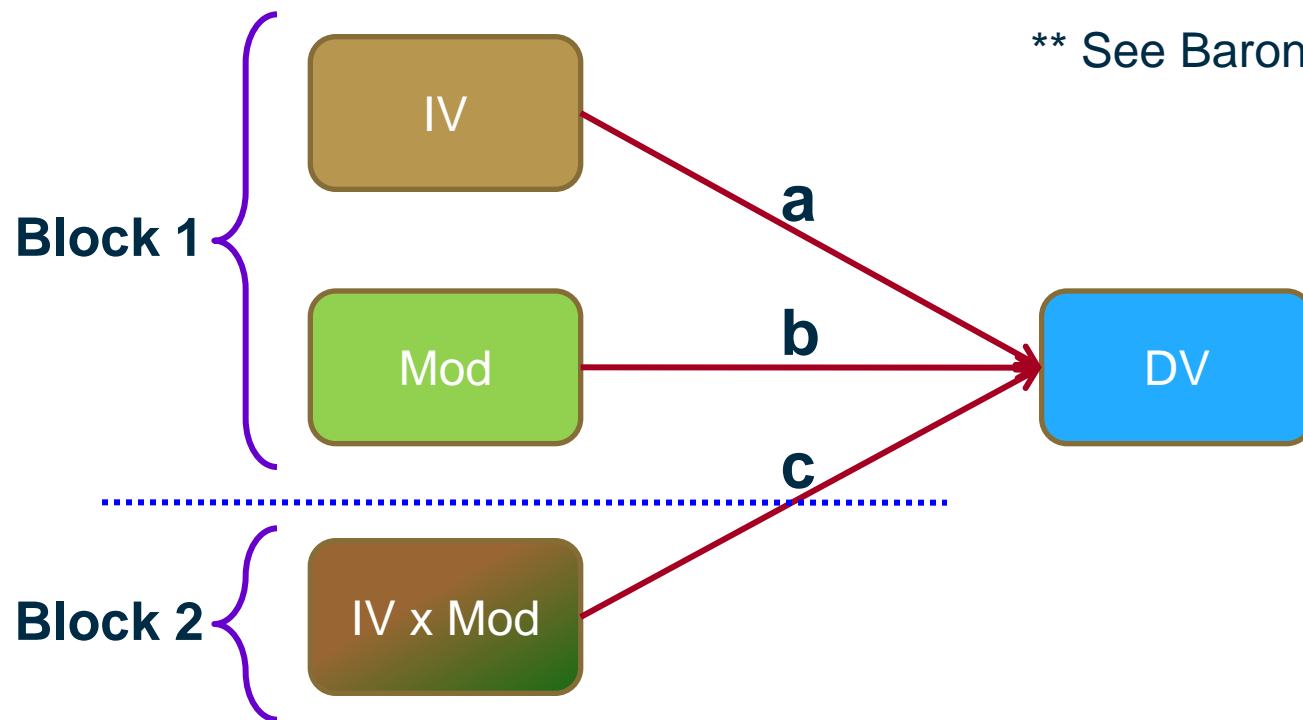
Mediators

- “A mediator is a variable that specifies how the association occurs between an IV and a DV. A mediator effect is only tested when there is a significant direct effect between the IV and the DV, but there is a possibility that a mediator variable conceptually occurs “between” the IV and DV. [Bennett]”
- “A mediator is a 3rd variable that links a cause and an effect.”
- Mediator is a causal model that explains the process of “why” and “how” a cause-and-effect happens. ... In other words, the IV is presumed to cause the mediator and the mediator causes the DV. [Wu, Zumbo]”





Moderators – “Interactions”



