How to Choose the Right Statistical Test

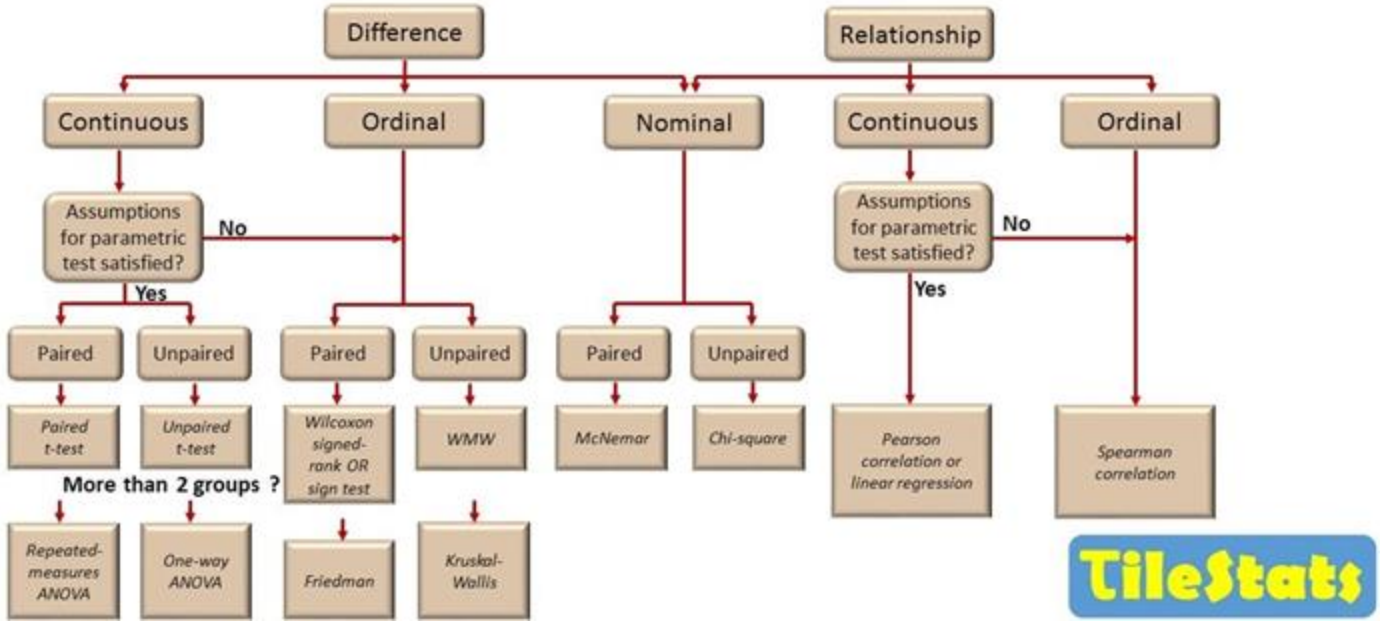
Christian Stephens

American Psychology-Law Society

Graduate Student Committee

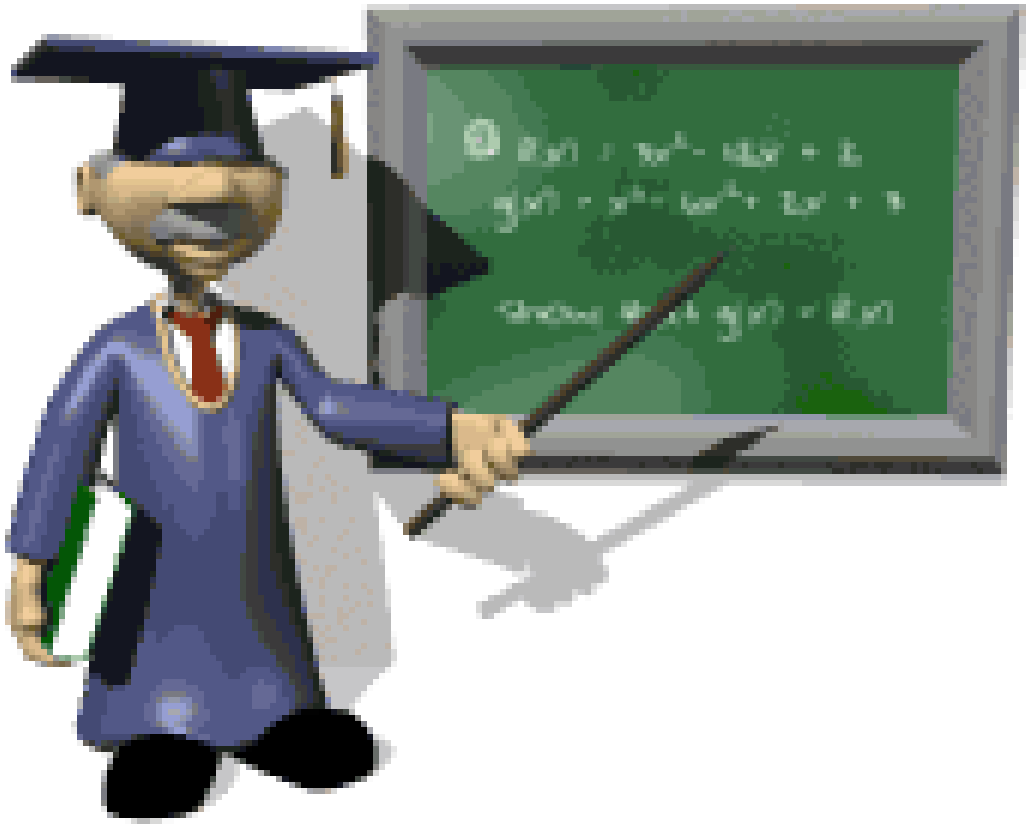
Agenda

- Setting Expectations
- Three Main Questions
- Clarifying Variables
- Knowing What's Out There
- Example Tests & Questions
