3

CAUSALITY, STATISTICAL SIGNIFICANCE, AND SUBSTANTIVE SIGNIFICANCE

SOLUTIONS

1. Evaluate whether each of these statements correctly conveys statistical significance. If not, rewrite the sentence so that the verbal description matches the numbers; leave the numeric values unchanged.
    a. Correct.
    b. Incorrect. A *p*-value of 0.95 corresponds to only a 5% probability that the observed difference is *not* due to chance (e.g., a 95% probability that the observed difference *is* due to chance.) "The *p*-value for the *t*-test for difference in mean ozone levels equals 0.95, so we can be 95% certain that the observed difference is due to chance."
    c. Correct.
    d. Correct.
    e. Incorrect. This sentence doesn't reveal anything about statistical significance of that change. The most we can say from the information given is "The price of gas increased by $0.05 over the past three months."
    f. Incorrect. Test-statistics and *p*-values are indicators of statistical significance. They do not measure the size of the association—in this case, the difference between two values, which cannot be calculated from the information given. The most we can say is "The *p*-value comparing trends in gas prices = 0.05."
    g. Correct.
    h. Incorrect. Sample size does not affect size of a difference between values—in this case, difference in average processor speeds. See part i of this question for correct wording.
    i. Correct.

3. Discuss whether each of the following research questions involves a causal relationship.
    a. Causal (partly). The flowers would likely bloom in May whether or not it rains in April, but they will bloom more nicely if it rains.
    b. Non-causal association. In many populations, blue eyes and blond hair co-occur, but neither causes the other.
    c. Spurious. Positive correlations between both pollen allergies and daylight with more flowers blooming causes a spurious association between allergies and daylight. In other words, if you could have more daylight without more blooming plants, there wouldn't be an association of daylight hours with pollen allergies.
    d. Could be causal or reverse causal. For example, people with heartburn might stop eating spicy foods if they think those foods irritate their heartburn.
    e. Reverse causal. Low prices probably induced greater sales. Could be causal in the long run if greater sales allow economies of scale in production, which in turn could lower prices.

f. Causal. Lack of protective pigment in fair-skinned people allows them to sunburn faster.
g. Spurious. Both reading ability and height increase dramatically with age, which is the real causal factor for both. Comparing kids with the same age but different heights would likely show much less difference in reading abilities than if age isn't taken into account.

5. For both topics in table 3A, the findings of studies 1 and 3 are statistically significant, studies 2 and 5 are not, and study 4 is borderline because the *p*-value is slightly above 0.05 and the sample size is small. However, the white hair/mortality association in topic II is spurious, so substantive and statistical significance are irrelevant. For topic I (curriculum change and test scores), where there is a plausible causal explanation, only the findings of study 3 are likely to be of substantive interest because the effect size in study 1 is so small.