** See Baron, Kenny (1986)

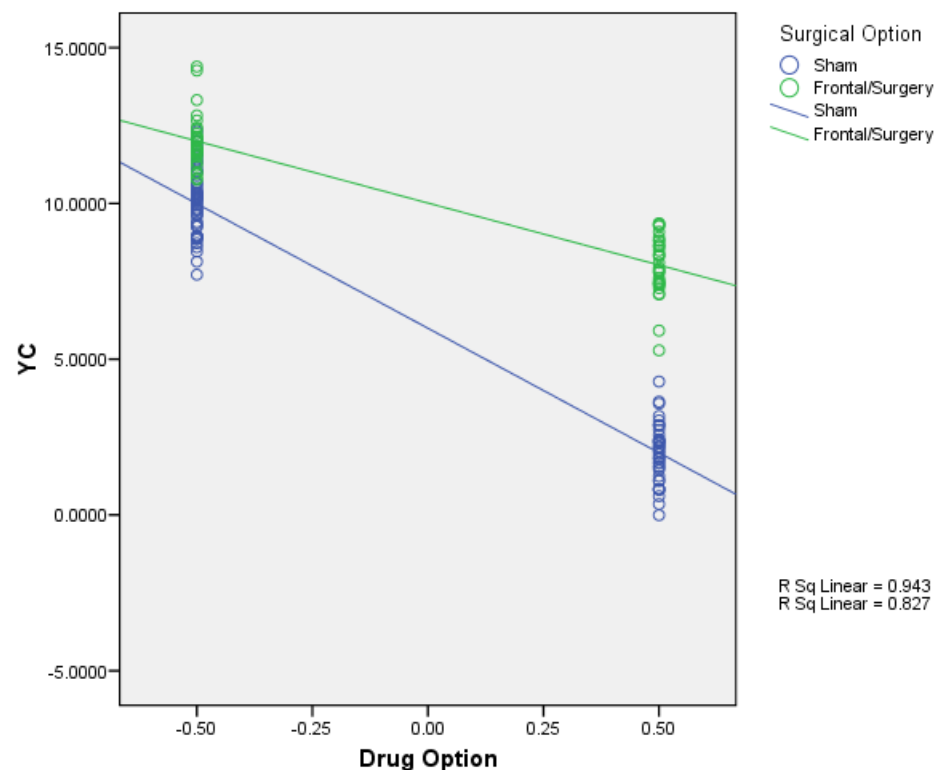
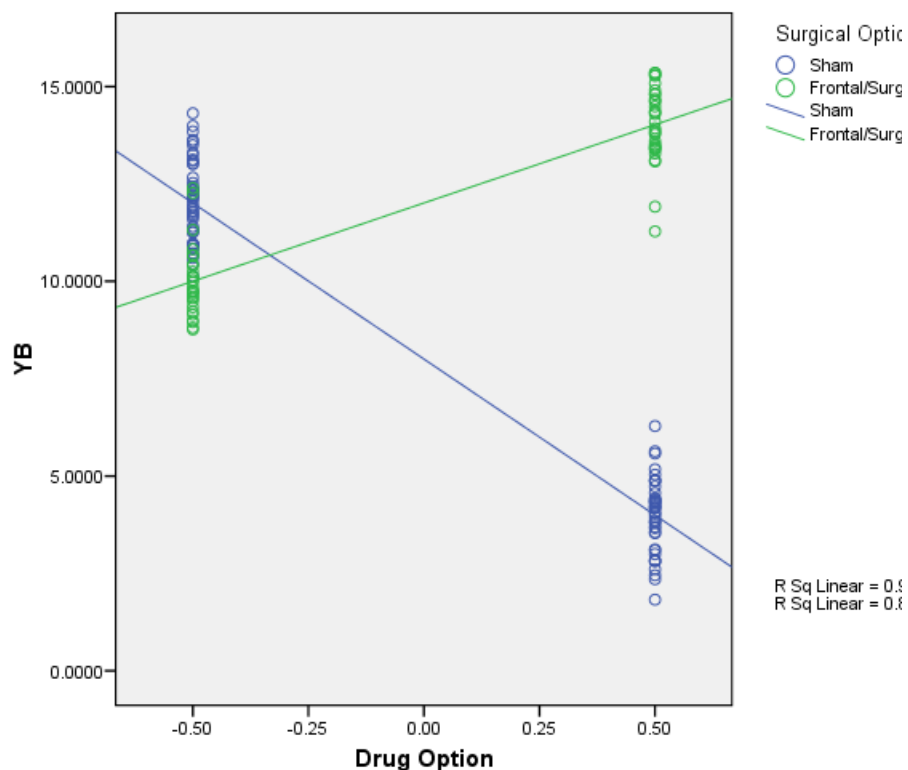
$$\text{DV} = \text{intercept} + a(\text{IV}) + b(\text{Mod}) + c(\text{IV} \times \text{Mod})$$
$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} X_1 X_2 + \varepsilon$$

Step 1 – enter IV and Mod into model – may or may not be significant

Step 2 – add interaction term – see if “c” or β_{12} is significant



Moderators - Interactions



Moderators can be either categorical or continuous and can “interact” with either categorical or continuous IVs.

The resulting interaction effect can change either the magnitude of the slope, change its sign (positive to negative) or both.



