INSTRUCTIONS

- This handout accompanies a video lecture on the Testing Center's website at Texas State University found at http://www.txstate.edu/trec/iirda/resource/onlinetraining.html

- This handout uses a fill-in-the-blank format such that it will likely make no sense whatsoever unless you watch the accompanying video

- Along with this handout and the video lecture is a SPSS data set so you can work along with the video and try the examples for yourself

- YOU MUST WATCHT THE VIDEO before you contact me for additional help!!!

Regression-Based Tests for Moderation

Brian K. Miller, Ph.D.

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Presentation Objectives

1. Differentiate between mediation & moderation
2. Differentiate between hierarchical and stepwise regression
3. Run and interpreting hierarchical regression in SPSS
4. Compute interaction terms
5. Mean center variables
6. Graphing interactions

2

1. Differentiate between mediation and moderation

3

Moderation vs. Mediation

- _____: third variable that affects strength of relationship between two other variables
  - Ex: relationship between performance and salary _____ _____ gender
  - Ex: relationship between X_1 and Y is strong, especially if X_2 is also strong
- _____: third variable that acts as _____ _____ between two other variables
  - Ex: performance mediates relationship between job knowledge and salary
  - Ex: X_1 "causes" X_2 which "causes" Y

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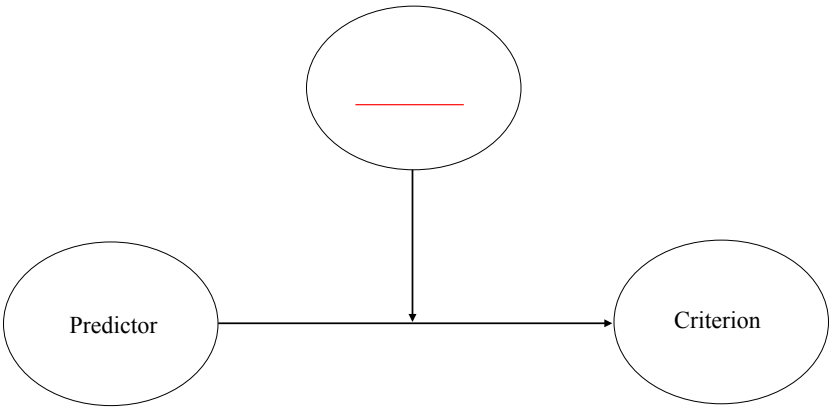
_____ Diagram



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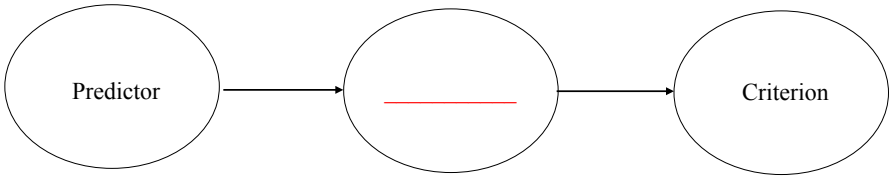
_____ Diagram



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2. Differentiate between hierarchical regression & stepwise regression

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Hierarchical Regression

- Variables entered in equation at various stages
- Important statistics and tests
  - Change in R^2 (i.e. _____)
  - Change in *F*-score (i.e. ΔF)
  - Overall equation _____
- Uses:
  - _____ variables
  - Interaction terms
- NOT same as _____ regression

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Stepwise Regression

- All variables entered at one stage
- Software enters every _____ of variables
  - Seeks to _____ R^2
  - Capitalizes on chance characteristics of THIS sample ☹
  - Like throwing spaghetti against the wall to see what sticks ☹
- Not recommended _____ by some journals

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3. Run hierarchical regression in SPSS

