# Quiz 10.2A AP Statistics Name:

**1.** In a study of heart surgery, one issue was the effect of drugs called beta-blockers on the pulse rate of patients during surgery. The available subjects were divided at random into two groups of 30 patients each. One group received a beta-blocker; the other group received a placebo. The pulse rate of each patient at a critical point during the operation was recorded. The treatment group had a mean pulse rate of 65.2 and standard deviation 7.8. For the control group, the mean pulse rate was 70.3 and the standard deviation was 8.3.

(a) Find the standard error for the difference in mean pulse rate between the two groups.

(b) Construct and interpret a 99% confidence interval for the difference in mean pulse rates.

(c) Suppose we want to test the hypothesis that beta-blockers reduce mean pulse rate. State the null and alternative hypotheses for this test.

(d) The test statistic is $t = -2.453$. Determine the *P*-value and draw an appropriate conclusion, using $\alpha = 0.05$.

Quiz 10.2B AP Statistics Name:

**1.** Jordan's cat "Fern" is a finicky eater. Jordan is trying to determine which of two brands of canned cat food Fern prefers, Tab-a-Cat or Chow Lion. For two months, she flips a coin each day to decide which of the two foods to feed Fern, and weighs how much Fern eats in grams. Here is the data:

| | $n$ | $\bar{x}$ | s |
|---|---|---|---|
| Tab-a-Cat | 31 | 85.2 | 3.45 |
| Chow Lion | 30 | 82.1 | 4.62 |

(a) Find the standard error for the difference in the mean amount of Tab-a-Cat that Fern eats and the mean amount of Chow Lion she eats.

(b) Construct and interpret a 99% confidence interval for the difference in mean amount of food Fern eats when she is offered Tab-a-Cat and when she is offered Chow Lion.

(c) Suppose we want to test the hypothesis that the mean amount of Tab-a-Cat Fern eats is higher than the mean amount of Chow Lion she eats. State the null and alternative hypotheses for this test.

(d) The test statistic is $t = 2.962$. Determine the *P*-value and draw an appropriate conclusion, using $\alpha = 0.01$.

# Quiz 10.2C AP Statistics Name:

**1.** As a non-native English speaker, Sanda is convinced that people find more grammar and spelling mistakes in essays when they think the writer is a non-native English speaker. To test this, she randomly sorts a group of 40 volunteers into two groups of 20. Both groups are given the same paragraph to read. One group is told that the author of the paragraph is someone whose native language is not English. The other group is told nothing about the author. The subjects are asked to count the number of spelling and grammar mistakes in the paragraph. While the two groups found about the same number of real mistakes in the passage, the number of things that were incorrectly identified as mistakes was more interesting. Here are the results:

| | Number of "mistakes" found | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Native English Speaker" | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 0 | 3 | 2 | 0 | 0 | 2 | 0 |
| "Non-native English speaker" | 2 | 1 | 5 | 0 | 1 | 4 | 8 | 7 | 6 | 0 | 1 | 0 | 1 | 4 | 7 | 4 | 2 | 1 | 4 | 5 |

Do these data provide convincing evidence that readers are more likely to incorrectly identify errors in writing if they think the author's native language is not English? Support your conclusions with an appropriate statistical test.

**2.** In many parts of the northern United States, two color variants of the Eastern Gray Squirrel—gray and black—are found in the same habitats. A scientist studying squirrels in a large forest wonders if there is a difference in the sizes of the two color variants. He collects random samples of 40 squirrels of each color from a large forest and weighs them. The 40 black squirrels have a mean weight of $\bar{x}_B = 20.3$ ounces and a standard deviation of $s_B = 2.1$ ounces. The 40 gray squirrels have a mean weight of $\bar{x}_G = 19.2$ ounces and a standard deviation of $s_G = 1.9$ ounces. There are no outliers in either sample. Construct and interpret a 90% confidence interval for the difference in mean weight of black and grey squirrels in this forest.

**Quiz 10.2A**

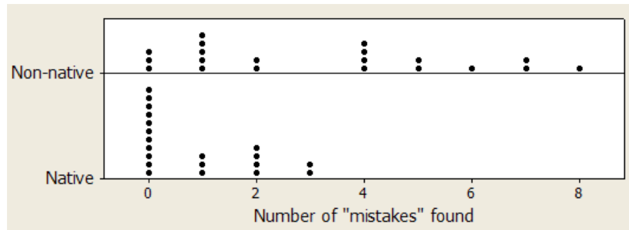
**1.** (a) Let $\mu_1$ = true mean pulse rate of patients similar to those in the experiment who take beta-blockers and $\mu_2$ = mean pulse rate of similar patients who do not take beta blockers. Standard error of is $\sqrt{\frac{7.8^2}{30}+\frac{8.3^2}{30}} = 2.08$. (b) State: We wish to estimate, with 99% confidence, the difference $\mu_1 - \mu_2$, as defined in part (a). Plan: We should use a 2-sample *t*-interval for $\mu_1 - \mu_2$. Conditions: *Random:* The subjects were randomly assigned to the experimental treatments. *10%:* Since no sampling took place, the 10% condition does not apply. *Normal/Large Sample:* since both samples are at least 30, the Normal condition is satisfied. Do: Using the conservative degrees of freedom of 29, the critical *t*-value for 99% confidence is 2.756, so the interval is $(65.2 - 70.3) \pm 2.756\sqrt{\frac{7.8^2}{30}+\frac{8.3^2}{30}} = -5.10 \pm 5.73$, or $(-10.83, 0.63)$. [Using a calculator and 57.78 degrees of freedom, the interval is $(-10.64, 0.44)$]. Conclude: We are 99% confident that the interval from –10.83 to 0.63 captures the true difference in the mean pulse rate of patients receiving a beta-blocker during surgery and those who take a placebo. (c) $H_0: \mu_1 - \mu_2 = 0$; $H_a: \mu_1 - \mu_2 < 0$. (d) Using Table A and df = 29, $0.01 < P$-value $< 0.02$. Using the calculator and df = 57.78, *P*-value = 0.0086. Since in both cases the *P*-value is less than $\alpha = 0.05$, we reject $H_0$. We have convincing evidence that the mean pulse rate of patients taking beta-blockers is lower than the mean pulse rate of patients taking a placebo.