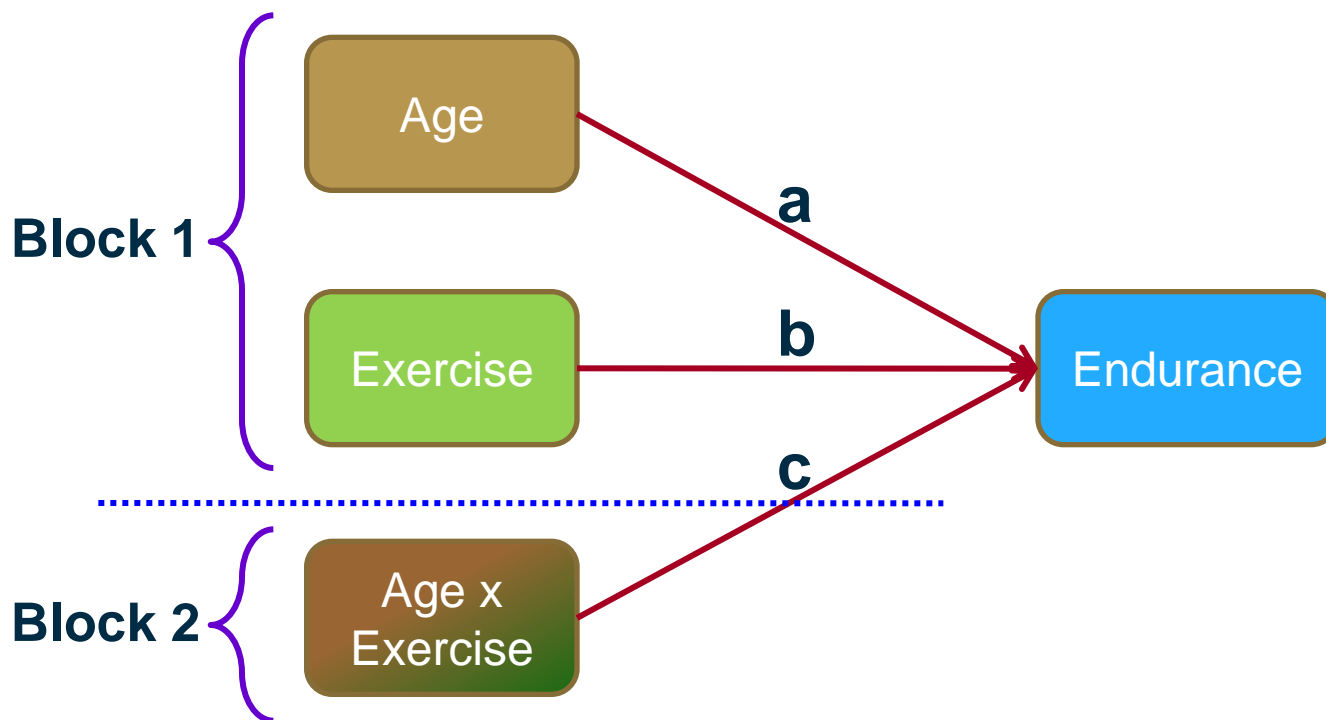
Example [Cohen, Cohen, et.al. 2003]

250 subjects:

DV = Endurance

IV = Age (centered)

Mod = Previous Years of Vigorous Physical Exercise (centered)



“centering” – i.e. subtracting the “grand mean” prevents “spurious relationships.”



SPSS Regression Output

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df 1	df 2	Sig. F Change
1	.408 ^a	.166	.159	9.919	.166	24.142	2	242	.000
2	.454 ^b	.206	.196	9.700	.040	12.080	1	241	.001

a. Predictors: (Constant), ExerciseC, AgeC

b. Predictors: (Constant), ExerciseC, AgeC, AgeCxExerciseC

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	26.528	.634		41.862	.000	25.280	27.777
	AgeC	-.257	.066	-.240	-3.925	.000	-.386	-.128
	ExerciseC	.916	.139	.404	6.610	.000	.643	1.189
2	(Constant)	25.886	.647		40.032	.000	24.613	27.160
	AgeC	-.262	.064	-.245	-4.087	.000	-.388	-.136
	ExerciseC	.973	.137	.429	7.123	.000	.704	1.241
	AgeCxExerciseC	.047	.014	.201	3.476	.001	.020	.074

a. Dependent Variable: Endurance



“Interaction” – \$5 software

The screenshot shows the Interaction! software window with a menu bar (File, Edit, View, Help) and a toolbar. The main text area displays the following output:

```
***** MODEL COEFFICIENTS *****
```

	B	Std Error	t	Significance
(Regression constant):	25.88872135	0.646618461	40.03708973	0.000000001
AgeC:	-0.26168976	0.064063836	-4.08482822	0.000059928
ExerciseC:	0.972715256	0.136532702	7.124412210	0.000000001
Interaction term:	0.047244737	0.013592930	3.475684400	0.000603366

95% CONFIDENCE INTERVALS

	Lower Bound	Upper Bound
(Regression constant):	24.61502886	27.16241384
AgeC:	-0.38788106	-0.13549846
ExerciseC:	0.703776633	1.241653878
Interaction term:	0.020469730	0.074019744

NOTE: Continuous predictors were centered prior to computing these values!

```
***** END MODEL COEFFICIENTS *****
```

***** INTERACTION LINE 1 *****

Moderator: ExerciseC
Level of the Moderator: +1 Std Dev
Simple Slope: -0.03608550
Intercept: 30.53365587

The window has two tabs at the bottom: "Interaction Graph" and "Statistical Output".



