Linear Regression, Mediation, & Moderation

EVEN MORE INFERENTIAL STATISTICS

Overview

- By the end of this unit you should be familiar with:
  - **F-tests**
  - **Regression weights**
  - **Mediation**
  - **Moderation**

ANOVA

- **An**alysis **o**f **Va**riance
- Used to compare three or more cells of factorial experimental design
  - How much, if at all, do the groups differ from each other? Is it a reliable difference?
- Assumes normal distribution of DVs
- Test statistic is F-distribution
- (An F with two cells equals a t^2)
- If there is a significant difference, you may see Tukey's HSD reported
  - This tells you which groups were different from each other and by how much
- η^2 (eta-squared)
  - Measure of effect size in ANOVA

Comparing More Than Two Groups of Observations

- T-tests can only compare one set of observations to a constant, or two groups to each other.
- If you have an experiment with 3 levels of a condition (e.g., high power, low power, no treatment control), you should do a different test: a one-way analysis of variance (ANOVA).
- If you have an experiment with 2 or more crossed factors, then you also would have more than two groups to compare, so you would do a multi-way ANOVA.

In ANOVA, whatever the type, there is always only 1 Dependent Variable

Must be continuous (numerical/scale)

ANOVA is UNIVARIATE (1 Dependent Variable). If there are more than 1 Dependent Variables, use MANOVA

ANOVA can be:

- 1-way
  - 1 independent variable

Must be categorical (nominal/ordinal)

- 2-way
  - 2 independent variable

Must be categorical

- 3,4,etc-way
  - 3,4,etc independent variable

Must be categorical

Reading Results: One-way ANOVA

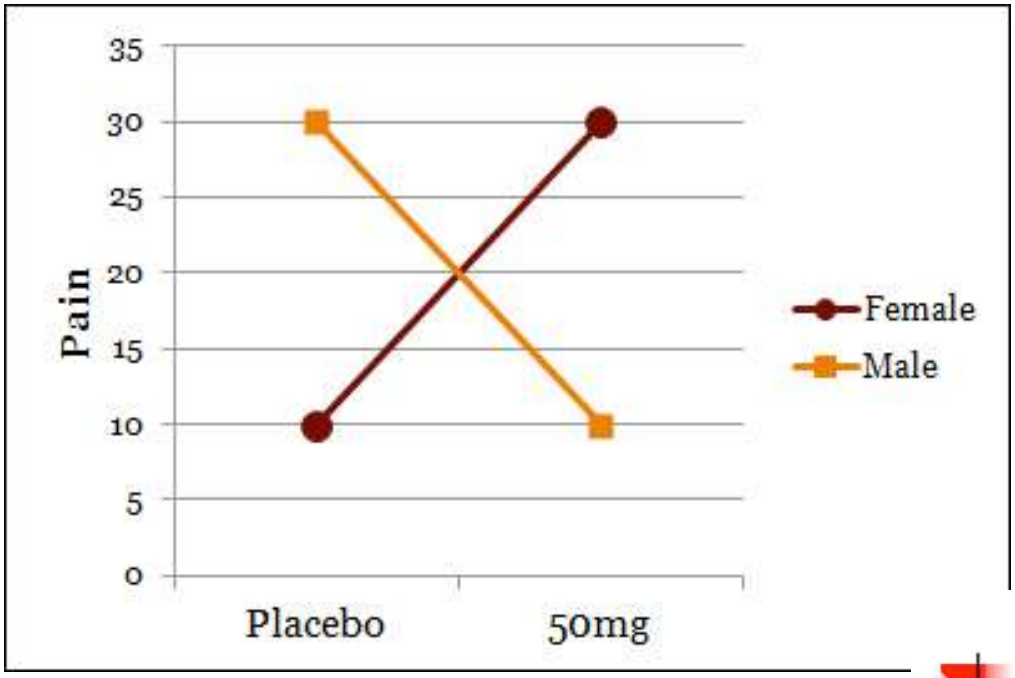
- "There was a statistically significant difference between groups as determined by a one-way ANOVA, $F(2, 30) = 5$, $p = .0003$. Tukey's HSD indicated that participants' reported self-esteem was statistically significantly lower when presented with sad images ($M = 4$, $SD = .25$) and neutral images ($M = 7$, $SD = 1.2$) compared to positive images ($M = 11$, $SD = 1.9$). "

- Example of one factor with 3 levels. The first df in the F test is from levels-1 or 3-1=2