**Quiz 10.2B**

**1.** (a) Let $\mu_T$ = mean amount of Tab-a-Cat Fern eats and $\mu_C$ = mean amount of Chow Lion she eats. Standard error of $\bar{x}_T - \bar{x}_C$ is $\sqrt{\frac{3.45^2}{31}+\frac{4.62^2}{30}} = 1.047$. (b) State: We wish to estimate, with 99% confidence, the difference $\mu_T - \mu_C$, as defined in part (a). Plan: We should use a 2-sample *t*-interval for $\mu_1 - \mu_2$. Conditions: *Random:* Feedings of each type of food were randomly determined by coin flip. *10%:* We can view this study as randomly assigning 61 feedings to one of two groups, thus sampling did not take place, so the 10% condition does not apply. *Normal/Large Sample:* since both samples are at least 30, the Normal condition is satisfied. Do: Using the conservative degrees of freedom of 29, the critical *t*-value for 99% confidence is 2.756, so the interval is $(85.2 - 82.1) \pm 2.756\sqrt{\frac{3.45^2}{31}+\frac{4.62^2}{30}} = 3.10 \pm 2.88$, or $(0.22, 5.98)$. [Using a calculator and 53.64 degrees of freedom, the interval is $(0.30, 5.90)$]. Conclude: We are 99% confident that the interval from 0.22 to 5.98 captures the true difference in the mean amount of Tab-a-Cat Fern eats and the mean amount of Chow Lion she eats. (c) $H_0: \mu_T - \mu_C = 0$; $H_a: \mu_T - \mu_C > 0$. (d) Using Table A and df = 29, $0.0025 < P$-value $< 0.005$. Using the calculator and df = 53.64, *P*-value = 0.0023. Since in both cases the *P*-value is less than $\alpha = 0.01$, we reject $H_0$. We have convincing evidence that Fern eats more, on average, when offered Tab-a-Cat than when offered Chow Lion.

**Quiz 10.2C**

**1.** State: We are testing the hypotheses $H_0: \mu_1 - \mu_2 = 0$ *versus* $H_a: \mu_1 - \mu_2 > 0$, where $\mu_1$ is the mean number of mistakes someone finds if they think the writer is a non-native English speaker and $\mu_2$ is the mean number of mistakes someone finds if they think the writer is a native English speaker. We will use a significance level of $\alpha = 0.05$. Plan: The procedure is a two-sample *t*-test for the difference of means. Conditions: *Random:* The problem states that subjects were assigned at random. *10%:* Since no sampling took place, the 10% condition does not apply. *Normal/Large Sample:* Since $n = 20$ for each group, we need to examine the distributions of sample data for strong skew or outliers. The dot plots at right indicate that both distributions are moderately skewed right, but the sample sizes are probably large enough to compensate for this.




| | $n$ | $\bar{x}$ | $s$ |
|---|---|---|---|
| Non-native | 20 | 3.15 | 2.58 |
| Native | 20 | 0.85 | 1.09 |

Do: Summary statistics at right.

$$t = \frac{(3.15 - 0.85) - 0}{\sqrt{\frac{2.58^2}{20} + \frac{1.09^2}{20}}} = \frac{2.30}{0.624} = 3.672$$

Using Table A and df = 19, $0.0005 < P\text{-value} < 0.001$.
Using the calculator and df = 25.56, $P$-value = 0.00055. Conclude: Since in both cases the $P$-value is less than $\alpha = 0.05$, we reject $H_0$. We have convincing evidence that the mean number of non-existent "mistakes" people find when reading something they think has been written by a non-Native English speaker is greater than the mean number they find if they think the writer's native language is English.

**2.** State: We wish to estimate, with 90% confidence, the difference $\mu_B - \mu_G$, where $\mu_B$ and $\mu_G$ are the mean weight of black and gray squirrels, respectively, in the forest. Plan: We should use a 2-sample *t*-interval for $\mu_B - \mu_G$. Conditions: *Random:* Random samples of each color variant were taken. *10%:* It seems reasonable to assume that there are at least $(40)(10) = 400$ squirrels of each color in a large forest. *Normal:* Since both samples are at least 30, the Normal condition is satisfied. Do: Since there is no line for 39 degrees of freedom in Table A, the conservative approach would be to use 30 degrees of freedom, for which the critical *t*-value for 90% confidence is 1.697, so the interval is

$$(20.3 - 19.2) \pm 1.697\sqrt{\frac{2.1^2}{40} + \frac{1.9^2}{40}} = 1.1 \pm 0.760$$, or $(0.34, 1.86)$. [Using a calculator and 77.23 degrees of freedom, the interval is $(0.35, 1.85)$]. Conclude: We are 90% confident that the interval $(0.35, 1.85)$ captures the true difference in the mean weights of black and gray squirrels in this forest.