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SPSS Example #1

- Click “Analyze” / “Regression” / “Linear”
- Choose “DV1” as Dependent Variable
- Choose “Control1”, “Control2” as IVs
  - Is there theoretical rationale for these control variables?
  - However, no need for stated hypotheses
- Click “Next”
- Choose “IV1”, “IV2” as Independent Variables
- Click “Statistics”
- Put check in box for “R squared change”
- Click “Continue”, click “OK”

Output1 [Document1] - IBM SPSS Statistics Viewer

- Output
  - Regression
    - Title
    - Active Dataset
    - Model Summary
    - ANOVA
    - Coefficients
    - Excluded Variables

Regression

[DataSet1] /Users/bkm/Desktop/Data Set for Moderation and Mediation.sav

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.028[a]	.001	-.016	.68648	.001	.046	2	122	.955
2	.672[b]	.452	.433	.51273	.451	49.349	2	120	.000

a. Predictors: (Constant), Control Variable 2, Control Variable 1
b. Predictors: (Constant), Control Variable 2, Control Variable 1, IV 1, IV 2

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.044	2	.022	.046	.955[a]
	Residual	57.494	122	.471		
	Total	57.537	124			
2	Regression	25.991	4	6.498	24.716	.000[b]
	Residual	31.547	120	.263		
	Total	57.537	124			

a. Predictors: (Constant), Control Variable 2, Control Variable 1
b. Predictors: (Constant), Control Variable 2, Control Variable 1, IV 1, IV 2
c. Dependent Variable: DV1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.784	.267		10.431	.000
	Control Variable 1	-.010	.067	-.014	-.153	.878
	Control Variable 2	.033	.131	.022	.247	.805
2	(Constant)	5.384	.381		14.123	.000
	Control Variable 1	-.017	.052	-.023	-.331	.741
	Control Variable 2	-.021	.100	-.014	-.206	.837
	IV 1	-.685	.123	-.404	-5.567	.000
	IV 2	-.316	.052	-.443	-6.079	.000

a. Dependent Variable: DV1

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4. Compute Interaction Terms

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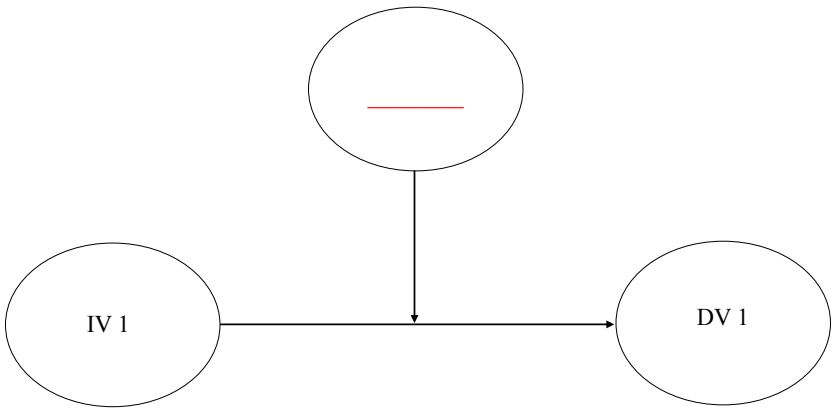
Review Diagram



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Reconceptualizing Diagram as 2 x 2

IV 1 \ IV 2	High	Low
High	_____ DV	Medium DV
Low	Medium DV	_____ DV

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Caution!

- Never _____ continuous variables (e.g. cutting in half at the median)
- Results in loss of useful information
- Treats scores close to each other as if far from each other
- In _____, no need to dichotomize since all IVs are **categorical**
- _____ subsumes ANOVA
- But, different method of creating interaction terms needed