Mediators – How to test for ...

[Preacher, Hayes] – 3 approaches:

(1) Baron, Kenny:

“suffers from low power”

(i) $Y = i_1 + cX$

(ii) $M = i_2 + aX$

(iii) $Y = i_3 + c'X + bM$

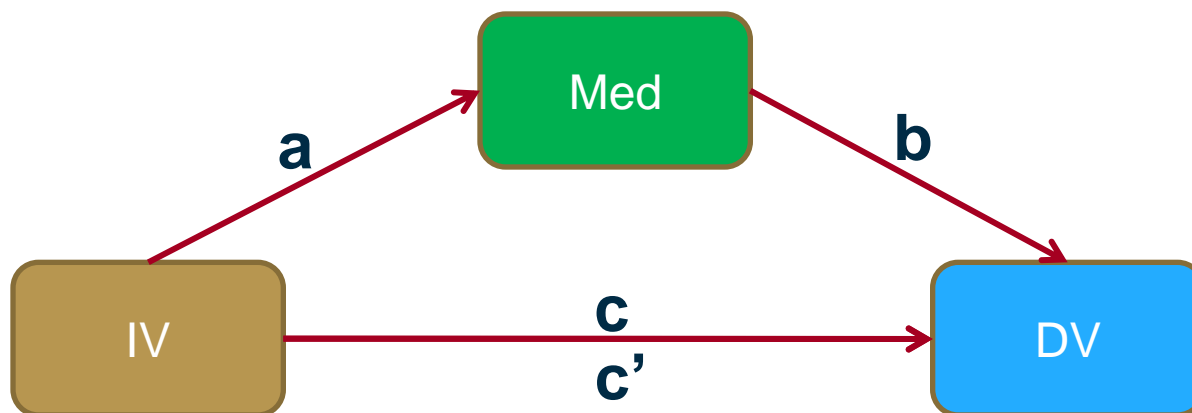
(2) Sobel Test

(i) calculate ab (assumption Normal Distribution)

(ii) calculate $s_{ab} = \text{sqrt}(b^2s_a^2 + a^2s_b^2 + s_a^2s_b^2)$

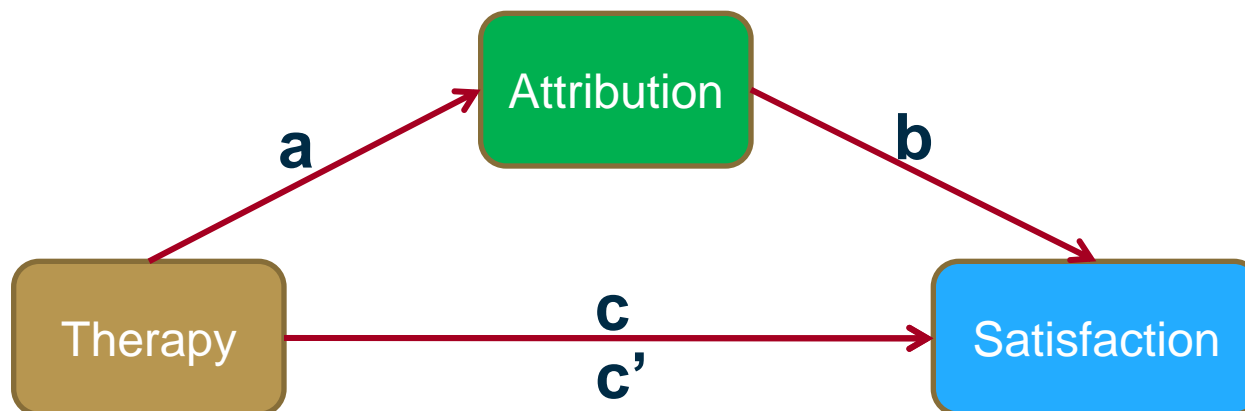
(iii) divide $ab/s_{ab} \rightarrow$ compare to $N(0,1)$ critical values

(3) Bootstrap sampling distribution for ab





Example [Preacher, Hayes]



“An investigator is interested in the effects of a new cognitive therapy on life satisfaction after retirement. Residents of a retirement home diagnosed as clinically depressed are randomly assigned to receive 10 sessions of a new cognitive therapy or an alternative method. After session 8, the “positivity of attributions” the residents make for a recent failure experience is assessed. After session 10 the residents are given a measure of life satisfaction (questionnaire).”



