8.1: Variables, Data, and Hypotheses that Fit the Independent Samples t-Test

The independent samples *t*-test is a bivariate test. This means two variables are measured and used. One of those variables must be a qualitative grouping variable with exactly two groups and the other must be a quantitative variable measured using an interval or ratio scale. An example of a qualitative grouping variable with two groups would be job status where participants are either grouped as being "Employed" or "Unemployed." Another example would be tutoring attendance where participants are grouped as either "Have Attended" or "Have Not Attended." The grouping variable is used to distinguish the two groups which are going to be compared. For simplicity, groups are often referred to as Group 1 and Group 2.

The thing being compared between the two groups is the quantitative variable. This is sometimes considered an outcome variable. An example of a quantitative variable would be hours of sleep. In this example, all participants would have their hours of sleep measured and used in the analysis. Another example of a quantitative variable would be exam scores. In this example, all participants would complete an exam and their scores on the exam would be computed and compared in the analysis. For example, if a researcher wanted to test whether those who attended tutoring had greater mean exam scores than those who did not, the qualitative grouping variable would be tutoring attendance and the quantitative variable being compared between the two groups would be exam scores.

Data

Each inferential test has some assumptions which must be met in order for the formula to function properly. In keeping, there are a few assumptions about the data which must be met before an independent samples *t*-test is used. First, the data for the quantitative variable must have been measured the same way for all cases in each of the two groups. You cannot use different ways of measuring the quantitative variable in each group; the test or measure used to obtain the scores to test cases in Group 1 should be the same as the measure used in Group 2. Second, the data for the quantitative variable must be measured on the interval or ratio scale of measurement. Third the members of the two groups must be non-overlapping and independent of one another. This means that no participant can be in both groups; each participant can only be a member of one of the two groups. You can see this important requirement reflected in most of the different names used for the independent samples *t*-test (i.e. "independent samples," "two sample," "unpaired"). Fourth, data for the quantitative variable should be fairly normally distributed in each group. Finally, there should be homogeneity of variances. **Homogeneity of variance** is when the variances for the quantitative variable are similar in both groups. When variances are not homogeneous it means that the two groups have different amounts of error (as estimated using variance) so their distribution curves have different widths and/or heights. When variances are not homogenous, adjustments to the formula are required. We will review that later in this chapter. For now, if all five of these assumptions are met, the independent samples *t*-test can be used.

Hypotheses

Hypotheses for the independent samples *t*-test must include both the qualitative variable and the quantitative variable and can be either non-directional or directional. For the independent samples *t*-test, the non-directional research hypothesis is that the sample means will be different from each other. The corresponding null hypothesis is that the sample means will not be different from each other. Because this research hypothesis is non-directional, it requires a two-tailed test. The non-directional research and corresponding null hypotheses can be summarized as follows:

Non-Directional Hypothesis for an Independent Samples t-Test

Research hypothesis	The mean of Group 1 is not equal to the mean of Group 2.	$H_A: \mu_1 \neq \mu_2$
Null hypothesis	The mean of Group 1 is equal to the mean of Group 2.	$H_0: \mu_1 = \mu_2$

There are two directional hypotheses possible for the independent samples *t*-test. One possible directional research hypothesis is that the mean for Group 1 will be *greater than* the mean for Group 2. The corresponding null hypothesis is that the mean for Group 1 will *not* be greater than the mean for Group 2. This could mean that the mean for Group 1 is less than or that it is equal to the mean for Group 2. Because this research hypothesis is directional, it requires a one-tailed test. This version of the research and corresponding null hypotheses can be summarized as follows:

Directional Hypothesis for an Independent Samples t-Test: Version 1

Research hypothesis	The mean of Group 1 will be greater than the mean of Group 2.	$H_A : \mu_1 > \mu_2$
Null hypothesis	The mean of Group 1 will be less than or equal to the mean of Group 2.	$H_0 : \mu_1 \leq \mu_2$

For the independent samples *t*-test, the other possible directional research hypothesis is that the mean for Group 1 will be *less than* the mean for Group 2. The corresponding null hypothesis is that the mean for Group 1 will *not* be less than the mean for Group 2. This could mean that the mean for Group 1 is greater than or that it is equal to the mean for Group 2. Because this research hypothesis is directional, it requires a one-tailed test. This version of the research and corresponding null hypotheses can be summarized as follows:

Directional Hypothesis for an Independent Samples t-Test: Version 2

Research hypothesis	The mean of Group 1 will be less than the mean of Group 2.	$H_A : \mu_1 < \mu_2$
Null hypothesis	The mean of Group 1 will be greater than or equal to the mean of Group 2.	$H_0 : \mu_1 \geq \mu_2$

These three version of the hypothesis are the broad form and would be refined to include the specific names or categories of the variables that are under investigation when working with specific hypotheses. For example, if a researcher expected that students who were given study guides would have different exam scores than those who were not given study guides, the research and null hypotheses would be written as follows:

Specific, Non-Directional Hypothesis for an Independent Samples t-Test

Research hypothesis	The mean exam score for those who received study guides will not be equal to the mean exam score for those who did not receive study guides.	$H_A : \mu_1 \neq \mu_2$
Null hypothesis	The exam score for those who received study guides will be equal to the mean exam score for those who did not receive study guides.	$H_0 : \mu_1 = \mu_2$

However, it is possible to also propose a directional hypothesis with these two variable: study guides (as the qualitative, grouping variable) and exam scores (as the quantitative variable). For example, if the researcher expected that students who were given study guides would have exam scores that were higher than those who are were not given study guides, the research and null hypotheses would be directional and could be written as follows:

Specific, Directional Hypothesis for an Independent Samples t-Test

Research hypothesis	The mean exam score for those who received study guides will be greater than the mean exam score for those who did not receive study guides.	$H_A : \mu_1 > \mu_2$
Null hypothesis	The exam score for those who received study guides will be less than or equal to the mean exam score for those who did not receive study guides.	$H_0 : \mu_1 \leq \mu_2$