(1) Recent events in Europe have brought attention to the fact that sometimes zoos euthanize animals that are not appropriate for breeding (http://www.cnn.com/2014/02/10/world/europe/denmark-zoo-giraffe/). People often claim that castration would be a solution. When I worked at CARE, a baboon sanctuary (http://www.primatecare.org/), the staff there said that male baboons often lost a large amount of muscle mass after castration so this procedure isn't without risk. Those observations were anecdotal however and maybe they get bigger sometimes instead. Imagine that we conduct a study in which we randomly assign sets of male baboons into two groups (castration and control) and measure their body masses. Imagine we collect the following mass data from each set of baboons:

<table>
<thead>
<tr>
<th>Control</th>
<th>Castration</th>
</tr>
</thead>
<tbody>
<tr>
<td>91.92</td>
<td>86.99</td>
</tr>
<tr>
<td>93.1</td>
<td>86.81</td>
</tr>
<tr>
<td>93.01</td>
<td>86.71</td>
</tr>
<tr>
<td>93.2</td>
<td>90.52</td>
</tr>
<tr>
<td>89.64</td>
<td>91.42</td>
</tr>
<tr>
<td>91.79</td>
<td>91.39</td>
</tr>
<tr>
<td>91.54</td>
<td>90.52</td>
</tr>
<tr>
<td>89.15</td>
<td>89.79</td>
</tr>
<tr>
<td>86.43</td>
<td>90.13</td>
</tr>
<tr>
<td>90.13</td>
<td>88.31</td>
</tr>
<tr>
<td>91.23</td>
<td>92.24</td>
</tr>
<tr>
<td>91.31</td>
<td>89.19</td>
</tr>
<tr>
<td>90.59</td>
<td>90.83</td>
</tr>
<tr>
<td>92.23</td>
<td>89.13</td>
</tr>
<tr>
<td>91.11</td>
<td>89.41</td>
</tr>
</tbody>
</table>

(a, 2 pts) State the biological question that we will be testing with our two-tailed test, be precise.

**We want to know if there is a significant difference in the mean size of castrated and control male baboons.**

If we wished to know whether we could do a homoscedastic t test (or have no choice and must do a heteroscedastic test) we need to do a preliminary F ratio test.

(b, 2 pts ea) Conduct the calculation for the F ratio test and fill in the blanks to the right.

\[
\begin{align*}
\text{df(num)} &= 16 \\
\text{df(den)} &= 15 \\
F_{\text{calc}} &= 2.308 \\
F_{\text{crit}} (\alpha=0.05) &= 2.84
\end{align*}
\]

(c, 2 pts) State the formal statistical conclusion of your F ratio test and what the practical conclusion of this test is (i.e., what t tests may be performed on this data).

**The variances are NOT SIGNIFICANTLY DIFFERENT (p>0.05). Both the heteroscedastic and homoscedastic t tests may be performed on this data.**

(d, 2 pts ea) Perform a two-tailed heteroscedastic t test using the data above and fill in the blanks to the right. (round df to the correct whole number).

\[
\begin{align*}
\text{df} &= 27 \\
\text{t}_{\text{calc}} &= 2.105 \\
\text{t}_{\text{crit}} (\alpha=0.05) &= 2.052
\end{align*}
\]

(e, 3 pts) State the biological conclusion of your t test in the box below. Use the grammar described in lecture and state with what degree of confidence you make your conclusion by providing the most specific range of p values from the table provided in lecture. You must use the phrase "significantly smaller", "significantly larger" or "not significantly different" in your answer. **Note:** no credit will be given for ANY text outside the box or hard to read answers.

**Castration appears to reduce body mass.**

**The male baboons in the castration treatment have a SIGNIFICANTLY SMALLER mean mass than the control males (0.04 < p < 0.05).**
Indiv. | Before | After
--- | --- | ---
1 | 42 | 41
2 | 29 | 38
3 | 38 | 43
4 | 37 | 43
5 | 44 | 46
6 | 40 | 44
7 | 32 | 35
8 | 36 | 44
9 | 39 | 36
10 | 34 | 39
11 | 40 | 42
12 | 44 | 42

(a, 2 pts ea) Conduct a two-tailed unpaired heteroscedastic t test on this data and fill in the blanks to the right.
\[ \text{df} = 20 \quad t_{\text{calc}} = -1.913 \]

(b, 3 pts) State the biological conclusion of your t test in the box below. Use the grammar described in lecture and state with what degree of confidence you make your conclusion by providing the most specific range of p values from the table provided in lecture. You must use the phrase "significantly lower", "significantly higher" or "not significantly different" in your answer. **Note:** no credit will be given for ANY text outside the box or hard to read answers.

The behaviors appear the same.
The mean number of positive social interactions of the male baboons are **NOT SIGNIFICANTLY DIFFERENT** before and after treatment \((0.05 < p < 0.1)\).

(c, 2 pts ea) Conduct a two-tailed paired t test on this data and fill in the blanks to the right.
\[ \text{df} = 11 \quad t_{\text{calc}} = -2.897 \]

(d, 3 pts) State the biological conclusion of your t test in the box below. Follow the instructions as in question (b). **Note:** no credit will be given for ANY text outside the box or hard to read answers.

The number of positive social interactions by the male baboons are **SIGNIFICANTLY HIGHER** after treatment \((0.01 < p < 0.02)\).

(e, 3 pts) If we had an *a priori* expectation of less aggression (i.e., an increase in positive social behaviors) and conducted a one-tailed paired t test on this data testing for whether the mean number of positive social behaviors are **HIGHER** after treatment, what would our statement be? Follow the answer format instructions as in question (b). **Note:** no credit will be given for ANY text outside the box or hard to read answers.

The number of positive social interactions of the male baboons are **SIGNIFICANTLY HIGHER** after treatment \((0.005 < p < 0.01)\).