10. In order to study the effectiveness of a vaccine, 120 experimental animals were given the vaccine and 180 were not. Then all 300 animals were infected with the disease. The results are in the 2-way table below. We want to know if the vaccination reduces the rate of death.

<table>
<thead>
<tr>
<th></th>
<th>Unvaccinated</th>
<th>Vaccinated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lived</td>
<td>162</td>
<td>114</td>
<td>276</td>
</tr>
<tr>
<td>Died</td>
<td>18</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>120</td>
<td>300</td>
</tr>
</tbody>
</table>

a) What are the null and alternative hypotheses for this test?

b) What percentage of the vaccinated animals died?

c) What percentage of the unvaccinated animals died?

d) How many vaccinated animals would we expect to die if the null hypothesis is true?

e) The $X^2$ value for this test is 2.446. Are the results of this test statistically significant? Explain.
Test 3 Solutions

1 a False. If the p-value is 0.03, for example, then the result is significant at the 0.05 level but not at the 0.01 level.
1 b True. If the P-value is less than 0.01, then it is certainly less than 0.05.
1 c False. Higher confidence yields wider intervals.
1 d True.
2 a True.
2 b False. The large P-value only says that the value of your test statistic would not be that unusual if the null hypothesis were true, but there may be other hypotheses besides the null hypothesis that also explain this.
2 c True.
2 e The value of the correlation coefficient alone is never enough to infer cause. Remember, effects are more easily determined than causes.
3 a A, .60; B, .91; C, -.52; D, -.42
4 e Outliers can make the correlation coefficient close to 1 even when their is not a strong linear association among the other pieces of data.
5 a reading score (quant), gender (cat); 2-sample t;
5 b whether a person has lived outside county (cat); 1-proportion
5 c "did you vote?”(cat), gender (quant) - 2-proportion (or Chi-square)
5 d favorite radio station, method of transportation; chi square
5 e fat (quant), type of snack (cat); ANOVA
5 f hours worked last week (quant), gender (cat); 2-sample t;
5 g regression/correlation
6 d D. P < 0.025
6 d d. P < 0.025. Notice that this is the same reasoning that tells us how to interpret the Tukey’s output.
7 a Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
<td>2</td>
<td>4.68</td>
<td>2.34</td>
<td>0.64</td>
<td>0.541</td>
</tr>
<tr>
<td>Error</td>
<td>15</td>
<td>54.88</td>
<td>3.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>59.56</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7 b 3 brands.
7 c 18 jars.
8 a Null hypothesis: The mean length of kuckoo eggs is the same in each kind of nest. Alternative hypothesis: The mean length is not the same in all three kinds of nests.
8 b 14 per nest type.
8 c each population is (approximately) normal; standard deviations of each population are (approximately) equal.
8 d The standard deviation rule of thumb can be checked: 0.505 x 2 > 0.997. So by our 2:1 rule for standard deviations, this is acceptable.
8 e histograms (look for bell shape), normal quantile plots (look for roughly linear plot).
8 f Yes, P-value is smaller than 0.05.
8 g Since our P-value indicates that the means are not all equal, it is appropriate to use Tukey’s to see which means differ significantly pairwise. Here we see that all three pairs are significantly different.
9 b Slope is 6.898, so every increase of 1/1000 inch in the diameter of the weld corresponds to an increase in strength of about 6.9 pounds.
9 c Yes. P-value (from either the t-test or the F-test) is 0.001.
9 d 6.9 ± t*SE = 6.9 ± (1.376)
9 e 6.9(225) = 569
9 f 6.9(325) = 569
9 g The prediction for 325 is better because 325 is much larger than any value in the data set.
10 a Null Hypothesis: Death rates are the same for vaccinated and unvaccinated animals. Alternative Hypothesis: Death rates are different for vaccinated animals than for unvaccinated.
10 b 6/120 = 5%
10 c 18/180 = 10%
10 d 120/300 = 40%