INTRO TO *t* TESTS

"The Lipton Company loves *t* tests." - Anonymous

A Review of Z-Tests

z = obtained difference between data and hypothesis
standard distance expected by chance

$$z = \frac{\overline{X} - \mu}{\sigma_{\overline{X}}}$$

The Problem with *z*-Scores:

The *t*-Statistic: An Alternative to *z*-Scores

Sample variance = $s^2 = \frac{\left(X - \overline{X}\right)^2}{n-1} = \frac{SS}{n-1}$

Sample standard deviation = $s = \sqrt{\frac{\left(X - \overline{X}\right)^2}{n-1}} = \sqrt{\frac{SS}{n-1}}$

Estimated standard error = $s_{\overline{X}} = \frac{s}{\sqrt{n}} = \sqrt{\frac{s^2}{n}}$

z-Score Test vs. *t*-Test

$$z = \frac{\overline{X} - \mu}{\sigma_{\overline{X}}} = \frac{\overline{X} - \mu}{\sqrt{\frac{\sigma^2}{n}}}$$

$$t = \frac{\overline{X} - \mu}{s_{\overline{X}}} = \frac{\overline{X} - \mu}{\sqrt{\frac{s^2}{n}}}$$

Degrees of freedom:

The *t* Distribution:

Determining Proportions & Probabilities for *t* Distributions

<u>3 Main Research Designs:</u>

1) Single Sample Techniques (single sample t-test)

2) Independent Measures/Between-Subjects Designs (t-test for independent samples)

3) Repeated Measures/Within-Subjects Designs (dependent t-test, t-test for related/matched samples)

t -Test Practice

Read each of the following scenarios and:

- *identify the appropriate t test (single sample, independent, or dependent)*
- *indicate whether the test is one-tailed or two-tailed*
- *identify the independent, dependent, and potential extraneous variables*

1. A research study was conducted to examine the differences between married men and married women on perceived life satisfaction. A group of 20 men (married 10 years or more) and a separate group of 20 women (married 10 years or more) completed the life satisfaction test. Scores ranged from 1 (low life satisfaction to 100 (high life satisfaction).

2. Researchers want to examine the effects of a new therapy to lower blood pressure. Participants' blood pressure was measured before the week-long therapy began and after the therapy was completed.

3. The effect of perceived control was examined by researchers among elderly patients residing in a convalescent home. Sixty participants were randomly selected to participant in the study. All patients were given a plant by the nursing staff. Half of the participants were randomly assigned to the responsibility of taking care of the plant. The other half of the patients had their plant cared for by the staff. The number of health complaints was recorded for each patient for two weeks.

4. Students in Dr. Trill's night class kept falling asleep during lecture. When Dr. Trill asked the students why they could not stay awake, they said it was because they slept fewer hours than other students. Dr. Trill knew that the campus population slept 7.1 hours per night and decided to test his students' explanation. The data indicated the mean sleep for the class was 6.3 hours per night with a standard deviation of 1.8 hours.

5. Researchers believed time pressure negatively influences memory. Thirty participants were randomly assigned to remember a list of words either under time pressure or no time pressure. The number of nonsense words correctly recalled was recorded.

Single-Sample *t* Test

$$t = \frac{\overline{X} - \mu}{\sqrt{\frac{s^2}{n}}} = \frac{\overline{X} - \mu}{s_{\overline{X}}}$$

- Uses a single sample to draw conclusions about a population
- Evaluates the difference between the sample mean and the population mean ($\overline{X} - \mu$)
- Since the standard deviation of the population is not known, the standard error of the mean is computed using the standard deviation of the sample

Examples:

An Optimism Test is administered yearly to graduating college seniors. The test measures how each graduating class feels about its future – the higher the score, the more optimistic the class. Last year's class had a mean score of μ = 15. A sample of n = 9 seniors from this year's class was selected and tested. The seniors' scores were as follows: 7, 12, 11, 15, 7, 8, 15, 9, 6. On the basis of this sample, can the psychologist conclude that this year's class has a different level of optimism than last year's class? Note that this hypothesis test will use a t-statistic because the population variance σ^2 is not known.