- Complex Model Examples
- Preregistration Notes
- Takeaways



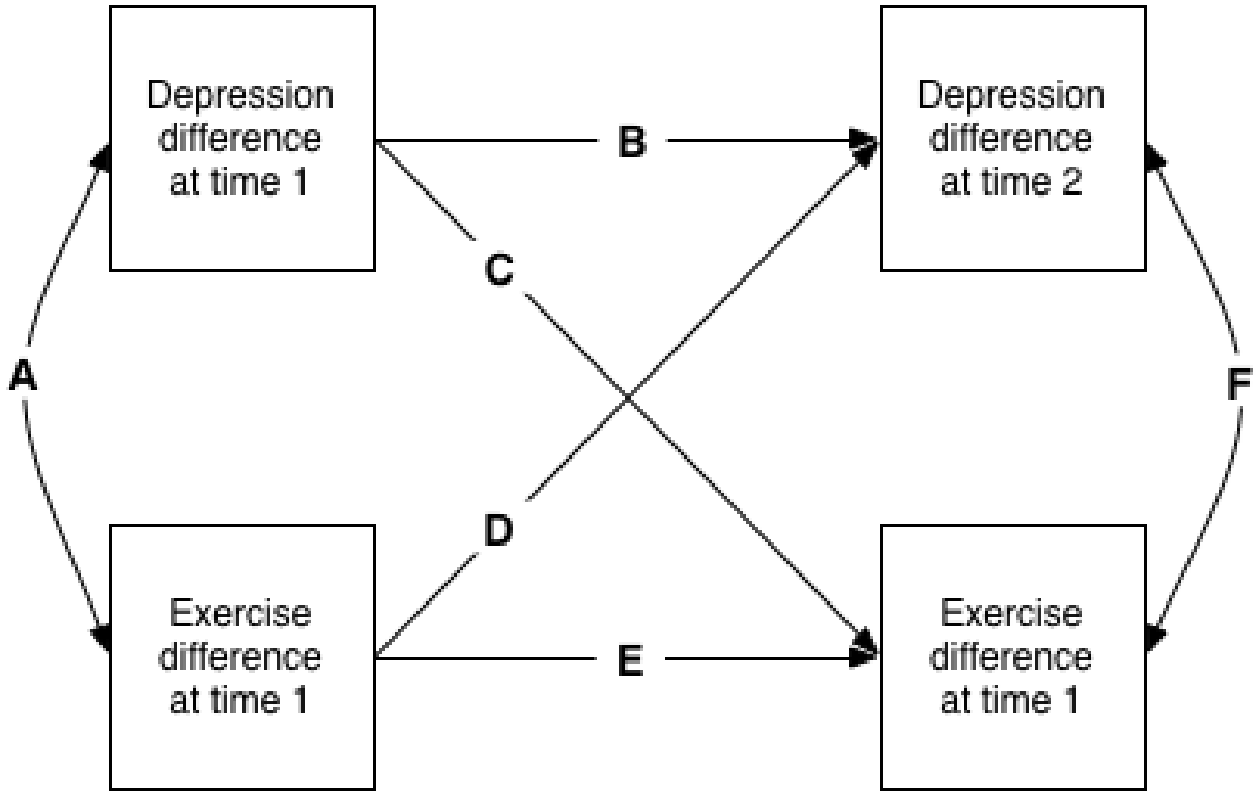
Setting Expectations

- Practice comes before mastery
- Choosing the right test comes down to identifying patterns, not memorizing everything
- If you have to try again later, it’s ok
- Even our professors make mistakes!



