Research Manual

COMPLETE MANUAL

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3/7/13

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INTRODUCTION

This manual is not to substitute any statistics or research methods books or courses that may have been completed in the past. The purpose is to provide a quick reference for students to use to quickly complete a research project when a short review is necessary. It is not a complete reference of all statistical tests or research methods. The manual is written in a broad step-by-step manner as it reviews some of the most common topics in designing studies and the most common statistical tests that you will see while working in the lab.

RESEARCH DESIGNS

It is important to think about validity and reliability when designing your study. This will impact how they will be able to be generalized to the population.

Validity-How likely the measure you are using actually measures your dependent variable.

Reliability-How likely the measure you are using measures the dependent variable consistently (does it measure it each time).

The type of research project you are doing will depict the design you will use:

Within subjects-Used when the researcher is interested in determining whether or not one condition is better than another and is dependent upon having the same participants in both conditions. An example could be determining whether website A is more efficient than website B.

Between subjects-Used when the researcher is interested in determining whether or not one condition is better than another. An example could be determining whether using PowerPoint presentations help students get better grades compared to overhead projections.

Counterbalancing-The practice of randomizing the order of condition for participants (see Tables 1 and 2).

Table 1. Counterbalancing for within subjects design

Participant #	First Condition	Second Condition
1	A	B
2	B	A
3	A	B
4	B	A

Table 2. Counterbalancing for between subjects design

Participant #	Condition
1	A
2	B
3	A
4	B

STATISTICAL ANAYLSIS

When performing research it is essential that you are able to make sense of your data. This allows you to inform other researchers in your field and others what you have found. It also can be used to help build evidence for a theory. Therefore an understanding of what test to use and when is necessary. There are some good practices to do if you are not familiar with performing statistical analysis. The first is to determine your variables.

Overview of basic statistics

Dependent variable (DV)-This is the one that you are measuring. From the example of the student's score.

Independent variable (IV)-This is the one that you are manipulating with the different conditions. From the example either PowerPoint or overhead projector presentation.

Levels of Measurement

Once this has been done you will want to determine the level of measurement that both variables are. This will help you later determine what test to use in your analysis. There are four levels of measurement:

Interval-These have equal numbers (i.e. Number of pets).

Ratio-There is no real zero and there are intervals between whole numbers (i.e. Birth weight).

Nominal-Simply naming categories (i.e. Male/Female).

Ordinal-Simply ordering (i.e.1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree).

Finally, you will have the information needed to determine what test you need to use. Until you get familiar with doing statistical analysis, it is good practice to keep track of this information (see Table 3).

Table 3. Variable, level of measurement and number of IV's

DV	Level of Measurement	IV	Number of IV's (conditions)
Grades	Ratio (there are intervals between 80% and 90%)	Presentation type	2 (PowerPoint/Overhead projection)

With this information you can refer to the following chart to determine what statistical test to use. First determine whether the study is within or between subjects, then the number of groups, then the level of measurement (see Figure 1).

Type of design?

Between-subjects Design
- Parametric Variable(s): Ratio/Interval
  - 2 Conditions → Independent samples t-test
  - <2 Conditions → Between-subjects ANOVA
- Nonparametric Variable(s): Ordinal/Nominal
  - 2 Conditions
    - Ordinal Variable(s) → Mann-Whitney test
    - Nomical Variable(s) → Chi square
  - <2 Conditions
    - Ordinal Variable(s) → Kruskal-Wallis test
    - Nomical Variable(s) → Chi square

Within-subjects Design
- Parametric Variable(s): Ratio/Interval
  - 2 Conditions → Dependent samples t-test
  - <2 Conditions → Within-subjects ANOVA
- Nonparametric Variable(s): Ordinal/Nomial
  - 2 Conditions
    - Ordinal Variable(s) → Wilcoxon test
    - Nominal Variable(s) → No test
  - <2 Conditions
    - Ordinal Variable(s) → Friedman's test
    - Nominal Variable(s) → No test