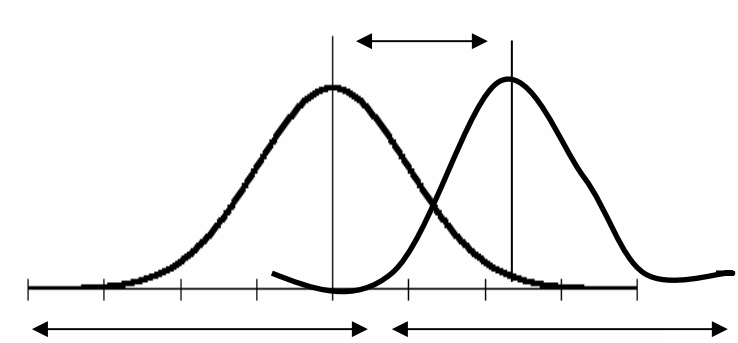
A researcher would like to evaluate the effect of a new cold medication on reaction time. It is known that under regular circumstances, the distribution of reaction times is normal with μ = 200. A sample of *n* = 4 participants is obtained. Each person is given the new cold medication, and 1 hour later reaction time is measured for each individual. The average reaction time for this sample is *M* = 215 with *SS* = 300. On the basis of these data, can the researcher conclude that the cold medication has an effect on reaction time?

Independent /Between-Subjects *t* Test

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{s_{\overline{X}_1 - \overline{X}_2}}$$

- t will be positive if $\overline{X}_1$ is larger than $\overline{X}_2$
- t will be negative if $\overline{X}_2$ is larger than $\overline{X}_1$

Difference Between Means $(\bar{X}_1 - \bar{X}_2)$



Variability of the 2 Samples

$$s_{(\overline{X}_1 - \overline{X}_2)} = \sqrt{\frac{s_p^{\,2}}{n_1} + \frac{s_p^{\,2}}{n_2}}$$

- Evaluates the mean difference between 2 independent samples ($\overline{X}_1 - \overline{X}_2$); i.e., compares 2 separate groups of individuals
- Uses a separate sample for each condition

Example:

In a study of jury behavior, 2 samples of participants were provided details about a trial in which the defendant was obviously guilty. Although group 2 received the same details as group 1, the second group was also told that some evidence had been withheld from the jury by the judge. Later the participants were asked to recommend a jail sentence. The length of term suggested by each participant is presented here. Is there a significant difference between the 2 groups in their responses?

Group 1 scores: 4 4 3 2 5 1 1 4

Group 2 scores: 3 7 8 5 4 7 6 8

There are 2 separate samples in this study. Therefore, the analysis will use the independent measures t-test.

Dependent *t* Test

$$t = \frac{\overline{X}_D - \mu_D}{s_{\overline{X}_D}} \qquad s_{\overline{X}_D} = \sqrt{\frac{s^2}{n}}$$

Repeated Measures/Within-Subject Design:

- Uses the same individuals for each TX condition
- A single sample of individuals is measured 2x on the same DV – 1x for each TX condition – and the means for each TX condition are compared

Matched/Paired/Related Subjects Design:

- Uses 2 separate samples, but each individual from 1 sample is matched with an individual from the other sample
- Individuals are matched with respect to specific variables that are considered to be especially important for the study, which ensures that the 2 samples are equivalent (at least with respect to these variables)
- Evaluates the mean difference for matched individuals across treatment conditions

Example:

A researcher in behavioral medicine believes that stress often makes asthma symptoms worse for people who suffer from this respiratory disorder. Because of the suspected role of stress, the investigator decides to examine the effect of relaxation training on the severity of asthma symptoms. A sample of 5 patients is selected for the study. During the week before treatment, the investigator records the severity of their symptoms by measuring how many doses of medication are needed for asthma attacks. Then the patients receive relaxation training. For the week following training, the researcher once again records the number of doses required by each patient. Do the data below indicate that the relaxation training alters the severity of symptoms?