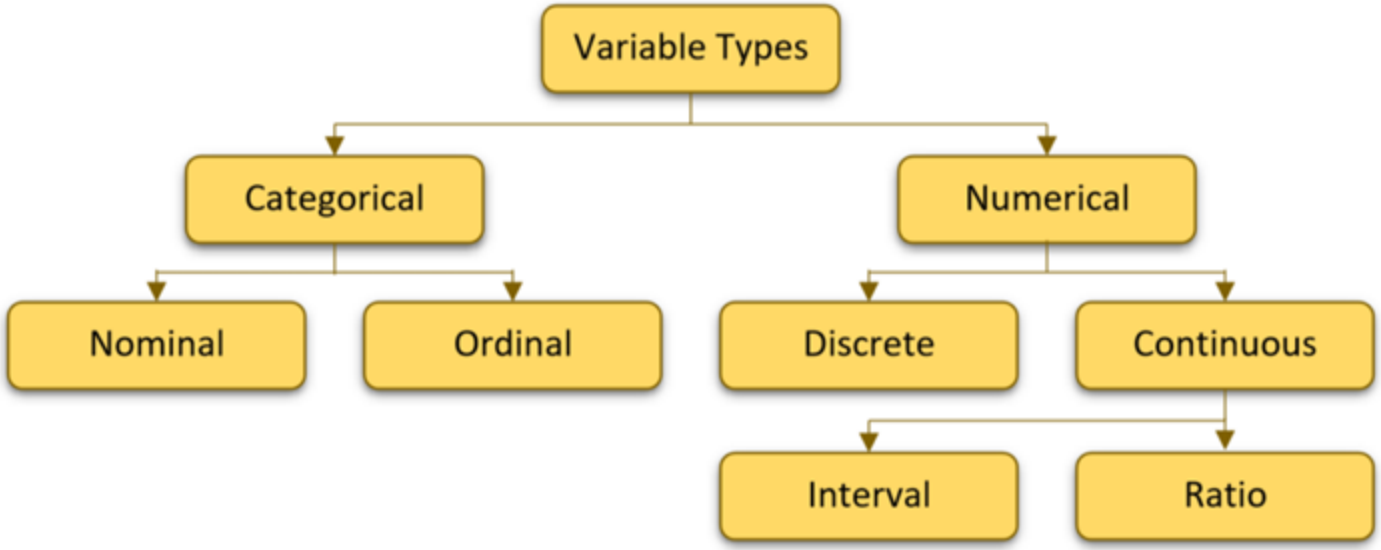
Three Main Questions

- What is your research question?
  - It is comparing **differences**, establishing **relationships**, or **predicting** variables?