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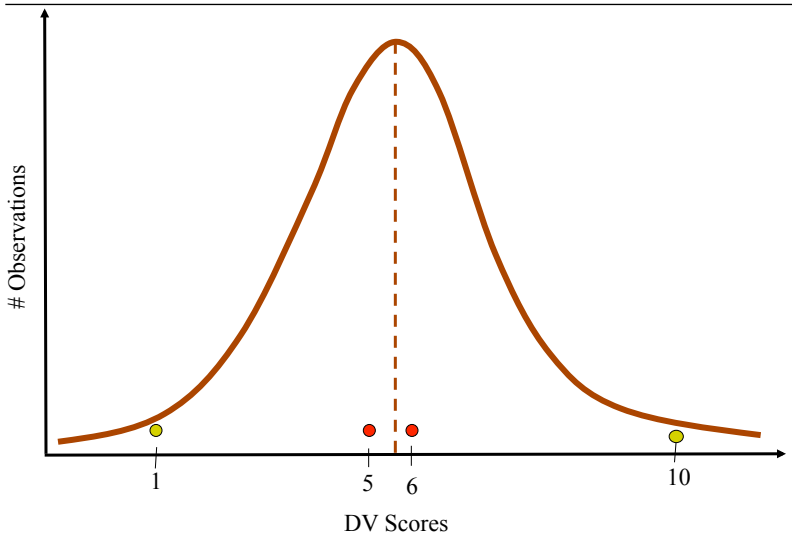
Problem:
_____ Continuous Variable



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Moderation Effects

- Strength of relationship between IV and DV _____ _____ Moderator
  - If one is low on the moderator (IV2) the correlation between IV1 and DV is different from same correlation for those high on moderator (IV2)
  - In regression
    - correlations manifest themselves as _____, or
    - _____ of lines
  - So…slope of lines is different based upon gender
- Caution: Moderating variables is ALSO **an IV**

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Moderation Effects (cont' d)

- MUST include bot_____(i.e. both IVs) in regression before including _____(cross product of IV1 and IV2)
  - Hierarchical regression model 1 has both main effects but **NO** interaction term
  - Hierarchical regression model 2 has main effects **PLUS** interaction term

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Example Hypothesis

1. There is an interaction effect between IV1 and IV2 in the prediction of DV, such that high levels of IV1 combined with high levels of IV2 will lead to higher levels of DV than will low levels of either or both of IV1 and IV2.

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Alternatively Written Hypotheses

2. The strength of the relationship between IV1 and DV depends upon IV2, such that IV1 is strongest when IV2 is high and weakest when IV2 is low.
3. There is a positive relationship between IV1 and DV especially if IV2 is also high.

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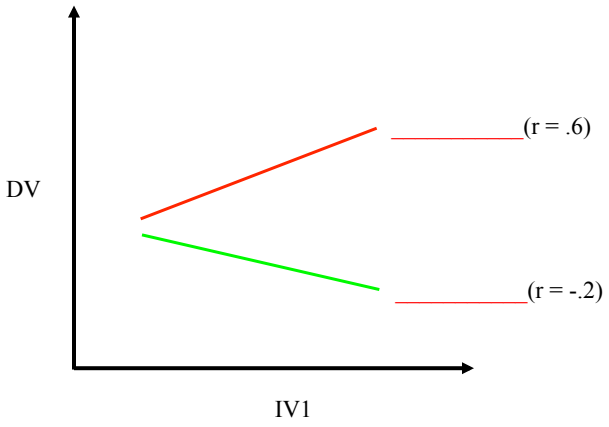
Plotting Interactions



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Creating Multiplicative Terms

- Most (but not all!) IVs in regression are _____
- For 2 IVs, create third term that serves as interaction
- Simply _____ both IVs to create new term
- *Heads up:* sometimes new term is _____ with component terms

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Collinearity Issues

- Product of two variables is almost always collinear with its _____
- When two variables are so strongly correlated with each other that they affect interpretation of regression
  - Can make _____ exceed ± **1.0** ☹
- Tolerance / _____ (VIF)
  - Tolerance is reciprocal of VIF
  - Collinearity indicated if:
    - Tolerance < .10, or…
    - …VIF > 10

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SPSS Example #2: Moderated Multiple Regression