Comparing sample mean to a known mean → Single samples t-test

Making Predictions
- Using 1 vriable → Simple Regression
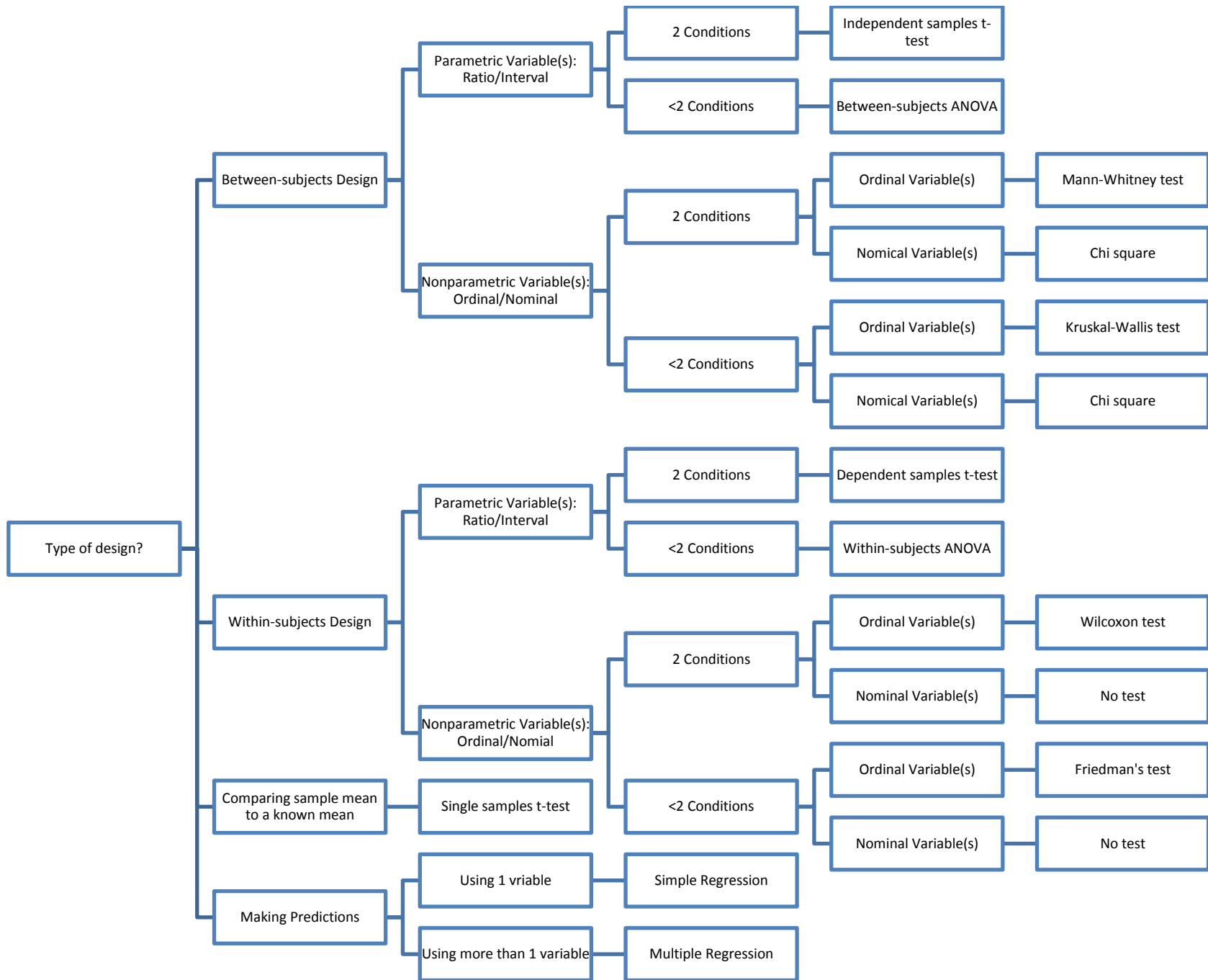- Using more than 1 variable → Multiple Regression

Figure 1. Chart of tests by design, number of conditions, and level of measurement

Statistical Tests can be broken into two groups, parametric and nonparametric and are determined by the level of measurement. Parametric tests are used to analyze interval and ratio data and nonparametric tests analyze ordinal and nominal data. There are different tests to use in each group. We will start with the parametric tests first.

<div align="center">**Parametric Tests**: (Interval/Ratio data)</div>

These tests assume that the data is normally distributed (bell curve) and are very strong when compared to nonparametric tests.

Within Subject Design

    1. **Dependent samples t-test**: Compares means of two groups. An example is determining if PowerPoint or an overhead projection impact grades.