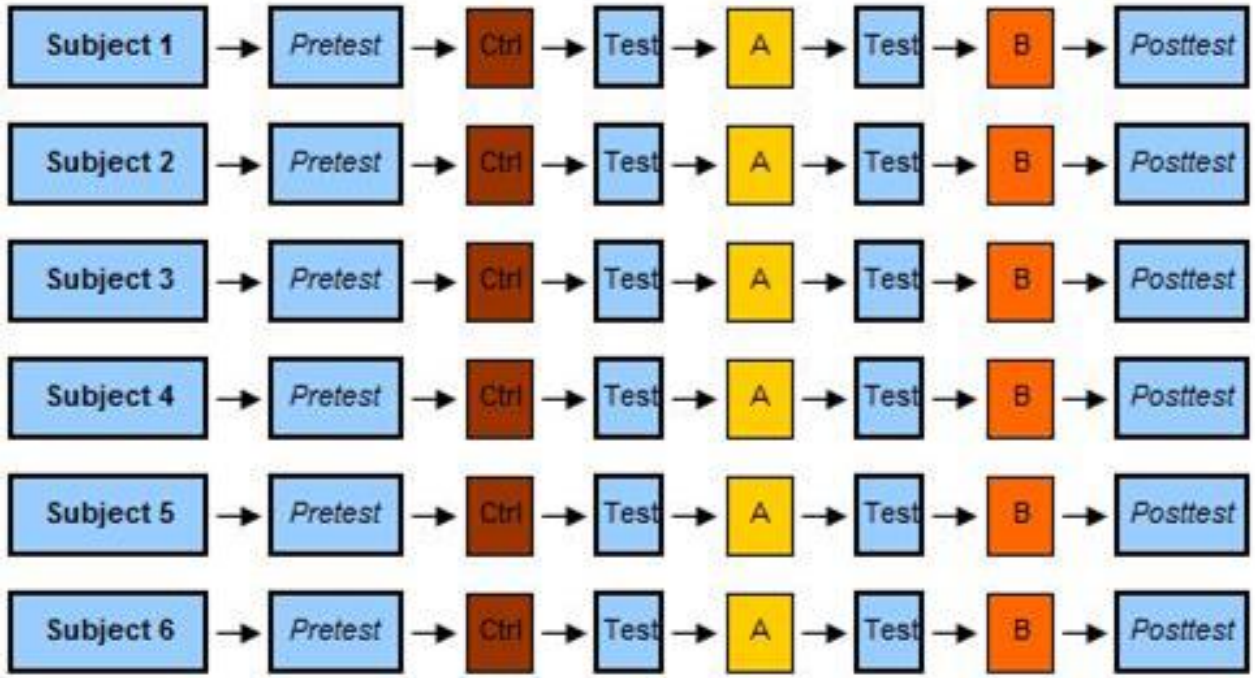
Three Main Questions

- What type of variables do you have?
  - Are they **categorized** by groups or **continuous** numbers?



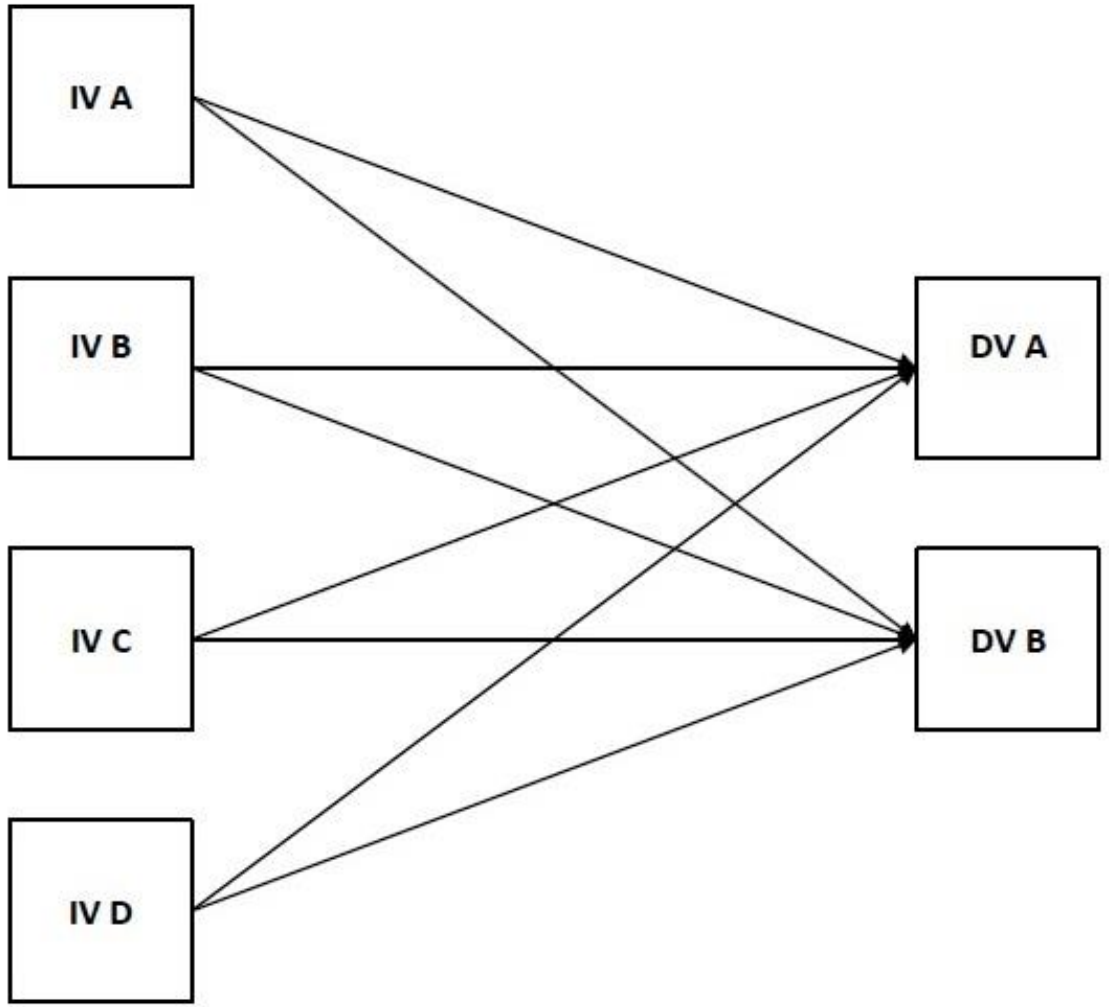
Three Main Questions

- How many groups/conditions are being compared?
  - Do these groups contain **repeat** participants or are they **independent** measurements?