- Click Analyze/Regression/Linear or Dialog Recall button
- Click "Reset" to start with all new variables (i.e. remove the control variables previously used)
- Choose "DV1" as DV
- Choose "IV1" and "IV2" as IVs
- Click "Next"
- Choose new term "IV1xIV2" (interaction term already created from product of two IVs above) as only IV in second step of hierarchical regression model
- Click "Statistics"
- Put check in boxes for "R square change" and "Collinearity Diagnostics"
- Click "Continue", click "OK"

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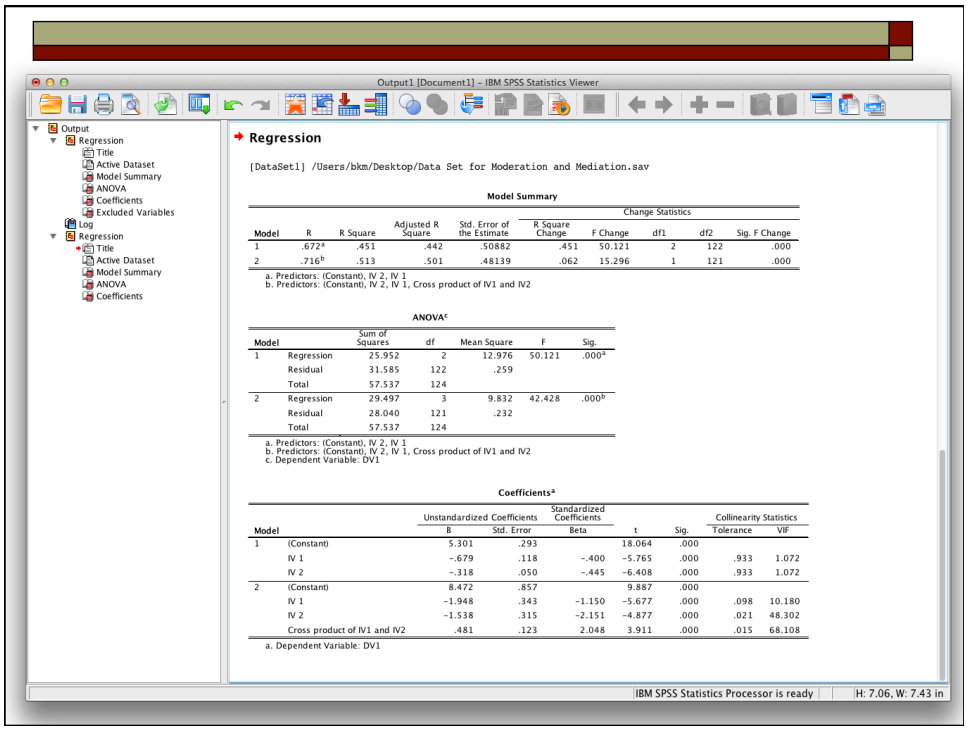

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.672[a]	.451	.442	.50882	.451	50.121	2	122	.000
2	.716[b]	.513	.501	.48139	.062	15.296	1	121	.000

a. Predictors: (Constant), IV 2, IV 1
b. Predictors: (Constant), IV 2, IV 1, Cross product of IV1 and IV2

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25.952	2	12.976	50.121	.000[a]
	Residual	31.585	122	.259		
	Total	57.537	124			
2	Regression	29.497	3	9.832	42.428	.000[b]
	Residual	28.040	121	.232		
	Total	57.537	124			

a. Predictors: (Constant), IV 2, IV 1
b. Predictors: (Constant), IV 2, IV 1, Cross product of IV1 and IV2
c. Dependent Variable: DV1

Coefficients[a]