SPSS Macro [Preacher, Hayes]:

Runs all 3 – Baron/Kenny, Sobel and Bootstrap

(1) Open dataset

(2) Open sobel_spss.sps – syntax file with macro – “select all” and click run

(3) Open new syntax window – run

```
sobel y=satis / x=therapy / m=attrib / boot=5000.
```

(4) WAIT!!!! It will seem like SPSS has locked up – but it is still running!!

See <http://www.comm.ohio-state.edu/ahayes/sobel.htm>



Run MATRIX procedure:

DIRECT AND TOTAL EFFECTS

		Coeff	s.e.	t	Sig(two)
c →	b (YX)	.7640	.3058	2.4984	.0186
a →	b (MX)	.8186	.2990	2.7375	.0106
b →	b (YM.X)	.4039	.1808	2.2337	.0340
c' →	b (YX.M)	.4334	.3221	1.3455	.1897

Baron/Kenny –
YES mediator

SOBEL – NO
mediator

INDIRECT EFFECT AND SIGNIFICANCE USING NORMAL DISTRIBUTION

		Value	s.e.	LL 95 CI	UL 95 CI	Z	Sig(two)
ab →	Sobel	.3306	.1985	-.0585	.7197	1.6653	.0959

BOOTSTRAP RESULTS FOR INDIRECT EFFECT

ab – “boot”

		Mean	s.e.	LL 95 CI	UL 95 CI	LL 99 CI	UL 99 CI
→	Effect	.3221	.1721	.0324	.7030	-.0754	.8664