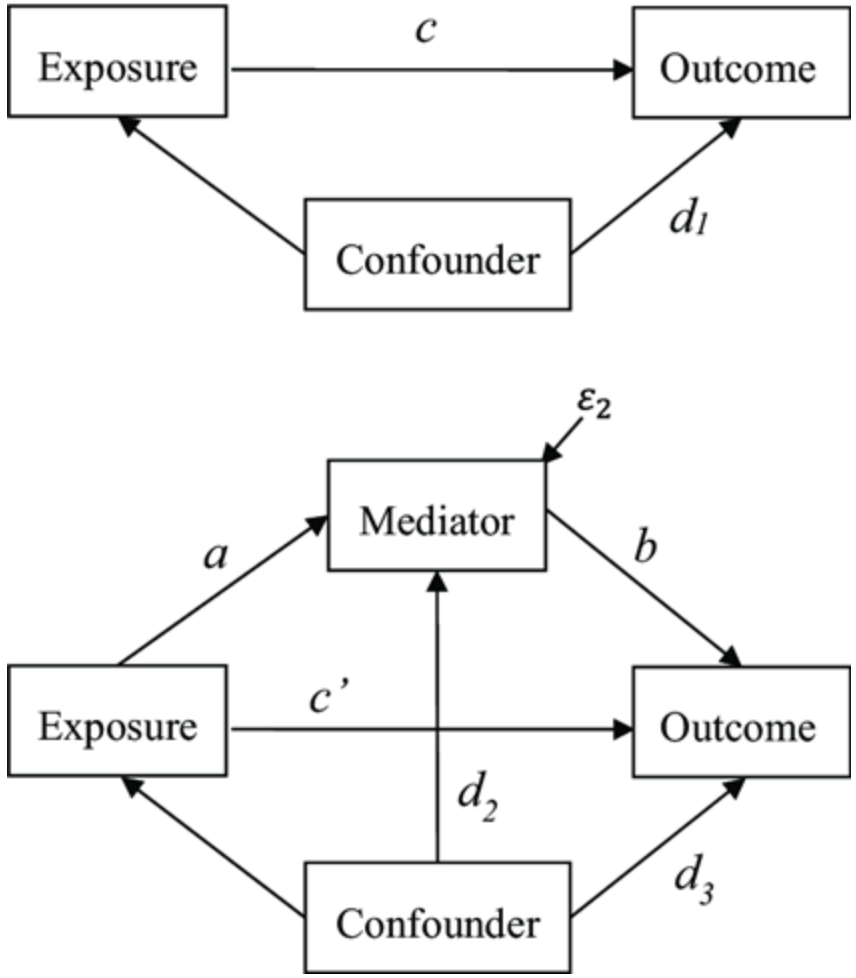
Clarifying Variables

- Independent variables
  - Are there multiple?
  - Are they all the same type (e.g., categorical and/or continuous?)
- Dependent variables
  - Are there multiple?
  - Are they all the same type?



Clarifying Variables

- Any…
  - controls/covariates?
  - mediators/moderators?
  - interaction terms?
- Keep statistical power in mind…



Knowing What's Out There

- The following resources are great for determining what approach you should take next
- Many also provide code and explanations for how to interpret your findings
- Check the following slides for links to each!

Statistical Test Selector

Work through the steps below to select the appropriate statistical test for your research. If we do not have a study design that matches your own, contact us.