Model		Unstandardized Coefficients: B	Unstandardized Coefficients: Std. Error	Standardized Coefficients: Beta	t	Sig.	Collinearity Statistics: Tolerance	VIF
1	(Constant)	5.301	.293		18.064	.000		
	IV 1	-.679	.118	-.400	-5.765	.000	.933	1.072
	IV 2	-.318	.050	-.445	-6.408	.000	.933	1.072
2	(Constant)	8.472	.857		9.887	.000		
	IV 1	-1.948	.343	-1.150	-5.677	.000	.098	10.180
	IV 2	-1.538	.315	-2.151	-4.877	.000	.021	48.302
	Cross product of IV1 and IV2	.481	.123	2.048	3.911	.000	.015	68.108

a. Dependent Variable: DV1

5. Mean Centering Variables

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Mean Centering Variables

- Mean centering of variables reduces impact of _____
- This is NOT same as _____ variables!
- Allows for better interpretation of regression weights
- Requires:
  - Calculation of _____ of the variable
  - Creation of new variable that…
  - …is _____ between measured variable and mean of variable

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Output1 [Document1] - IBM SPSS Statistics Viewer

- Output
  - Regression
    - Title
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    - ANOVA
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    - Excluded Variables
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Regression

[DataSet1] /Users/bkm/Desktop/Data Set for Moderation and Mediation.sav

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2	.716[b]	.513	.501	.48139	.062	15.296	1	121	.000

a. Predictors: (Constant), Mean Centered IV2, Mean Centered IV1
b. Predictors: (Constant), Mean Centered IV2, Mean Centered IV1, Cross product of IV1 and IV2

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a. Predictors: (Constant), Mean Centered IV2, Mean Centered IV1
b. Predictors: (Constant), Mean Centered IV2, Mean Centered IV1, Cross product of IV1 and IV2
c. Dependent Variable: DV1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.756	.046		60.552	.000		
	Mean Centered IV1	-.679	.118	-.400	-5.765	.000	.933	1.072
	Mean Centered IV2	-.318	.050	-.445	-6.408	.000	.933	1.072
2	(Constant)	-.497	.833		-.597	.552		
	Mean Centered IV1	-1.948	.343	-1.150	-5.677	.000	.098	10.180
	Mean Centered IV2	-1.538	.315	-2.151	-4.877	.000	.021	48.302
	Cross product of IV1 and IV2	.481	.123	2.048	3.911	.000	.015	68.108

a. Dependent Variable: DV1

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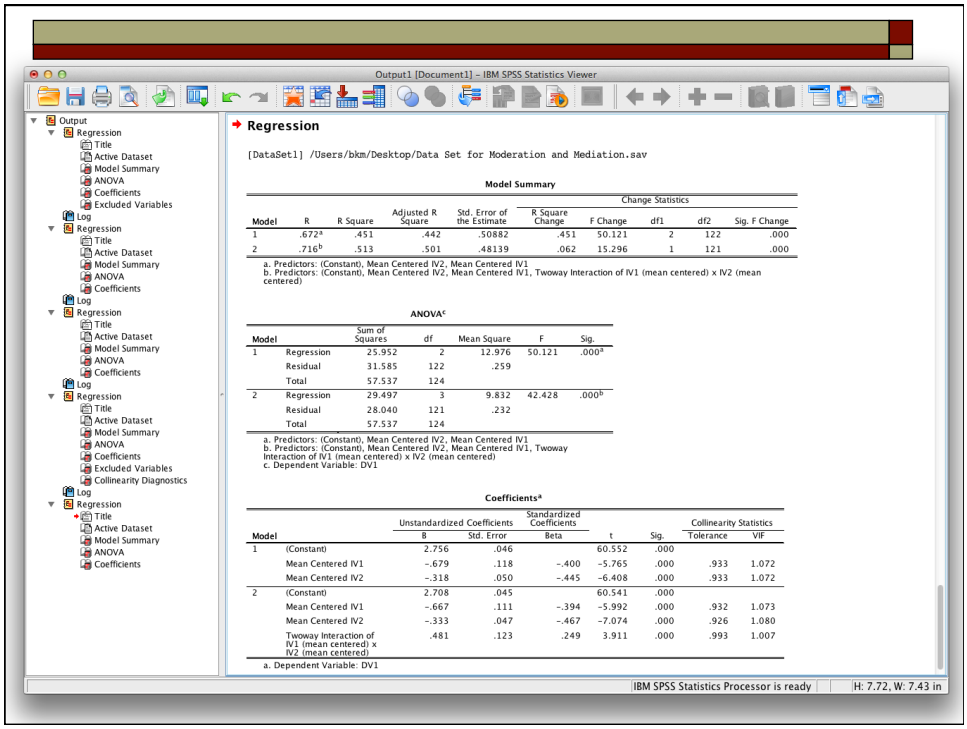
	IV 1	-.679	.118	-.400	-5.765	.000	.933	1.072
	IV 2	-.318	.050	-.445	-6.408	.000	.933	1.072
2	(Constant)	5.267	.278		18.959	.000		
	IV 1	-.667	.111	-.394	-5.992	.000	.932	1.073
	IV 2	-.333	.047	-.467	-7.074	.000	.926	1.080
	Twoway Interaction of IV1 (mean centered) x IV2 (mean centered)	.481	.123	.249	3.911	.000	.993	1.007