SAMPLE SIZE
30

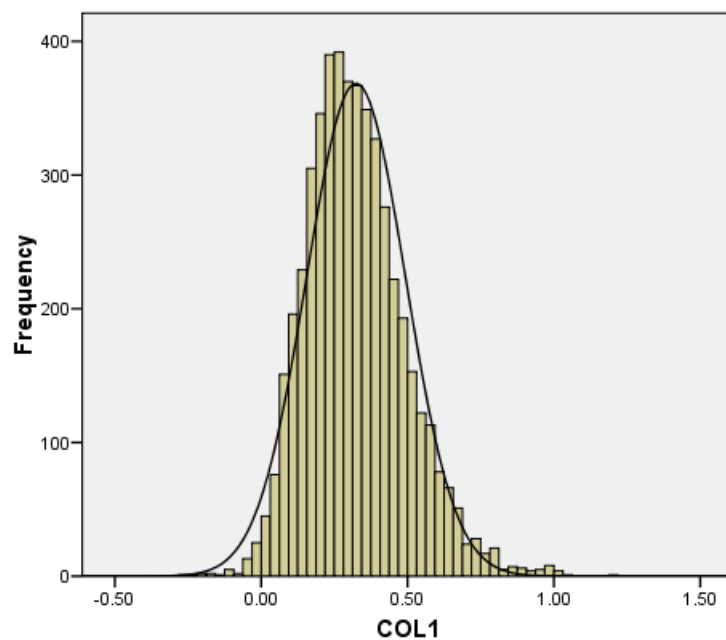
NUMBER OF BOOTSTRAP RESAMPLES
5000

Bootstrap –
YES mediator

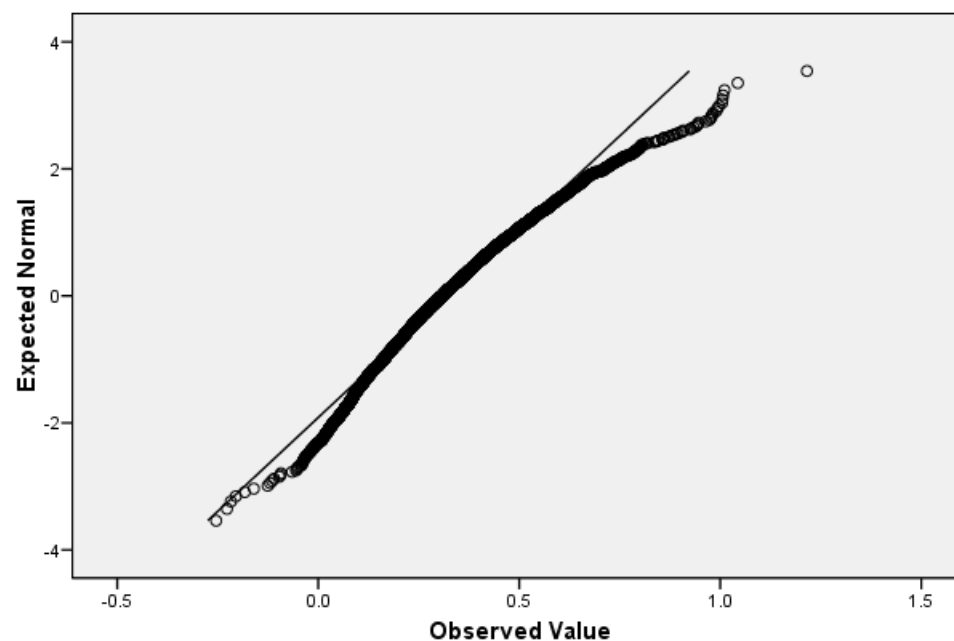


“ab” distribution – Sobel Need for Bootstrapping

Histogram

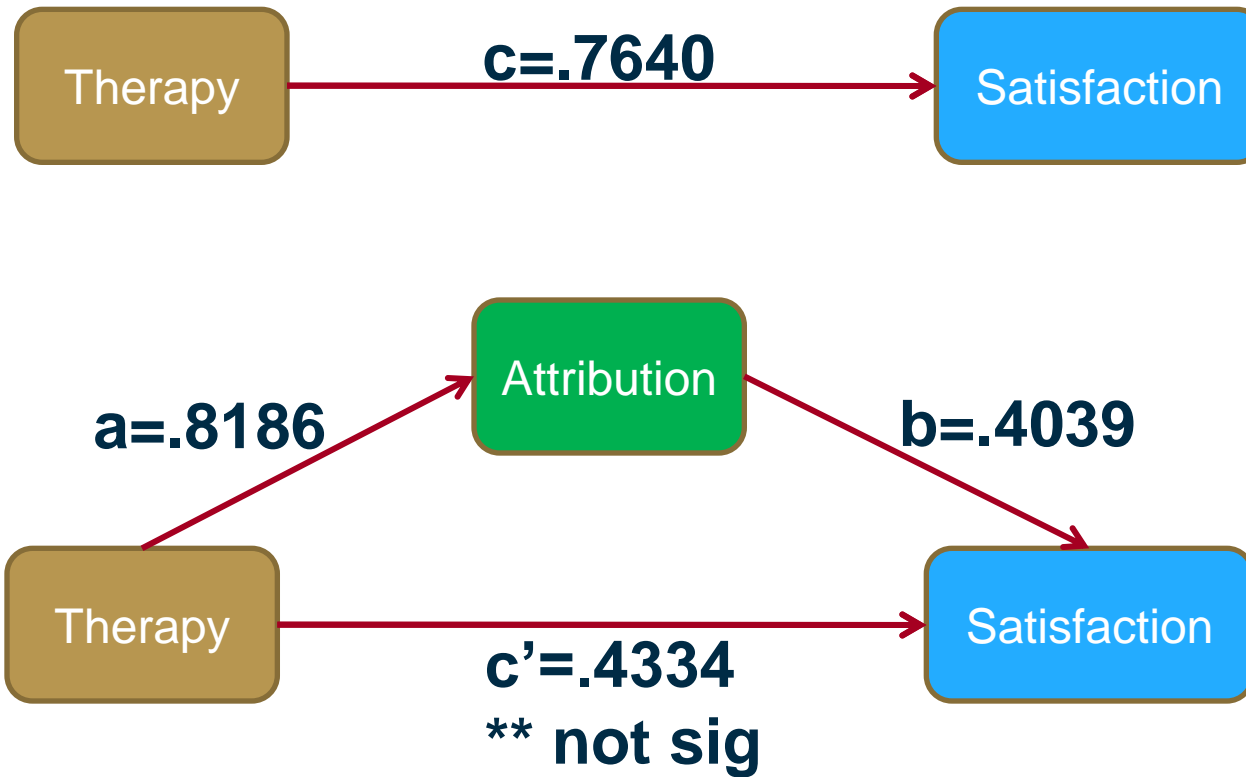


Normal Q-Q Plot of COL1