STEP ONE
STUDY DESIGN

STEP ONE
Choose your study design

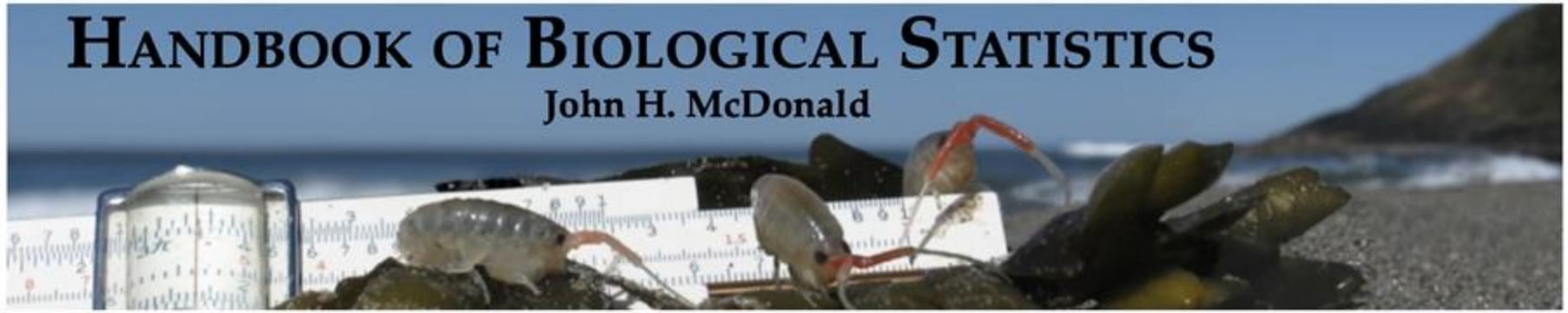
Select

CONTINUE

CHOOSING THE CORRECT STATISTICAL TEST IN SAS, STATA, SPSS AND R

The following table shows general guidelines for choosing a statistical analysis. We emphasize that these are general guidelines and should not be construed as hard and fast rules. Usually your data could be analyzed in multiple ways, each of which could yield legitimate answers. The table below covers a number of common analyses and helps you choose among them based on the number of dependent variables (sometimes referred to as outcome variables), the nature of your independent variables (sometimes referred to as predictors). You also want to consider the nature of your dependent variable, namely whether it is an interval variable, ordinal or categorical variable, and whether it is normally distributed (see What is the difference between categorical, ordinal and interval variables? for more information on this). The table then shows one or more statistical tests commonly used given these types of variables (but not necessarily the only type of test that could be used) and links showing how to do such tests using SAS, Stata and SPSS.

Number of Dependent Variables	Nature of Independent Variables	Nature of Dependent Variable(s)*	Test(s)	How to SAS	How to Stata	How to SPSS	How to R
1	0 IVs (1 population)	interval & normal	one-sample t-test	SAS	Stata	SPSS	R
		ordinal or interval	one-sample median	SAS	Stata	SPSS	R
		categorical (2 categories)	binomial test	SAS	Stata	SPSS	R
		categorical	Chi-square goodness-of-fit	SAS	Stata	SPSS	R
	1 IV with 2 levels (independent groups)	interval & normal	2 independent sample t-test	SAS	Stata	SPSS	R
		ordinal or interval	Wilcoxon-Mann Whitney test	SAS	Stata	SPSS	R
		categorical	Chi-square test	SAS	Stata	SPSS	R



⇐ Previous topic |

Choosing a statistical test

This table is designed to help you decide which statistical test or descriptive statistic is appropriate for your experiment. In order to use it, you must be able to identify all the variables in the data set and tell what kind of variables they are.

test	nominal variables	measurement variables	ranked variables	purpose	notes	example
Exact test for goodness-of-fit	1	–	–	test fit of observed frequencies to expected frequencies	use for small sample sizes (less than 1000)	count the number of red, pink and white flowers in a genetic cross, test fit to expected 1:2:1 ratio, total sample <1000
Chi-square test of goodness-of-fit	1	–	–	test fit of observed frequencies to expected frequencies	use for large sample sizes (greater than 1000)	count the number of red, pink and white flowers in a genetic cross, test fit to expected 1:2:1 ratio, total sample >1000
G–test of goodness-of-fit	1	–	–	test fit of observed frequencies to expected frequencies	used for large sample sizes (greater than 1000)	count the number of red, pink and white flowers in a genetic cross, test fit to expected 1:2:1 ratio, total sample >1000
Repeated G–tests of goodness-of-fit	2	–	–	test fit of observed frequencies to expected frequencies in multiple experiments	-	count the number of red, pink and white flowers in a genetic cross, test fit to expected 1:2:1 ratio, do multiple crosses

Two-way anova

Summary

Use two-way anova when you have one measurement variable and two nominal variables, and each value of one nominal variable is found in combination with each value of the other nominal variable. It tests three null hypotheses: that the means of the measurement variable are equal for different values of the first nominal variable; that the means are equal for different values of the second nominal variable; and that there is no interaction (the effects of one nominal variable don't depend on the value of the other nominal variable).

When to use it

You use a two-way anova (also known as a factorial anova, with two factors) when you have one measurement variable and two nominal variables. The nominal variables (often called "factors" or "main effects") are found in all possible combinations.

For example, here's some data I collected on the enzyme activity of mannose-6-phosphate isomerase (MPI) and MPI genotypes in the amphipod crustacean *Platorchestia platensis*. Because I didn't know whether sex also affected MPI activity, I separated the amphipods by sex.

