LO 1. Use the t-distribution for inference on a single mean, difference of paired (dependent) means, and difference of independent means.

LO 2. Explain why the t-distribution helps make up for the additional variability introduced by using s (sample standard deviation) in calculation of the standard error, in place of σ (population standard deviation).

LO 3. Describe how the t-distribution is different from the normal distribution, and what “heavy tail” means in this context.

LO 4. Note that the t-distribution has a single parameter, degrees of freedom, and as the degrees of freedom increases this distribution approaches the normal distribution.

LO 5. Use a t-statistic, with degrees of freedom $df=n-1$ for inference for a population mean:

$$\text{CI:}~\bar{x} \pm t^\star_{df} SE \qquad \qquad \text{HT:}~T_{df} = \frac{\bar{x} - \mu}{SE}$$

where $SE = \frac{s}{\sqrt{n}}$.

LO 6. Describe how to obtain a p-value for a t-test and a critical t-score ($t^\star_{df}$) for a confidence interval.

LO 7. Define observations as paired if each observation in one dataset has a special correspondence or connection with exactly one observation in the other data set.

LO 8. Carry out inference for paired data by first subtracting the paired observations from each other, and then treating the set of differences as a new numerical variable on which to do inference (such as a confidence interval or hypothesis test for the average difference).

LO 9. Calculate the standard error of the difference between means of two paired (dependent) samples as $SE = \frac{s_{diff}}{\sqrt{n_{diff}}}$ and use this standard error in hypothesis testing and confidence intervals comparing means of paired (dependent) groups.

LO 10. Use a t-statistic, with degrees of freedom $df = n_{diff} - 1$ for inference for the difference in two paired (dependent) means:

$$\text{CI:}~\bar{x}_{diff} \pm t^\star_{df} SE \qquad \qquad \text{HT:}~T_{df} = \frac{\bar{x}_{diff} - \mu_{diff}}{SE}$$

where $SE = \frac{s}{\sqrt{n}}$. Note that μ_{diff} is often 0, since often $H_0: \mu_{diff} = 0$

LO 11. Recognize that a good interpretation of a confidence interval for the difference between two parameters includes a comparative statement (mentioning which group has the larger parameter).

LO 12. Recognize that a confidence interval for the difference between two parameters that doesn't include 0 is in agreement with a hypothesis test where the null hypothesis that sets the two parameters equal to each other is rejected.

LO 13. Calculate the standard error of the difference between means of two independent samples as $SE = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ and use this standard error in hypothesis testing and confidence intervals comparing means of independent groups.

LO 14. Use a t-statistic, with degrees of freedom $df = \min(n_1 - 1, n_2 - 1)$ for inference for the difference in two independent means:

$$\text{CI:}~(\bar{x}_{1} - \bar{x}_{2}) \pm t^\star_{df} SE \qquad \qquad \text{HT:}~T_{df} = \frac{(\bar{x}_{1} - \bar{x}_{2}) - (\mu_{1} - \mu_{2})}{SE}$$

where $SE = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$ Note that $(\mu_1-\mu_2)$ is often 0, since often $H_0: \mu_{1} - \mu_{2} = 0$.

LO 15. Calculate the power of a test for a given effect size and significance level in two steps: (1) Find the cutoff for the sample statistic that will allow the null hypothesis to be rejected at the given significance level, (2) Calculate the probability of obtaining that sample statistic given the effect size.

LO 16. Explain how power changes for changes in effect size, sample size, significance level, and standard error.

LO 17. Use bootstrap methods for confidence intervals for categorical variables with at most two levels.