Hypothesis Testing

Reject or Fail to Reject?
That is the question!

From: Bish et al.

http://education.uncc.edu/rglamber/Hypothesis%20Testing.ppt
Objectives

- Sample vs. Population
  - Is there a difference?
- Null and Research Hypotheses
  - What are they, what do they look like, and what do they mean?
- A Good Hypothesis
  - What are the criteria?
- Testing the Hypothesis
  - The six-step program
Samples and Populations

How do we select?

Population

$\mu$ of population

Sample

Inference

Parameters

Statistics

$\bar{X}$ of sample
Samples and Populations Contd.

- Samples must match characteristics of the population.
- Similarity results in generalizability.
- Type of sample impacts research quality
  - Systematic Sample
  - Random Sample
  - Sample of Convenience
  - Volunteerism
Pitfalls of Samples

- **Sample Bias**
  - Over represent subgroups.
  - Not representative of population.

- **Sampling Error**
  - Sample group not accurate picture.
  - Reduce by enlarging sample.
  - Larger sample, less error.

- **Standard Error**
  - Measure of how much sampling error likely to occur when sample is extracted from population
  - Standard deviation of values of the sampling
Null and Research Hypotheses

- Hypothesis
  - Educated guess
  - Reflects the research problem being investigated
  - Determines the techniques for testing the research questions
  - Should be grounded in theory
Hypotheses Contd.

Research Question
Research Hypothesis
Test

In research we **NEVER** prove a hypothesis!
Purposes of the Null Hypothesis

- Acts as a starting point
  - State of affairs accepted as true in the absence of any other information
  - Until a systematic difference is shown, assume that any difference observed is due to chance
  - Research job is to eliminate chance factors and evaluate other factors that may contribute to group differences
Null Hypothesis Purpose # 2

- Provides a benchmark to measure actual outcomes
  - How likely is it that outcomes are due to some other factor?
  - Helps define range within which observed differences can be reasonably attributed to chance or something other than chance
Null Hypotheses

- Usually a statement of no differences or no associations – an equality
  - Sentence
    - There will be no difference in at-home and pre-school program children on pre-social and pre-literacy tests.
  - Symbols
    - $H_0$: $\mu_{\text{at-home}} = \mu_{\text{day-care}}$
    - $H_0$: $\mu_{\text{at-home}} - \mu_{\text{day-care}} = 0$
Research/Alternative Hypotheses

- A statement of a relationship between the variables – an inequality.
- May be nondirectional (two-tailed)
- May be directional (one-tailed) which is more powerful in research results as it splits the $p$ – value in half
Nondirectional Alternative Hyp.

Reflects a difference between groups but the direction of the difference is not specified
- Nondirectional Sentence
  • There is a difference in at-home and pre-school program children on pre-social and pre-literacy tests.
- Nondirectional Symbols
  • \(H_a: \mu_{\text{at-home}} \neq \mu_{\text{day-care}}\)
Directional Alternative Hyp.

- Reflects a difference between groups, and the direction of the difference is specified
  - Directional Sentence
    - Children in pre-school programs will have higher pre-social and pre-literacy scores than children who stay at home.
  - Directional Symbols
    - $H_a$: $\mu_{\text{at-home}} < \mu_{\text{day-care}}$
What Makes a Good Hypothesis?

A good hypothesis:
- is stated in declarative form and not as a question.
- posits an expected relationship between variables.
What Makes a Good Hypothesis?

A good hypothesis:

- reflects the theory or literature on which it is based.
- should be brief and to the point.
- is testable, which means that it can carry out the intent of the question reflected by the hypothesis.
Six Steps of Hypothesis Testing

1. State the null hypothesis.
2. State the alternative hypothesis.
3. Select a level of significance.
4. Collect and summarize the sample data.
5. Refer to a criterion for evaluating the sample evidence.
6. Make a decision to keep/reject the null.
1. State the Null Hypothesis

- States that there is no relationship between the variables.
- Refers to the population.
Examples of the Null Hypothesis

- Written: There are no differences in the pre, mid, and post test scores of students who are either enrolled in Headstart, daycare, or homecare.

- Symbols: $\mu_{\text{pre}} = \mu_{\text{mid}} = \mu_{\text{post}}$
Step 2: State the Alternative Hypothesis

- Symbolically referred to as $H_a$
- States the opposite of the $H_o$
Example of Alternative Hypothesis

- **Written:** There are differences in the scores between the students in Headstart, daycare, or homecare who either took the pre, mid, or post literacy skills test.

- **Symbols:** $\mu_{\text{Headstart}} \neq \mu_{\text{daycare}} \neq \mu_{\text{homecare}}$, for at least one pair
Step 3: Select a Level of Significance

- Most researchers select a small number such as 0.001, 0.01, or 0.05.
- The most common choice is 0.05
- Otherwise known as “alpha level”, p=0.05, $\alpha=0.05$
- The significance level serves as a scientific cutoff point that determines what decision will be made concerning the null hypothesis.
Type I and Type II Errors

- Mistakes can occur:
  1. Type I Error – designates the mistake of rejecting the $H_0$ when the null is actually false. When the level of significance is set at 0.05, this means the chance of a Type I error becomes equal to 1 out of 20.
Type II Errors

- Designates a mistake made if $H_0$ is not rejected when the null is actually false.
Step 4: Collection and Analysis of Sample Data

- The summary of the sample data will always lead to a single numerical value which is referred to as the calculated value. (r, t, or f).
- The computer calculates the probability of the above value in the form of $p =$ ____.
Step 5: The Criterion for Evaluating the Sample Evidence

Two Methods:

- Compare the calculated and critical values.
- Compare the data-based $p$-value against a preset point on the 0-1 scale on which the $p$ must fall. (Level of Significance)
Step 6: Make a Decision!

- Reject the Null if the $p$-value is less than the established level of significance.
  - a statistically significant difference was obtained
  - $p < 0.05$
Fail to Reject the Null

- Retain the Null if the $p$-value is greater than the established level of significance.
  - $H_0$ was tenable
  - The null was retained.
  - No significant difference was found.
  - The result was not statistically significant.