Genotype	Female	Male
FF	2.838	1.884
	4.216	2.283
	2.889	4.939
	4.198	3.486
FS	3.55	2.396
	4.556	2.956
	3.087	3.105
	1.943	2.649
SS	3.620	2.801
	3.079	3.421
	3.586	4.275
	2.669	3.110

Unlike a nested anova, each grouping extends across the other grouping: each genotype contains some males and some females, and each sex contains all three genotypes.

A two-way anova is usually done with replication (more than one observation for each combination of the nominal variables). For our amphipods, a two-way anova with replication means there are more than one male and more than one female of each genotype. You can also do two-way anova without replication (only one observation for each combination of the nominal variables), but this is less informative (you can't test the interaction term) and requires you to assume that there is

An R Companion for the Handbook of Biological Statistics

Salvatore S. Mangiafico

Contents

Two-way Anova

Examples in *Summary and Analysis of Extension Program Evaluation*

SAEPER: Two-way ANOVA
SAEPER: Using Random Effects in Models
SAEPER: What are Least Square Means?

Packages used in this chapter

The following commands will install these packages if they are not already installed:

```
if(!require(FSA)){install.packages("FSA")}
if(!require(ggplot2)){install.packages("ggplot2")}
if(!require(car)){install.packages("car")}
if(!require(multcompView)){install.packages("multcompView")}
if(!require(lsmeans)){install.packages("lsmeans")}
if(!require(grid)){install.packages("grid")}
if(!require(nlme)){install.packages("nlme")}
if(!require(lme4)){install.packages("lme4")}
if(!require(lmerTest)){install.packages("lmerTest")} if(!require(rcompanion)){install.packages("rcompanion")}
```

When to use it
Null hypotheses
How the test works
Assumptions

See the *Handbook* for information on these topics.

Examples

The rattlesnake example is shown at the end of the "How to do the test" section.

How to do the test

For notes on linear models and conducting anova, see the "How to do the test" section in the *One-way anova* chapter of this book. For two-way anova with robust regression, see the chapter on *Two-way Anova with Robust Estimation*.

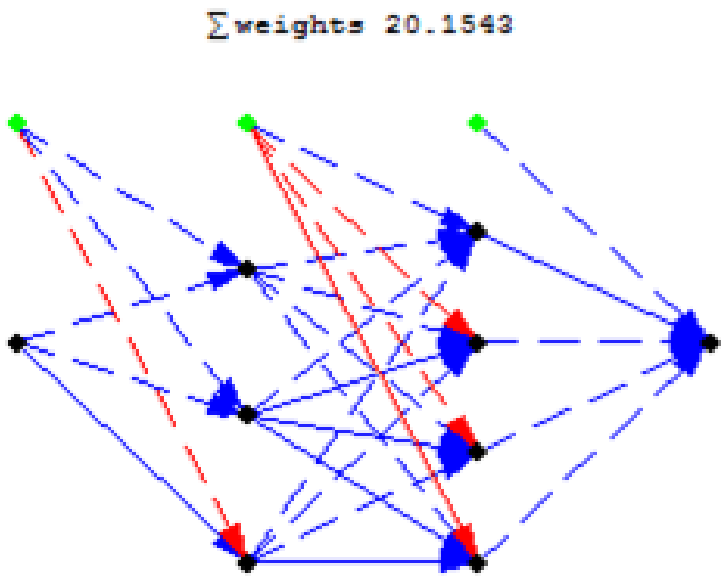
Example Tests & Questions

- Effect of 3 types of therapy on anxiety scores
- 1 categorical IV (3 groups), 1 continuous DV
- One-way ANOVA
- Why?
  - Comparing a **single continuous** outcome variable across **three independent categorical** groups

