5. Researchers want to determine whether drivers are significantly more distracted while driving when using a cell phone than when talking to a passenger in the car. In a study involving 48 people, 24 people were randomly assigned to drive in a driving simulator while using a cell phone. The remaining 24 were assigned to drive in the driving simulator while talking to a passenger in the simulator. Part of the driving simulation for both groups involved asking drivers to exit the freeway at a particular exit. In the study, 7 of the 24 cell phone users missed the exit, while 2 of the 24 talking to a passenger missed the exit.

   (a) Would this study be classified as an experiment or an observational study? Provide an explanation to support your answer.

   (b) State the null and alternative hypotheses of interest to the researchers.

   (c) One test of significance that you might consider using to answer the researchers' question is a two-sample z-test. State the conditions required for this test to be appropriate. Then comment on whether each condition is met.

   (d) Using an advanced statistical method for small samples to test the hypotheses in part (b), the researchers report a p-value of 0.0683. Interpret, in everyday language, what this p-value measures in the context of this study and state what conclusion should be made based on this p-value.

GO ON TO THE NEXT PAGE.

STATISTICS
SECTION II
Part B
Question 6
Spend about 25 minutes on this part of the exam.
Percent of Section II grade—25

Directions: Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

6. A study was designed to explore subjects' ability to judge the distance between two objects placed in a dimly lit room. The researcher suspected that the subjects would generally overestimate the distance between the objects in the room and that this overestimation would increase the farther apart the objects were.

   The two objects were placed at random locations in the room before a subject estimated the distance (in feet) between those two objects. After each subject estimated the distance, the locations of the objects were rerandomized before the next subject viewed the room.

   After data were collected for 40 subjects, two linear models were fit in an attempt to describe the relationship between the subjects' perceived distances (y) and the actual distance, in feet, between the two objects.

   Model 1: $\hat{y} = 0.238 + 1.080 \times$ (actual distance)

   The standard errors of the estimated coefficients for Model 1 are 0.260 and 0.118, respectively.

   Model 2: $\hat{y} = 1.102 \times$ (actual distance)

   The standard error of the estimated coefficient for Model 2 is 0.393.

   (a) Provide an interpretation in context for the estimated slope in Model 1.

   (b) Explain why the researcher might prefer Model 2 to Model 1 in this context.

   (c) Using Model 2, test the researcher's hypothesis that in dim light participants overestimate the distance, with the overestimate increasing as the actual distance increases. (Assume appropriate conditions for inference are met.)

   The researchers also wanted to explore whether the performance on this task differed between subjects who wear contact lenses and subjects who do not wear contact lenses. A new variable was created to indicate whether or not a subject wears contact lenses. The data for this variable were coded numerically (1 = contact wearer, 0 = noncontact wearer), and this new variable, named "contact," was included in the following model.

   Model 3: $\hat{y} = 1.05 \times$ (actual distance) $+ 0.12 \times$ (contact) $\times$ (actual distance)

   The standard errors of the estimated coefficients for Model 3 are 0.357 and 0.032, respectively.

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Question 5

Intent of Question

The primary goals of this statistical inference question are to assess a student's ability to: (1) distinguish an observational study from an experiment; (2) state the appropriate hypotheses for a research problem; (3) check the appropriate conditions for an inference procedure; and (4) interpret standard results for an inference procedure that is unfamiliar to students.

Solution

Part (a):

This is an experiment because the researchers imposed treatments by randomly assigning drivers to the two different conditions (simulated driving while talking on a cell phone versus simulated driving while talking to a passenger).

Part (b):

Let p_{cell} denote the proportion of drivers who miss an exit while using a cell phone and p_{pass} denote the proportion of drivers who miss an exit while talking to a passenger.

H_0: $p_{cell} = p_{pass}$
H_A: $p_{cell} > p_{pass}$

Part (c):

The conditions required for a two-sample z-test of equal proportions are:
(1) independent random samples or random assignment, and
(2) large sample sizes $\left[n_1 \hat{p}_1 \geq 10, n_1(1-\hat{p}_1) \geq 10, n_2 \hat{p}_2 \geq 10, n_2(1-\hat{p}_2) \geq 10 \right]$.
Random assignment is stated in the stem so the first condition is met. However, the numbers of successes ($n_{cell}\hat{p}_{cell} = 7$ and $n_{pass}\hat{p}_{pass} = 2$) are both smaller than 10, so the large sample condition is not met in this situation. Note: If the student uses the rule of thumb with 10 replaced by 5, then the number of successes for the second sample is still too small.

Part (d):

Interpretation: Assuming that talking on a cell phone and talking to a passenger are equally distracting (there is no difference in the two population proportions of drivers who will miss the exit), the p-value measures the chance of observing a difference in the two sample proportions as large as or larger than the one observed.

Conclusion: Since the p-value 0.0683 is larger than 0.05, we cannot reject the null hypothesis. That is, we do not have statistically significant evidence to conclude that using a cell phone is more distracting to drivers than talking to another passenger in the car.

Notice that if we increase the significance level to 0.1, then we could reject the null hypothesis and conclude that drivers are significantly more distracted when using a cell phone.

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Question 5 (continued)

Scoring

Parts (a) and (b) are scored as essentially correct (E) or incorrect (I). Parts (c) and (d) are scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as essentially correct (E) if the student indicates that this is an experiment because treatments were imposed.

Part (a) is scored as incorrect (I) if no explanation is provided, or the student says that this is an observational study.

Part (b) is scored as essentially correct (E) if the student correctly identifies the two population proportions with the correct hypotheses. Nonstandard notation must indicate reference to population proportions.

Part (b) is scored as incorrect (I) if the student is *clearly* referring to the sample proportions.

Part (c) is scored as essentially correct (E) if the student provides both conditions and correctly comments on both.

Part (c) is scored as partially correct (P) if the student provides and correctly comments on only one of the conditions.

Part (c) is scored as incorrect (I) if conditions are provided but no correct comments are given.

Part (d) is scored as essentially correct (E) if the *p*-value is correctly interpreted *AND* the correct conclusion is provided *AND* context is given.

Part (d) is scored as partially correct (P) if:

i) either the *p*-value is correctly interpreted OR the correct conclusion is provided
AND
ii) context is given.

Part (d) is scored as incorrect (I) if *neither* a correct interpretation of the *p*-value in context *NOR* a correct conclusion in context is provided.

In part (d) if both an α and a *p*-value are given together, the linkage between the *p*-value and the conclusion is implied. If no α is given, the solution must be explicit about the linkage by giving a correct interpretation of the *p*-value or explaining how the conclusion follows from the *p*-value.

Note: Any choice of an α could have been made as long as the appropriate interpretation is made relative to that choice of α.

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Question 5 (continued)

Each essentially correct (E) response counts as 1 point; each partially correct (P) response counts as ½ point.

4 **Complete Response**

3 **Substantial Response**

2 **Developing Response**

1 **Minimal Response**

If a response is between two scores (for example, 2½ points), use a holistic approach to determine whether to score up or down depending on the strength of the response and communication.