

**Mean Tests &  $X^2$**   
**Parametric vs Nonparametric**  
**Errors**  
**Selection of a Statistical Test**

SW242

# Creation & Description of a Data Set

- \* 4 Levels of Measurement
  - \* Nominal, ordinal, interval, ratio
- \* Variable Types
  - \* Independent Variables, Dependent Variables
  - \* Moderator variables
  - \* Discrete Variables
    - \* Finite answers, limited by measurement e.g. test scores,
  - \* Continuous variables
    - \* All values possible (GPA not exceed 5.0)
  - \* Dichotomous variable
    - \* Only 2 values, yes or no, male or female
  - \* Binary variable
    - \* Assign a 0 (yes) or 1 (no) to indicate presence or absence of something
  - \* Dummy variable
    - \* Assign a binary value to a dichotomous value for analytic purposes (e.g. male = '0', female = '1').

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# Categories of Analysis

## Number of Variables Analyzed

### Univariate analyses

- \* Examine the distribution of value categories (nominal/ordinal) or values (interval or ratio)

### Bivariate analyses

- \* Examine relationship between 2 variables

### Multivariate analyses

- \* Simultaneously examine the relationship among 3 or more variables

# Purpose of Analysis

## Descriptive

- \* Summaries of population studied (parameters)
- \* Preliminary to further analysis

## Inferential

- \* Used with sample from total population and how well can results be generalized to total population

# Parametric vs. Non-parametric

- \* Parametric Tests require:
  - \* One variable (usually the DV) is at the interval or ratio level of measurement
  - \* DV is normally distributed in the population; independent samples should have equal or near equal variances
  - \* Cases selected independently (random selection or random assignment)
  - \* Robustness how many and which assumptions above can be violated without affecting the result (delineated in advanced texts).

# Parametric vs. Non-parametric

- \* Nonparametric Tests require nominal or ordinal level data
  - \* Samples compiled from different populations and we want to compare the distribution of a single variable within each of them
  - \* Variables are nominal or can only be rank ordered
  - \* Very small samples: 6 or 7 are available
  - \* Statistical power is low, increases with sample size (as with parametric tests)

# Creation & Description of a Data Set

- \* Frequency Distributions
  - \* Array is an arrangement of data from smallest to highest
  - \* Absolute/simple frequency distribution displays number of times a value occurs (all levels of measurement)
  - \* Cumulative frequency distribution adds cases together so that its last number in distribution is the total number of cases observed
  - \* Percentage distribution adds the percent of occurrence in the table
  - \* Cumulative Percentage

# Example of an Array

| Initial     | Age | Frequency | Cumulative<br>Frequency | %  | Cumulative<br>% |
|-------------|-----|-----------|-------------------------|----|-----------------|
| A + T       | 21  | 2         | 2                       | 10 | 10              |
| B+G+C       | 26  | 3         | 5                       | 15 | 25              |
| R+W+S       | 27  | 3         | 8                       | 15 | 40              |
| K+V+R<br>+D | 31  | 4         | 12                      | 20 | 60              |
| Q+F         | 32  | 2         | 14                      | 10 | 70              |
| S+O+P       | 37  | 3         | 17                      | 10 | 95              |
| M+A         | 49  | 2         | 19                      | 10 | 95              |
| B           | 69  | 1         | 20                      | 5  | 100             |

# Graphical Representations

- \* Bar Graph/Histogram (bars touch)
- \* Line Graph/Frequency Polygon
- \* Pie Chart
- \* Keep graphs simple.
  - \* Limit to only salient information.
  - \* Collapse categories/distributions when possible.

# Measures of Central Tendency

- \* Typical representation of data, e.g. find a number or groups of numbers that is most representative of a dataset
- \* **Mode**
  - \* Values within a dataset that occur most frequently, if two occur equally then bimodal distribution, etc.
- \* **Median**
  - \* The value in the exact middle of a linear array, mean between 2 values if even number of values.
- \* **Mean: arithmetic mean**
  - \* Trimmed mean (outliers removed) minimize effect of extreme outliers
  - \* Weighted mean: compute an average for values that are not equally weighted (proportionate / disproportionate sampling)

# Measures of Central Tendency

## \* **Variability/Dispersion**

- \* Nominal or Ordinal use a frequency distribution or graph (bar chart)
- \* Interval or ratio use range
- \*  $\text{Range} = \text{maximum value} - \text{minimum value} + 1$
- \* Informs about the number of values that exist between the ends of the distribution e.g. 31 to 46 there are potentially 16 values possible. The larger the range, the greater the variability. However, outliers make the range misleading. Therefore use median, or mean and standard deviation whenever possible for interval & ratio data.