Example Tests & Questions

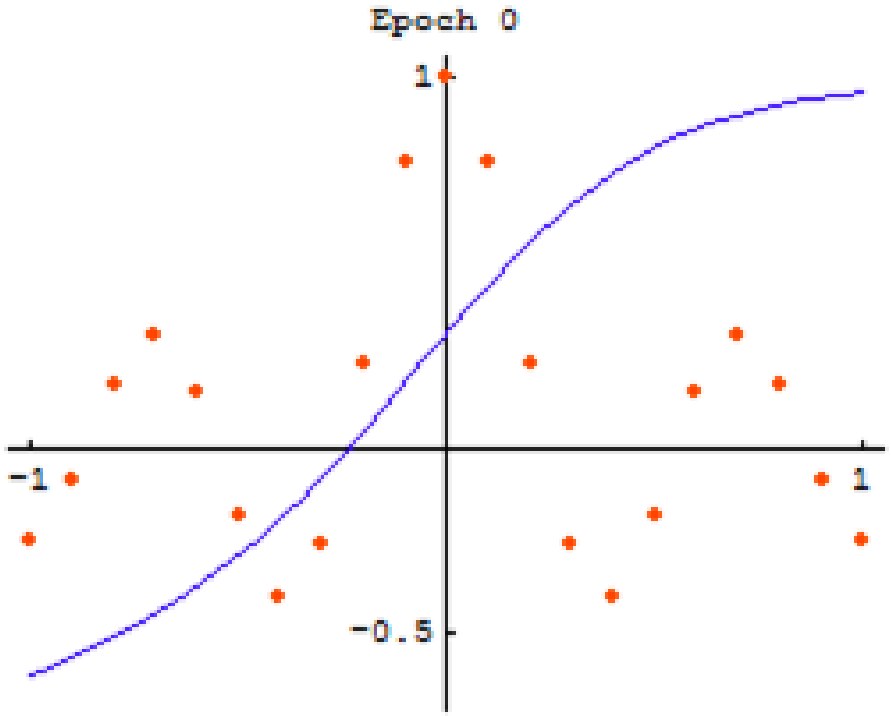
- Measuring mood change before and after a mindfulness activity
- One group, repeated measure
- Paired samples t-test
- Why?
  - Comparing **the same group**'s mood scores at **two different times**, making the measurements dependent

Complex Models



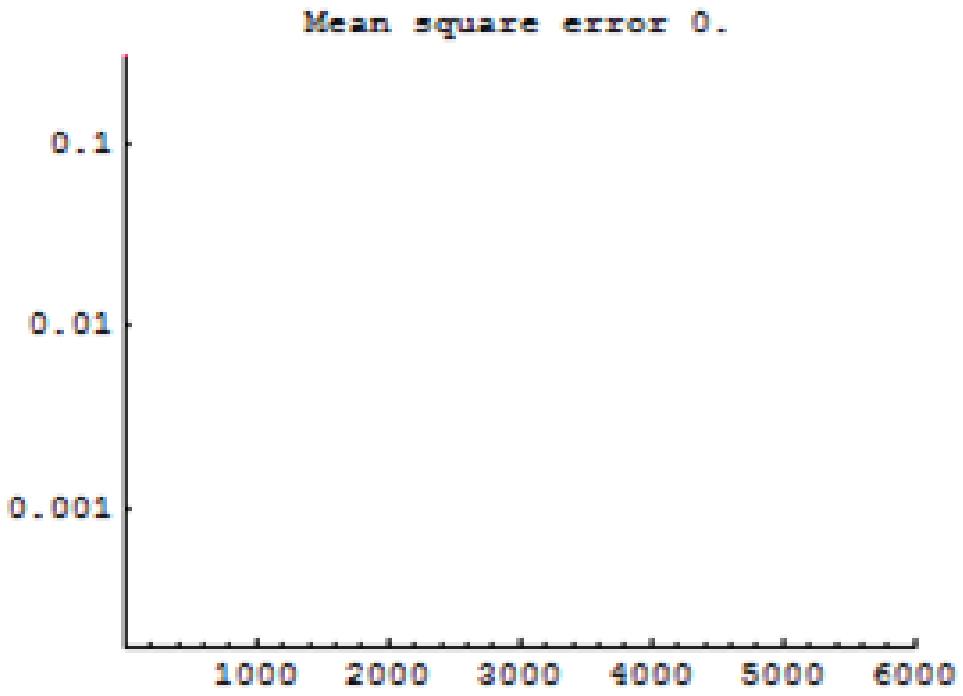
- Multiple predictors influencing one outcome
- ANOVA tests only one predictor
- Multiple regression / hierarchical regression
- Why?
  - Examine the effects of **several predictor** variables on a **single continuous** outcome while **controlling** for the influence of other predictors

Complex Models



- Nonlinear or categorical outcomes
- Linear regression assumes outcomes are continuous and normally distributed
- Logistic regression / poisson regression / generalized linear models
- Why?
  - Extend regression to handle **non-continuous** outcomes such as **binary categories, counts**, or other **distributions**

Complex Models



- Mediating or moderating effects
- Correlation and regression don’t account for these mechanisms
- Path analysis / PROCESS macro / SEM
- Why?
  - Specifically designed to model indirect effects through **mediators** and conditional effects through **moderators**

Preregistration Notes

- Common procedure your PI may recommend you complete
- What you list here may change, and that's okay
- Just be able to defend why the change was necessary

Takeaways

- Determine a few aspects of your proposed design
- Refer to useful resources regarding recommended approaches
- Double check if your test aligns with your study design before launching

Questions?

Email me: cgsteph@iastate.edu

Feel free to refer to these slides for future reference!