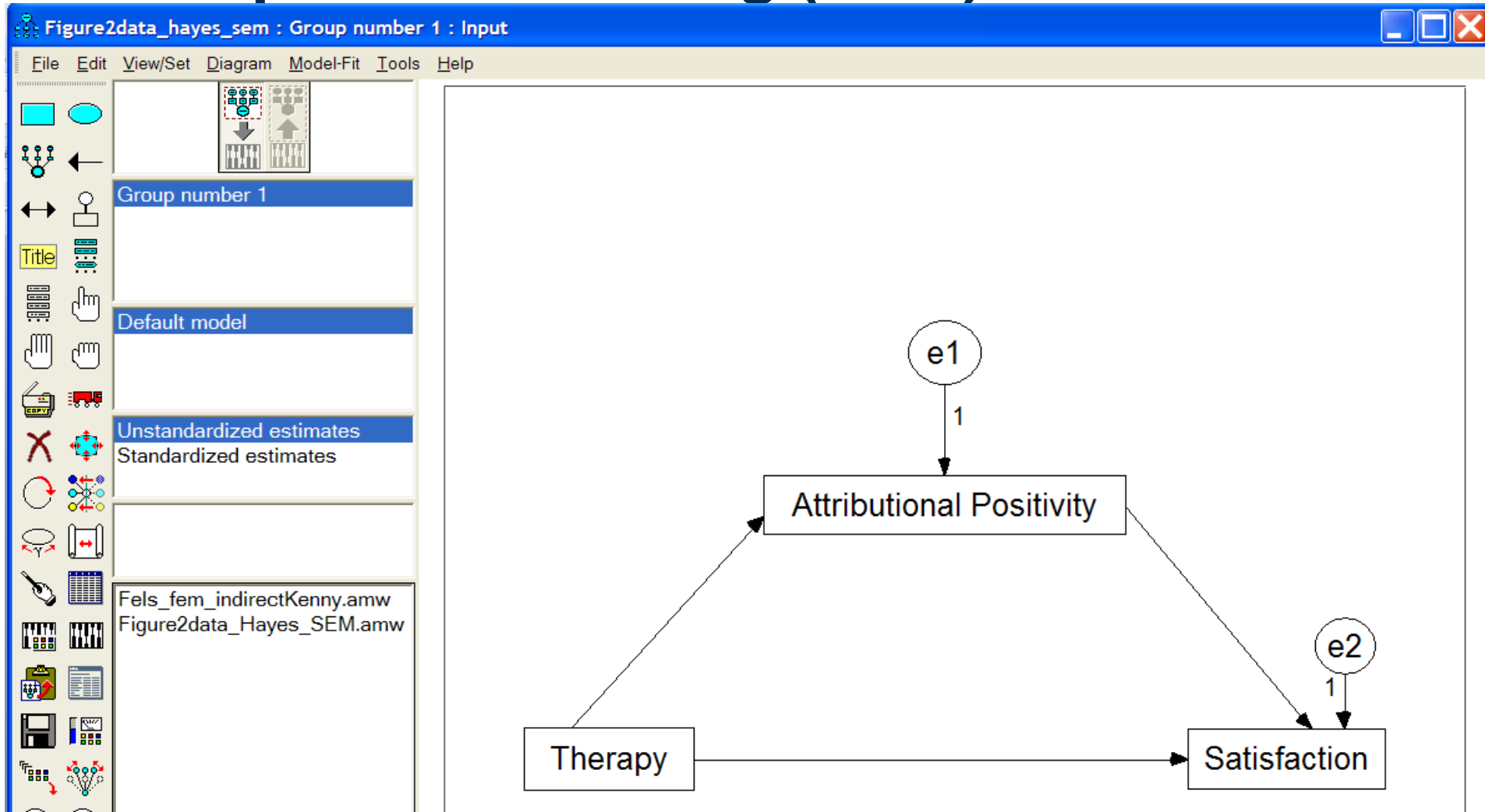


Results – SPSS Macro



(Baron/Kenny) C' is not significantly different from 0 ($pval=0.1897$)
(Sobel) $ab = 0.3306$ 95% CI = [-0.0585, 0.7197] not significant
(Bootstrap) $ab = 0.3205$ 95% CI = [0.0334, 0.7008] significant