Interactions

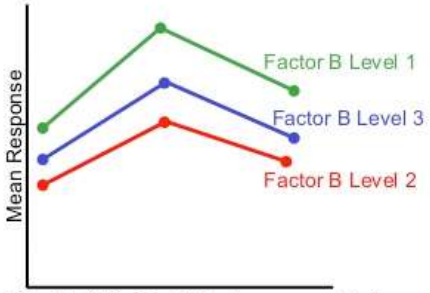
- The effect of IV_1 on the DV could be influenced by IV_2
- Factorial design (multiple factors)
  - ANOVA
- The interaction itself is NOT a variable, but a mathematical placeholder representing the relationship between IV_1 and IV_2 on the DV

- A reliable interaction shows that there is a condition to when a statement is true. This can also be known as a dissociation, or one can say that IV_2 *moderates* the influence of IV_1 on the dependent variable X.

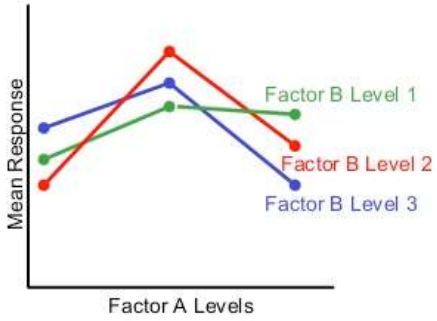


Examples: Interaction vs. No Interaction

- No interaction:



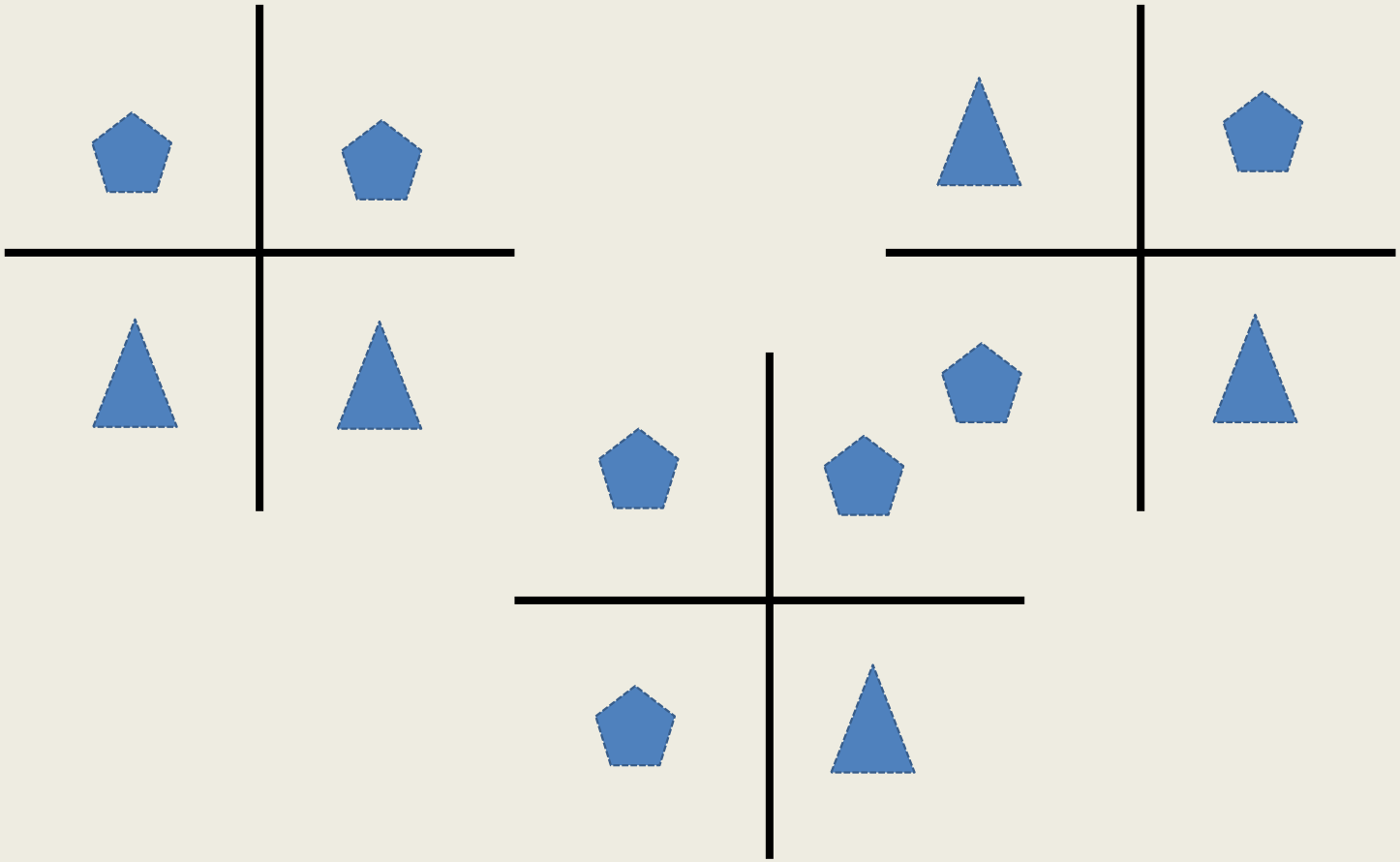
- Interaction is present:



More on Interactions

- Because they are contingencies, they can be hard to think about at once.
- An interaction means at least 2 different things happened.
- When someone has to describe ANOVA results with an “IF” in them, they might have an interaction.
- Interactions are also called “moderation” (because one variable ”moderates” the effect on another one.
- Interactions are also called “dissociation” in experimental psychology, because one effect get unassociated with the other.

Interaction: One of these things is not like the other



Reading Interaction Results

- From Naranyana et al (2013) Study 3

"A 2 (high power vs. low power) x 2(exclusion vs. inclusion) between-participant ANOVA on the intention to connect with others revealed a significant main effect of power, $F(1,114) = 12.34$, $p < .05$, $\eta^2_p = .04$. Consistent with our prediction … the high power group ($M = 7.52$, $SD = 2.34$) displayed a greater intention to connect with others than the low power group ($M = 6.68$, $SD = 2.16$), $t(113) = 2.01$, $p = .05$. There was no main effect of social feedback, $F(1,114) = .84$, $p = .36$."

Reading Interaction Results

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"A 2 (high power vs. low power) x 2(exclusion vs. inclusion) between-participant ANOVA on the intention to connect with others revealed a significant main effect of power, $F(1,114) = 12.34$, $p < .05$, $\eta^2_p = .04$. "

This sentence tells us what analysis they did, the DV, and that there was a reliable main effect of power condition.

Reading Interaction Results

- From Naranyana et al (2013) Study 3

"Consistent with our prediction … the high power group (M = 7.52, SD = 2.34) displayed a greater intention to connect with others than the low power group (M = 6.68, SD = 2.16), t(113) = 2.01, p = .05. "

This sentence tells us the means and SD of each power condition, and that they followed up the overall F test with a test that compared the high power condition with the other two conditions together.

Reading Interaction Results

- From Naranyana et al (2013) Study 3

"There was no main effect of social feedback, F (1,114) = .84, p = .36."

This sentence tells us that there was no main effect of social feedback. Even effects that are not reliable ("significant") have to be reported.

Naranyanan et al (2013) Stud y 3Results cont'd

" Social feedback moderated the effect of power on intention to connect, $F(1,115) = 3.99$, $p < .05$, $\eta^2_p = .03$, such that power led to a greater intention to connect only when participants were excluded."

This sentence tells us there IS an interaction, and its form.