    2. **Within subjects ANOVA**: Compares means of more than two groups. An example is determining if PowerPoint, overhead projection, and podcast impacted grades and if so which one.

Between Subject Design

    1. **Independent samples t-test**: Compares means of two groups. An example is determining if a PowerPoint presentation impacted grades compared to a control group.

    2. **Between subjects ANOVA**: Compares means of more than two groups. An example is determining if PowerPoint or an overhead projector impacted grades and if so which one.

    3. **Pearson Correlation**: Determines if there is a relationship between two variables. It also determines the strength of the relationship, if one exists.

The correlation coefficient ranges from -1.0 to 1.0. The closer to -1.0 or 1.0, the stronger the relationship. When r is negative that means there is a negative relationship (one variable goes up/down the other does the opposite). When r is positive that means there is a positive relationship (one variable goes up or down so does the other). See the example below examining the correlation between texts sent per week and grades. Another way to determine the relationship and strength is to look at the graph. The closer the data points are to the line, the stronger the relationship (see Figure 2).

Caution: a strong correlation does not mean that a condition caused the outcome. It only means that the two variables are related in some way.
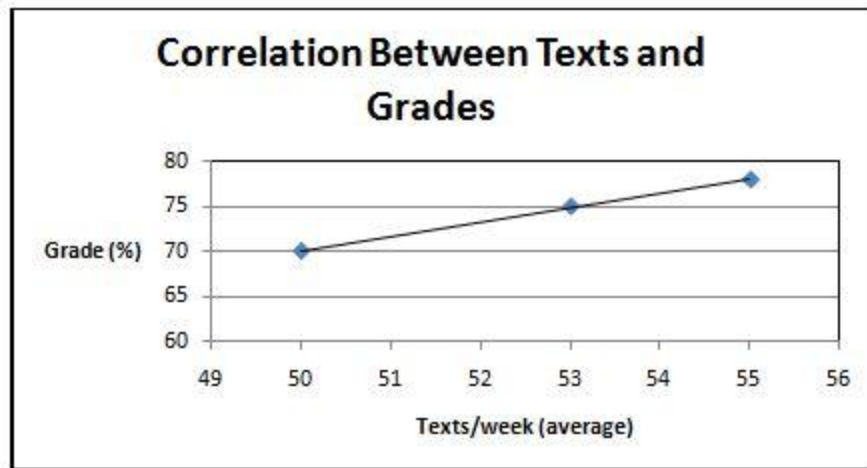
Figure 2. Graph of texts vs. grade correlation

Nonparametric Tests: (Ordinal/Nominal data)

These tests do not assume anything about the shape of the data. These tests are not as strong as the parametric ones.

Within Subject Design

1. **Wilcoxon**: This is the nonparametric version of the dependent samples t-test as it compares the difference of ranks for groups of two with **ONLY** ordinal data. An example is determining participant's ranking for visual preference between two iPad game apps.

2. **Friedman**: This is the nonparametric version of the within subjects ANOVA as it compares ranks for groups of more than two with **ONLY** ordinal data. An example is determining the rank of three different websites based on user friendliness.

Between Subject Design

1. **Chi square**: Compares ranks for both two group and more than two group designs with ONLY nominal data.

A. Chi square (Goodness of Fit)-Compares the proportion of the sample to an already existing value. An example would be comparing literacy rates in central Missouri against those of the entire state.

B. Chi square (Test of Independence)-Compares the proportions of two variables to see if they are related or not. An example would be are there similar numbers of baseball and softball athletes enrolled in this semester's general psychology course.

2. **Kruskall-Wallis**: This is the nonparametric version of the between subjects ANOVA as it sees if multiple samples are from the same population. An example is determining how participants rate a physician based on whether he/she used a computer, book, or no assistance in diagnosing them.

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3. **Mann-Whitney**: This is the nonparametric version of the independent samples t-test as it compares ranks for groups of more than two with **ONLY** ordinal data. An example would be determining if eating Snickers candy bars affects student's grades in math courses.

4. **Correlations**:

   A. Spearman's Rho: Like the Pearson correlation, this test too determines the strength of the relationship between two variables based on their ranks. An example would be to determine the relationship between physics and English course grades.

Comparing Means

Sometimes a researcher will want to compare the mean of a sample against an already known population. An example would be comparing the ACT scores of students in one state against that of the entire country. In such a case, a z-test would need to be conducted

Prediction

In some cases, a researcher may want to use one or more variables to predict another variable. In this case, the researcher would use a regression.

