SECTION 10.3B Exercises

89. **Right versus left** The design of controls and instruments affects how easily people can use them. A student project investigated this effect by asking 25 right-handed students to turn a knob (with their right hands) that moved an indicator. There were two identical instruments, one with a right-hand thread (the knob turns clockwise) and the other with a left-hand thread (the knob must be turned counterclockwise). Each of the 25 students used both instruments in a random order. The following table gives the times in seconds each subject took to move the indicator a fixed distance:[30]

L3 = L2 - L1   Left / Right

Subject	Right thread	Left thread
1	113	137
2	105	105
3	130	133
4	101	108
5	138	115
6	118	170
7	87	103
8	116	145
9	75	78
10	96	107
11	122	84
12	103	148
13	116	147
14	107	87
15	118	166
16	103	146
17	111	123
18	104	135
19	111	112

(L1 = Right thread, L2 = Left thread)

Subject	Right thread	Left thread
20	89	93
21	78	76
22	100	116
23	89	78
24	85	101
25	88	123

(a) Explain why it was important to randomly assign the order in which each subject used the two knobs.

(answer here ↓)

IT IS IMPORTANT TO RANDOMLY ASSIGN SO THAT WE AVERAGE OUT ANY EFFECT DUE TO DOING THE ACTIVITY BETTER THE SECOND TIME NO MATTER WHICH KNOB IS USED SECOND.

Calculator Tip

(STAT) (TESTS)
2: T-Test

DATA
$\mu_0 = 0$
L3
FREQ: 1

$> \mu_0$

CALCULATE
$\mu > 0$
$t = 2.904$
$P = .0038$

$\bar{x} = 13.32$
$S_x = 22.936$
$n = 25$

(b) The project designers hoped to show that right-handed people find right-hand threads easier to use. Carry out a significance test at the 5% significance level to investigate this claim.

Complete Test Template

NOTE: You would get the same Conclusion if you did Right - Left. You would just change H_A.

$H_0 \; \mu_d = 0$
$H_A \; \mu_d < 0$

$t = -2.904$
$P = .0039$

TRY THIS: $H_0: \mu_d = 0$ $H_A: \mu_d \neq 0$

$t = -2.904$ $P = .0078$ STILL REJECT H_0

94. **Significance and sample size** A study with 5000 subjects reported a result that was statistically significant at the 5% level. Explain why this result might not be particularly large or important.

The study may have rejected Ho, But with such a large sample size, such a rejection might occur even if the actual DIFFERS ONLY SLIGHTLY FROM THE HYPOTHESIZED VALUE. FOR EXAMPLE, THE DIFFERENCE BETWEEN $\mu = 10$ AND $\mu = 10.5$ might have no Practical importance.

95. **Sampling shoppers** A marketing consultant observes 50 consecutive shoppers at a supermarket, recording how much each shopper spends in the store. Explain why it would not be wise to use these data to carry out a significance test about the mean amount spent by all shoppers at this supermarket.

ANY NUMBER OF THINGS COULD GO WRONG WITH A CONVENIENCE SAMPLE. DEPENDING ON THE TIME OF DAY OR THE DAY OF THE WEE, CERTAIN TYPES OF SHOPPERS WOULD OR WOULD NOT BE PRESENT.

Remember! THE ONLY WAY TO SHOW CAUSE AND EFFECT IS WITH A WELL-DESIGNED, WELL-CONTROLLED EXPERIMENT! 3 COMPONENTS ① Randimization ② CONTROL ③ REPLICATION

96. **Ages of presidents** Joe is writing a report on the backgrounds of American presidents. He looks up the ages of all the presidents when they entered office. Because Joe took a statistics course, he uses these numbers to perform a significance test about the mean age of all U.S. presidents. Explain why this makes no sense.

We have information about the whole population of interest.

97. **Do you have ESP?** A researcher looking for evidence of extrasensory perception (ESP) tests 500 subjects. Four of these subjects do significantly better ($P < 0.01$) than random guessing.

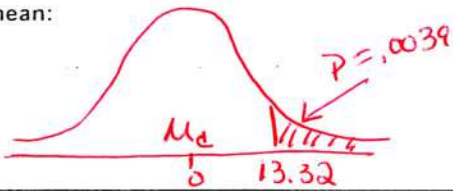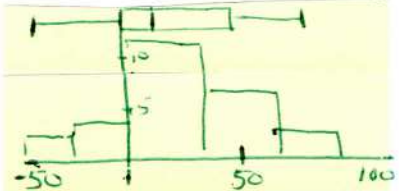(a) Is it proper to conclude that these four people have ESP? Explain your answer.

(b) What should the researcher now do to test whether any of these four subjects have ESP?

$500(.01) = 5$

(a) No we would expect about 5 of the 500 subjects who don't have ESP to do better then randomly Guessing just by chance.

(b) The researcher should repeat the Procedure on these 4 to see if they again per form well

#89

Test of Significance Template

Parameter of Interest	μ_d = actual mean difference (left−right) in the time it takes to turn the knob with left thread and right thread
Choice of Test	PAIRED T-Test for μ
Level of Significance	$\alpha = .05$ since no α was given
Null Hypothesis	**English:** RIGHT HANDED SAMPLE **Symbols:** $H_0: \mu_d = 0$ seconds
Alternative Hypothesis	**English:** Does it take longer to turn knob <u>left</u> than <u>right</u>. **Symbols:** $H_A: \mu_d > 0$ seconds
Conditions of Test	① σ is unknown (t-inference) ② THIS IS A RANDOMIZED EXPERIMENT. ③ INDEPENDENT: we aren't sampling(10%). The difference in times for individual subjects should be independent if the experiment is conducted properly ④ Normal − Small sample (n=25<30). A HISTOGRAM LOOKS FAIRLY SYMMETRIC AND A BOX PLOT. SHOWS NO OUTLIERS. SEE GRAPHS BELOW →

Sampling Distribution

Sketch of the sampling distribution of the sample statistic under the null hypothesis, indicating the mean:

$P = .0039$

μ_d = 0, 13.32

Test Statistic

Formula:
$$t = \frac{\bar{x} - \mu}{s_x / \sqrt{n}}$$

Plug-ins & Value:
$\mu = 0$, $\bar{x} = 13.32$
$n = 25$, $s_x = 22.936$
$df = 24$

$$t = \frac{13.32 - 0}{\frac{22.934}{\sqrt{25}}}$$

$$t = 2.904$$

P-value

Use correct probability notation.

$$p = P(t \geq 2.904) = tcdf(2.904, E99, 24) = .0039$$

Meaning of the P-value

P_{value} is very small so we Reject H_0

Conclusions

☒ Reject null hypothesis ☐ Significant result
☐ Fail to reject null hypothesis ☐ Not Significant result

English:

Since our p value < .05, we reject H_0.

We have enough evidence to conclude that it takes longer for right handed students to complete the task when the knob has a left hand thread, on average.