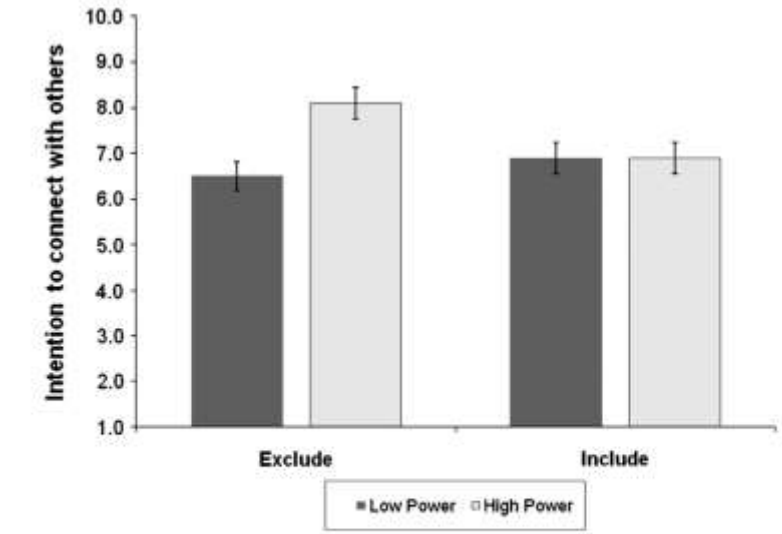
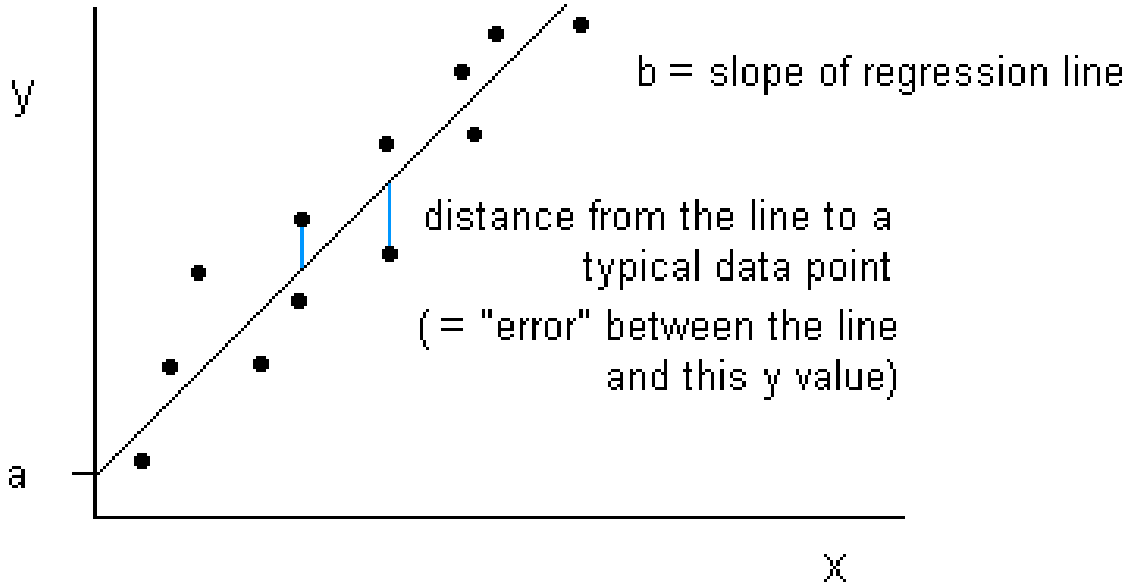


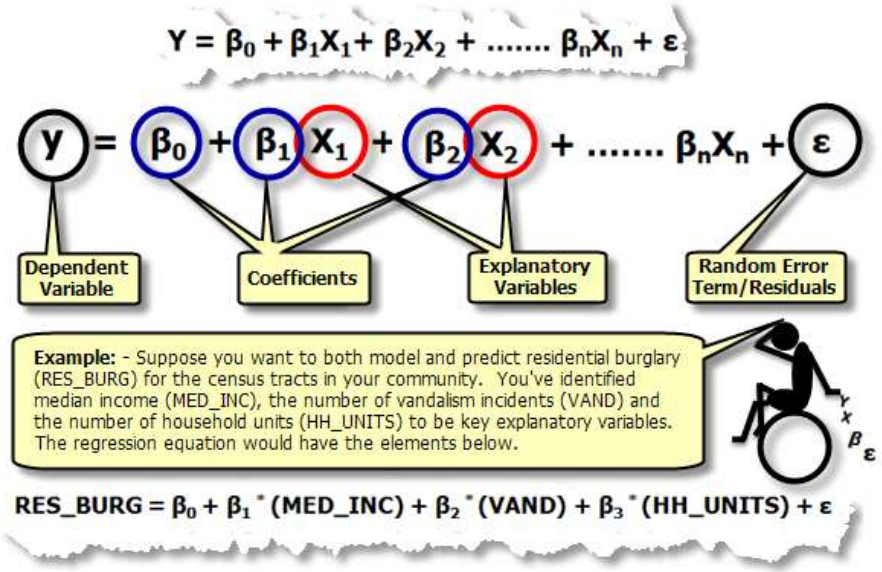
Fig. 2. Results from Study 3: Mean score on intention to connect with others in respective social feedback conditions (exclude, include). Error bars indicate standard errors of the means.