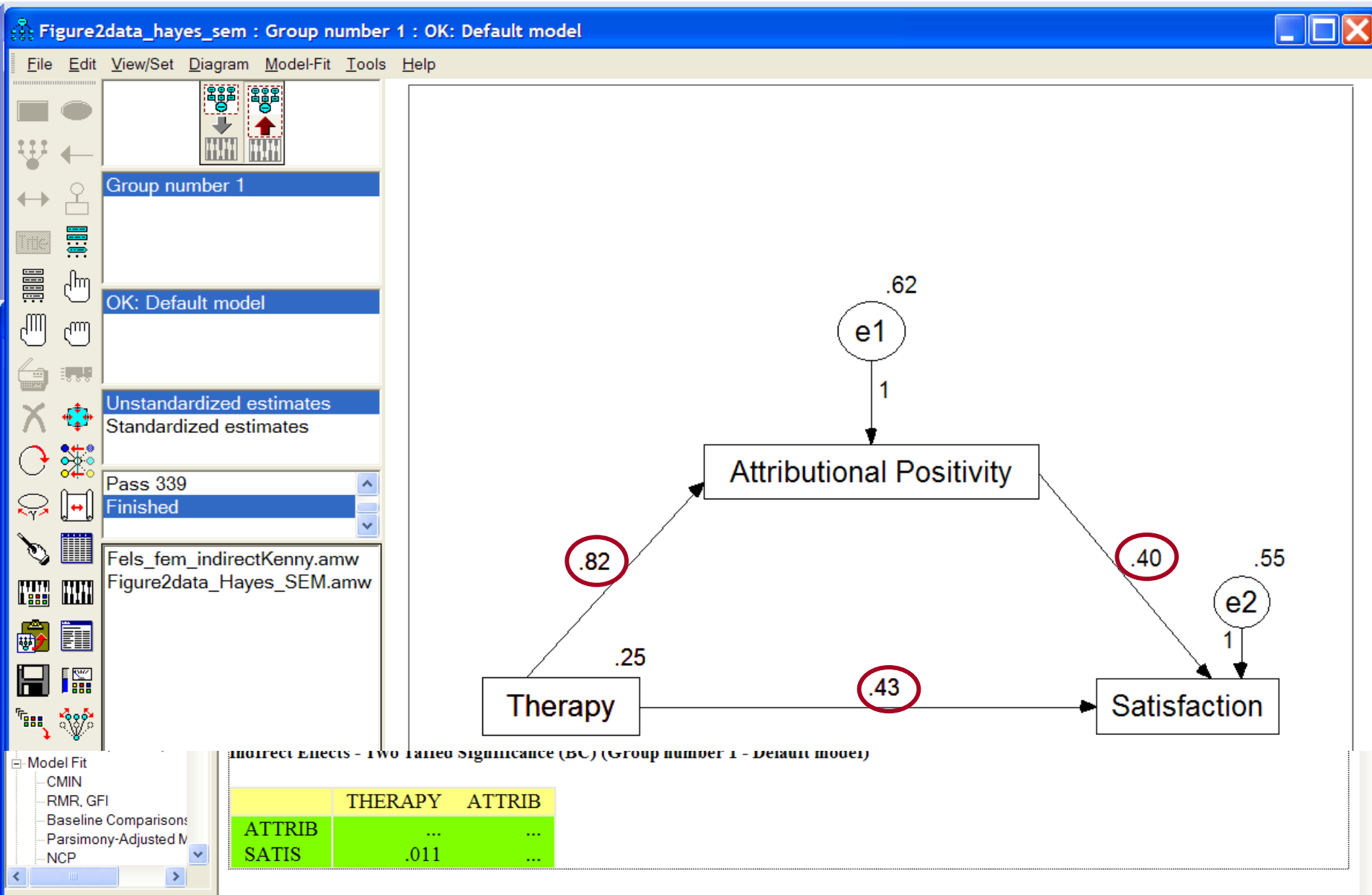
Example (cont'd) – Mediation Using Structural Equation Modeling (SEM) via AMOS



See <http://davidakenny.net/cm/mediate.htm> and tutorial (video and sound) at <http://amosdevelopment.com/video/indirect/flash/indirect.html>



SEM (cont'd)





Summary

Moderator

- “interaction”
- affects strength or direction of IV-DV
- explains "when" or "for whom"
- modifies a causal effect

Mediator

- only tested then there is a significant effect between IV-DV
- specifies how the association occurs BETWEEN IV-DV
- explains "why" and "how"
- links a cause (IV) and effect (DV)



References

- Bennett, Jill. “Mediator and Moderator Variables in Nursing Research: Conceptual and Statistical Differences.” Research in Nursing and Health, 23, 2000, pp. 415-420.
- Wu, Amery; Zumbo, Bruno. “Understanding and Using Mediators and Moderators.” Social Indicators Research, 87 (3), July 2008, pp. 367-392. [DOI 10.1007/s11205-007-9143-1]
- Baron, Reuben; Kenny, David. “The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations.” Journal of Personality and Social Psychology, 51 (6), 1986, pp. 1173-1182.
- Preacher, Kristopher; Hayes, Andrew. “SPSS and SAS procedures for estimating indirect effects in simple mediation models.” Behavior Research Methods, Instruments and Computers, 36 (4), 2004, pp. 717-731.
- Cohen, Jacob; Cohen, Patricia; West, Stephen; Aiken, Leona “Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences” 3rd edition, Lawrence Erlbaum Associates Inc., 2003.



VIII. Statistical Resources and Contact Info

SON S:\Shared\Statistics_MKHiggins\website2\index.htm

[updates in process]

Working to include tip sheets (for SPSS, SAS, and other software), lectures (PPTs and handouts), datasets, other resources and references

Statistics At Nursing Website: [website being updated]
<http://www.nursing.emory.edu/pulse/statistics/>

And Blackboard Site (in development) for
“Organization: Statistics at School of Nursing”

Contact

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