a. Dependent Variable: DV1

IBM SPSS Statistics Processor is ready



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	Mean Centered IV1	-.679	.118	-.400	-5.765	.000	.933	1.072
	Mean Centered IV2	-.318	.050	-.445	-6.408	.000	.933	1.072
2	(Constant)	2.708	.045		60.541	.000		
	Mean Centered IV1	-.667	.111	-.394	-5.992	.000	.932	1.073
	Mean Centered IV2	-.333	.047	-.467	-7.074	.000	.926	1.080
	Twoway Interaction of IV1 (mean centered) x IV2 (mean centered)	.481	.123	.249	3.911	.000	.993	1.007

a. Dependent Variable: DV1

6. Graphing Interactions

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Graphing Interactions

- DV on _____(Y) axis
- IV on _____(X) axis
- Calculate values of Moderator (other IV) 1 sd above and below mean
- Calculate values of IV 1 sd above and below mean
- Insert value of Moderator at lower sd in _____ _____
- Insert value of Moderator at upper sd in regression equation

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Using Regression Formula to Plot Interactions

Use the regression equation:

$$Y = 2.708 - .667IV_1 - .333IV_2 + .481IV_1IV_2$$

Find 4 different values (points) for Y

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Using Regression Formula (cont' d)

- Calculate one equation for:
  - Insert value of IV2 at 1sd above mean
  - Insert value of IV1 at 1sd above mean
- Calculate another equation for:
  - Insert value of IV2 at 1sd below mean
  - Insert value of IV1 at 1sd below mean
- Calculate one equation for:
  - Insert value of IV2 at 1sd above mean
  - Insert value of IV1 at 1sd below mean
- Calculate another equation for:
  - Insert value of IV2 at 1sd below mean
  - Insert value of IV1 at 1sd above mean
- Connect the dots (i.e. draw the line segments)