Regression

- Simple Linear
  - What's the relationship between one IV and one DV?
    - As the name implies, assumes a linear relationship between variables. The DV has to be continuous. The IV could be dichotomous or continuous
    - Examples: DV: how warm do you feel towards Democrats from 1 to 10? IV: Are you a Republican or not? IV: How warm do you feel towards Republicans from 1 to 10?
    - Beta, R^2
- Multiple Linear
  - What's the relationship between 2+ IVs and one DV?
- Logistic
  - DV is categorical, so a log transform must be utilized
    - Example: Are you Democrat, Republican, Green, Working Families, independent, unregistered?



When reading articles, the authors may explain their models like this:



Reading Results: Regression

- Constant is the mean.
- Each predictor variable will have an estimated weight, known as B or β.
- There is a t-test for each β that tests whether it differs reliably from 0.
- β can be positive or negative. β close to zero means there is no relation between X and Y.
- R^2 indicates how much variance in the outcome variable was accounted for by the whole set of predictor variables.

Other Helpful Resources

- These resources are easy to navigate and explain both simple and complex statistical concepts well. They may not use examples relevant to this course, but if you're having trouble deciphering results or want to know more about experimental/analytical methods check these out!

- UCLA stats help page (http://www.ats.ucla.edu/stat/)
- Wolfram Alpha (https://www.wolframalpha.com/examples/Statistics.html)
- Texas A&M Stats

(http://bobhall.tamu.edu/FiniteMath/Module8/Introduction.html)

- Laerd Stats

(https://statistics.laerd.com/spss-tutorials/independent-t-test-using-spss-statistics.php) *click around to navigate to another test—there was not a homepage to link to*

Mediation: Checking a set of regressions

- Mediation
  - One variable explains the relationship between two other variables
    - E.g., Stress → **Rumination** → Depression
- To test this, you have to measure all 3 variables in the same people.
- It could be a correlational design, or an experimental design with two measured variables.

Mediation with a non-expt

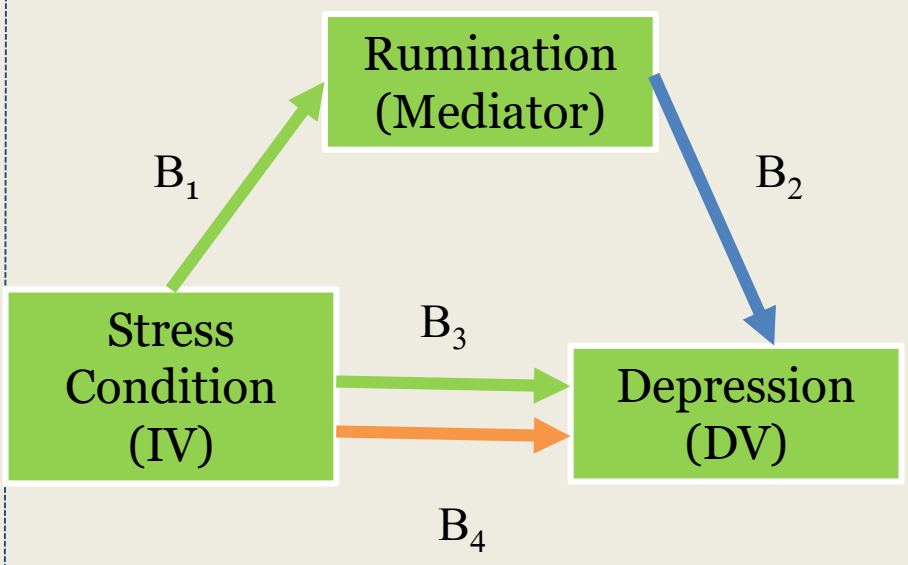
- Correlational design
- Measure self-reported levels of stress, self-reported rumination, and depression symptoms.
- Conduct 3 regressions on the data.

1. Stress predicts Rumination
2. Rumination predictions Depression
3. Stress predicts Depression
4. Stress and Rumination predict Depression

- Mediation is demonstrated if the B for Stress is smaller in Eqn 4 than Eqn 3, but the weights for Eqn 1 and 2 are non-zero.

Mediation in an Experiment

- Manipulate Stress as the IV (say, low, high)
- Measure rumination after
- Measure depression after.
- Tests with 4 regression equations again.



Mediation vs. Moderation

- Mediation
  - One variable explains the relationship between two other variables
    - E.g., Stress → **Rumination** → Depression
- Moderated Mediation
  - In moderation, one variable affects the strength of the relationship between two other variables
    - Suppose the results look like this:
    - Stress → Rumination→ Depression for women
    - Stress does not make for more rumination for men.
      - **Gender** moderates the strength relationship between rumination and depression, so it's the moderator of the mediation (Stress → Rumination→ Depression)