# Chi Square Test of Independence

- \* Statistical significance of the Chi Square only tells us that the result is not due to sampling error.
  - \* Nominal variables only
  - \* Small group use

# Purpose of $\chi^2$ --- Chi-Square

1. Test the relationship of nominal Variables.
  - \* Not a statistic that can infer causality.
  - \* Tells us the difference between Observed and Expected frequencies.
  - \* Pre-Experimental research designs, limited practice issues.
    - Use for one direction hypothesis testing (directionality).
    - Chi Square only tells us that the result is not due to sampling error.

# Limitations & Common Problems

- \* Implying cause rather than association
- \* Overestimating the importance of a finding, especially with large sample sizes
- \* Failure to recognize spurious relationships
- \* Nominal variables only (both IV and DV)

# Mean Comparison Tests

- \* One Sample t-test
  - \* You have the test scores for one population only. Compare to a known value e.g. average non-clinical population test score = 30
  - \* Analyze
  - \* Research design for this type of comparison
    - \* Pre-experimental
    - \* Other uses: establish external validity of the sample not significantly different from the general population parameter (what is a population parameter?)

# Mean Comparison Tests (cont.)

- \* Independent Samples t-Test
  - \* 2 different samples/populations are tested for comparison
  - \* not matched, receive same treatment (if matched they would be paired sample t-test)
  - \* Prepare dataset all scores in one column, tx\_time = 2.
- \* Paired T-Test
  - \* Same populations is tested for comparison

# Measures of Association

- \* Squared Pearson product moment correlation tells the strength of a relationship which represents the amount of variation explained by the DV about the IV.
- \* Used for Comparing Two Interval/Ratio Groups
- \* Obtain a Correlation Coefficient that Ranges from -1 (perfect inverse relationship) 0 (no relationship) or +1 (perfect positive relationship)

# Errors

|   | Our Decision                                  |  |
|---|---|--|
| Real World  | Reject Null (-1)<br>Does work =<br>difference | Accept Null (1)<br>Doesn't work =<br>no difference |
| Null Hypothesis<br>False (-1) Does<br>work =<br>difference      | No Error (+1)                                 | Type II (-1)                                       |
| Null Hypothesis<br>True (+1)<br>Doesn't work =<br>no difference | Type I (-1)                                   | No Error (+1)                                      |

# Errors (continued)

- \* The smaller the p value, the less likelihood of committing a type I, the greater the p value, the greater the chance of a type II error. p values range from 0 (total significance) to 1.0 (least significance).
- \* Generally p values less than .05 are considered significant, while those more than .05 are not.

# How to Select a Statistical Test

- \* **Sampling Method Used**
  - \* How was sample selected?
  - \* What is the size of the sample?
  - \* Were the samples related?
  - \* Was probability sampling used? Disproportionate selection?
  - \* What type of variables were used
  
- \* **Variable Distribution among Population**
  - \* Evenly distributed?
  - \* Judgement call

# How to Select a Statistical Test

- \* Level of Measurement of the Independent & Dependent Variables
  - \* Inclusionary/ exclusionary criteria (screening mechanisms)
  - \* Variable measurement levels (nominal, ordinal, etc.)
  - \* Measurement precision (best measurement level used) Use of low level measurement reduces the availability of stronger statistical techniques.

# How to Select a Statistical Test

- \* Statistical Power (Reduction in Type II error)
  - \* True relationship between variables is strong not weak
  - \* Variability of variables is small rather than large
  - \* A higher p value is used (e.g. .1 vs .05) thereby increases risk of Type I error
  - \* Directional hypothesis used (one tailed)
  - \* Large sample versus a small sample (power analysis)
    - \* Cost effective sample just right for analysis
    - \* Avoid too small a sample since even if the IV is effective, it would not yield a statistically significant relationship