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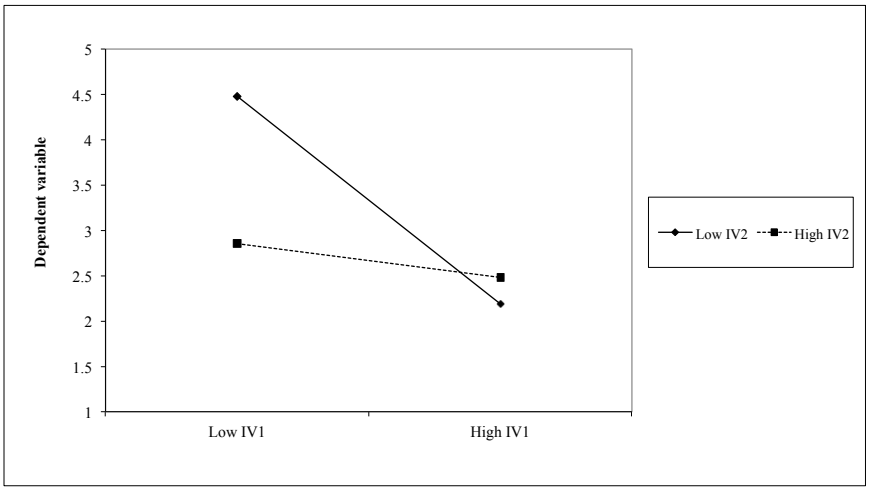
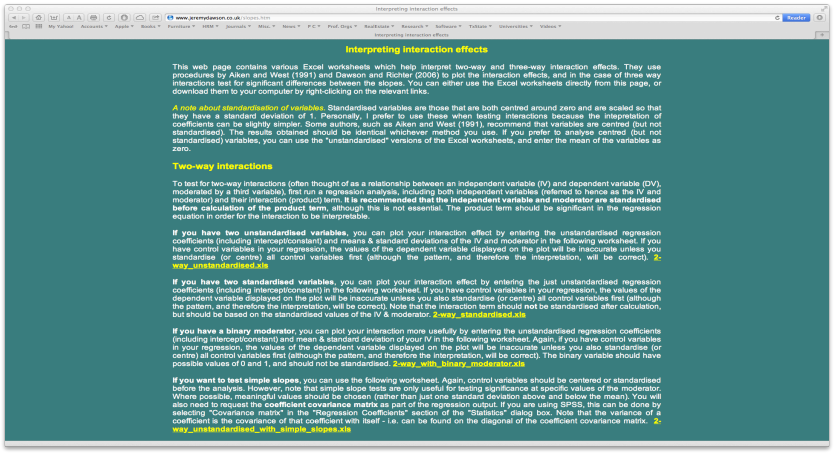
Sample Graph



Using Online Calculators Instead

- See http://www.jeremydawson.co.uk/slopes.htm



Interpreting interaction effects

This web page contains various Excel worksheets which help interpret two-way and three-way interaction effects. They use procedures by Aiken and West (1991) and Dawson and Richter (2006) to plot the interaction effects, and in the case of three way interactions test for significant differences between the slopes. You can either use the Excel worksheets directly from this page, or download them to your computer by right-clicking on the relevant links.

A note about standardisation of variables. Standardised variables are those that are both centred around zero and are scaled so that they have a standard deviation of 1. Personally, I prefer to use these when testing interactions because the interpretation of coefficients can be slightly simpler. Some authors, such as Aiken and West (1991), recommend that variables are centred (but not standardised). The results obtained should be identical whichever method you use. If you prefer to analyse centred (but not standardised) variables, you can use the "unstandardised" versions of the Excel worksheets, and enter the mean of the variables as zero.