1. **Simple Regression**: This is when one known variable is used to predict the value of another variable. An example would be using a student's GRE scores to predict their graduate school GPA.

2. **Multiple Regression**: This is when more than one variable is used to predict the value of another variable. An example would be temperature, wind speed, and humidity to predict the amount of precipitation that will fall.

Hypothesis and Error Types

In research there are two main hypotheses:

1. **Null hypothesis**: This states that there is NO statistical significance between the groups.

2. **Alternative hypothesis**: This states that there IS a statistical significance between the groups.

No matter how well a study is designed there is always the probability that chance is what caused the results, not the different treatments. When a researcher accepts results that are not accurate it is called an error . There are two main types of error:

1. **Type I error**: The alternative hypothesis is rejected when the null hypothesis is actually true.

2. **Type II error**: The null is accepted when in fact the alternative hypothesis is true. (see Table 4).

Table 4. Rejected/accepted the null when it was either true/false

	True	**False**
Accepted Null	Type I	Good decision
Rejected Null	Good decision	Type II

USING SPSS FOR DATA ANALYSIS

Before you start running participants it is important to set up your data collection sheets. There are a lot of different ways to do a statistical analysis, but in our lab we have SPSS which does a lot of work for you (see Figure 3).

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	Group	Numeric	8	2		(1.00, No Ai...	None	8	Right	Scale
2	Thoroughness	Numeric	8	2		(-3.00, Extr...	None	8	Right	Ordinal
3	Wait	Numeric	8	2		(-3.00, Very...	None	8	Right	Ordinal
4	DiagnosticC...	Numeric	8	2		(-3.00, Very...	None	8	Right	Ordinal
5	Professional...	Numeric	8	2		(-3.00, Extr...	None	8	Right	Ordinal
6	Satisfaction	Numeric	8	2		(-3.00, Extr...	None	8	Right	Ordinal
7	Liability	Numeric	8	2		(-3.00, Extr...	None	8	Right	Ordinal
8	Age	Numeric	8	2		None	None	8	Right	Scale
9	Gender	Numeric	8	2		None	None	8	Right	Nominal

Figure 3. SPSS allows you to set up your spreadsheet by naming variables and also determining the level of measurement. Taken from SPSS.

It is set up similar to an excel spreadsheet in that the DV's you are examining are across the top (see Figure 4).

	Group	Thoroughness	Wait	DiagnosticCa pabilities	Professionali sm	Satisfaction	Liability	Age	Gender
1	1.00	1.00	-1.00	-1.00	2.00	-2.00	-3.00	19.00	2.00
2	2.00	-1.00	3.00	-3.00	3.00	-2.00	3.00	19.00	2.00
3	3.00	2.00	1.00	2.00	2.00	2.00	1.00	18.00	1.00
4	1.00	-2.00	.00	2.00	2.00	2.00	.00	29.00	2.00
5	2.00	2.00	1.00	1.00	2.00	2.00	-1.00	18.00	2.00

Figure 4. Once your spreadsheet is set up in SPSS you can view it and model your excel spreadsheet after it. Taken from SPSS.

It is good practice to set up both your SPSS spreadsheet and your excel spreadsheet to be the same (see Figure 5). This will allow you to copy and paste your data into SPSS for quick statistical analysis.

	A	B	C	D	E	F	G	H	I
1	Group	Thorough	Wait	Diagnosti	Professio	Satisfact	Liability	Age	Gender
2	1	1	-1	-1	2	-2	-3	19	2
3	2	-1	3	-3	3	-2	3	19	2
4	3	2	1	2	2	2	1	18	1
5	1	-2	0	2	2	2	0	29	2
6	2	2	1	1	2	2	-1	18	2

Figure 5. Model your excel spreadsheet after the one in SPSS. You can simply copy and paste your data into SPSS and quickly perform your analysis.

RESOURCES

The following are some additional resources that you may find useful in addition to this manual:

Research Methods Resource:

Heiman, G. (2001). Research Methods in Psychology (3rd ed.). Cengage Learning.

SPSS and Statistics Resource:

Cronk, B. (2011). How to use SPSS (7th ed.). Pyrczak.

Statistics Resource:

Aron, A., Aron, E., & Coups, E. (2005). Statistics for Psychology (4th ed.).Pearson.