Two-way interactions

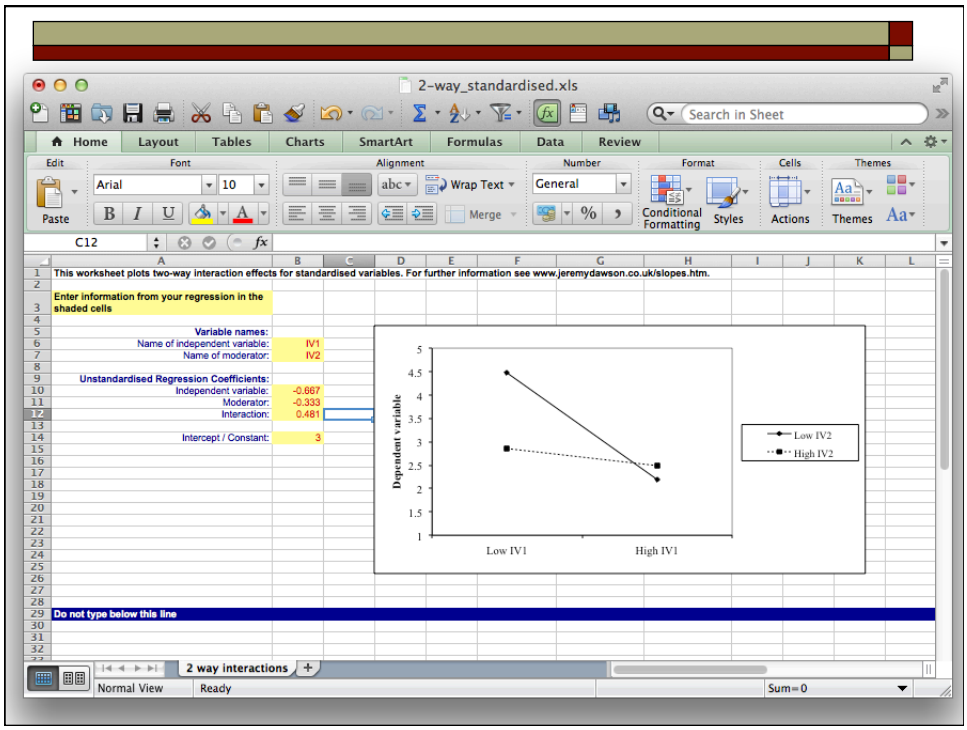
To test for two-way interactions (often thought of as a relationship between an independent variable (IV) and dependent variable (DV), moderated by a third variable), first run a regression analysis, including both independent variables (referred to hence as the IV and moderator) and their interaction (product) term. **It is recommended that the independent variable and moderator are standardised before calculation of the product term**, although this is not essential. The product term should be significant in the regression equation in order for the interaction to be interpretable.

If you have two unstandardised variables, you can plot your interaction effect by entering the unstandardised regression coefficients (including intercept/constant) and means & standard deviations of the IV and moderator in the following worksheet. If you have control variables in your regression, the values of the dependent variable displayed on the plot will be inaccurate unless you standardise (or centre) all control variables first (although the pattern, and therefore the interpretation, will be correct). 2-way_unstandardised.xls

If you have two standardised variables, you can plot your interaction effect by entering the just unstandardised regression coefficients (including intercept/constant) in the following worksheet. If you have control variables in your regression, the values of the dependent variable displayed on the plot will be inaccurate unless you also standardise (or centre) all control variables first (although the pattern, and therefore the interpretation, will be correct). Note that the interaction term should **not** be standardised after calculation, but should be based on the standardised values of the IV & moderator. 2-way_standardised.xls

If you have a binary moderator, you can plot your interaction more usefully by entering the unstandardised regression coefficients (including intercept/constant) and mean & standard deviation of your IV in the following worksheet. Again, if you have control variables in your regression, the values of the dependent variable displayed on the plot will be inaccurate unless you also standardise (or centre) all control variables first (although the pattern, and therefore the interpretation, will be correct). The binary variable should have possible values of 0 and 1, and should not be standardised. 2-way_with_binary_moderator.xls

If you want to test simple slopes, you can use the following worksheet. Again, control variables should be centered or standardised before the analysis. However, note that simple slope tests are only useful for testing significance at specific values of the moderator. Where possible, meaningful values should be chosen (rather than just one standard deviation above and below the mean). You will also need to request the **coefficient covariance matrix** as part of the regression output. If you are using SPSS, this can be done by selecting "Covariance matrix" in the "Regression Coefficients" section of the "Statistics" dialog box. Note that the variance of a coefficient is the covariance of that coefficient with itself - i.e. can be found on the diagonal of the coefficient covariance matrix. 2-way_unstandardised_with_simple_slopes.xls



Things We Learned

1. Mediation and moderation are very different
2. Hierarchical regression is NOT stepwise regression
3. Interpreting hierarchical regression output is easy
4. Computing interaction terms is just simple multiplication
5. Mean centered variables offset collinearity
6. Graphing interactions is easier with Excel

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That's all folks!!!

BrianMillerPhD@gmail.com

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