Fruit Fly Feeding Behaviour

Result and Analysis

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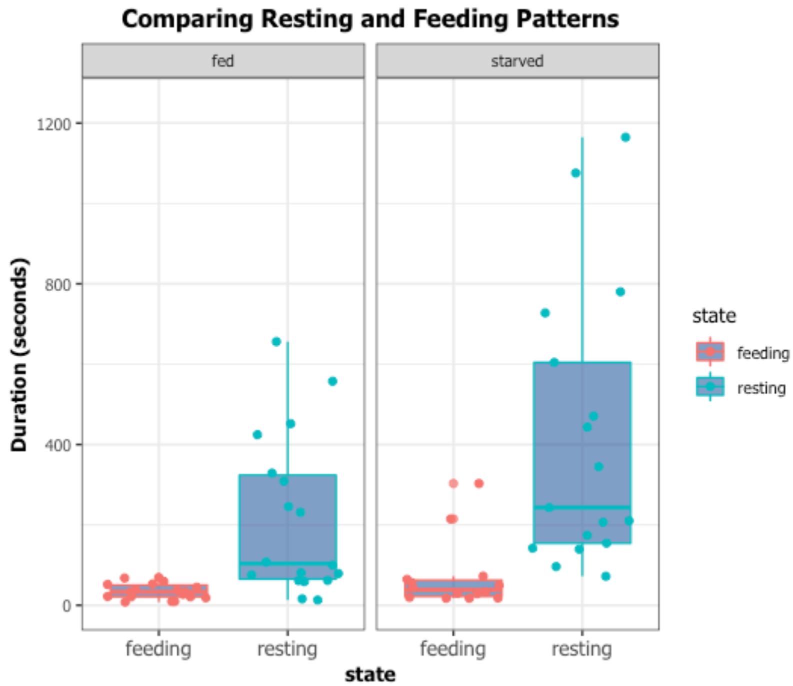
1. Boxplots: Comparing Resting and Feeding Patterns Between Fed and Starved Flies



The boxplots represent the five-number summary of the lengths of a given state - either feeding or resting - in seconds. The five numbers are the first, second and third quartiles as well as the minimum and maximum. The left side contains the boxplots of the three flies that were fed prior to recording the data. The right side contains the boxplots of the three other flies that were not given glucose water for a long period of time (not given) prior to recording the data. See Appendix A for the boxplots of individual flies.

The boxplots show that the duration of feeding time are not significantly different between the fed and starved flies. However, it can be observed that the resting time for the starved flies are significantly longer than that of the fed flies. Summary of the data can be obtained as the following:

	FED FLIES	**STARVED FLIES**
FEEDING INTERVAL	Min. 1st Qu. Median Mean 3rd Qu. Max. 8.06 21.18 33.59 34.80 50.03 69.43	Min. 1st Qu. Median Mean 3rd Qu. Max. 17.55 22.17 38.49 69.24 62.40 303.04
RESTING INTERVAL	Min. 1st Qu. Median Mean 3rd Qu. Max. 13.23 65.35 103.59 214.40 323.87 656.11	Min. 1st Qu. Median Mean 3rd Qu. Max. 72.21 154.43 243.15 414.73 604.31 1164.76

When feeding, the fed flies spend 33.59 seconds (median) or less, half the time, whereas the starved flies spend 38.49 seconds (median) or less, half the time. When resting, the fed flies spend 103.59 seconds (median) or less, half the time, whereas the starved flies spend 414.73 seconds (median) or less, half the time.

Before analyzing the difference between the two conditions of the flies, a test for normality and a test for homogeneity are done.

2. Normality and Homogeneity of Data

We wish to understand the statistical properties of the data to conduct a suitable test. We set the significance level of the tests as $\alpha = 0.05$.
Shaprio-Wilk test is done to check the null hypothesis that the data's distribution is not different from the normal distribution.

Feeding Intervals Data

```
> residuals(feed.aov) %>% shapiro.test()

Shapiro-Wilk normality test

data:  .
W = 0.68069, p-value = 4.528e-07
```

Resting Intervals Data

```
> residuals(rest.aov) %>% shapiro.test()

Shapiro-Wilk normality test

data:  .
W = 0.89102, p-value = 0.002288
```

For both sets of data, p-values are below the significance level 0.05 - the probabilities that the distribution of the data being normal are unlikely. We reject the null hypothesis. Therefore, we cannot assume normality however, we must also note that normality test is sensitive to the size of the data. Smaller data tend to easily pass the test however, we cannot be certain until the normality test is redone with a large dataset. In this analysis, we will assume that the datasets are **not** normal.

Now we conduct *Levene*'s test to check the null hypothesis that the variance across the two factor groups (fed and starved conditions) is not different.

Feeding Intervals Data

```
> leveneTest(duration ~ condition, data = feeding)
Levene's Test for Homogeneity of Variance (center = median)

      Df F value Pr(>F)
group  1  2.6685 0.1128
      30
```

Resting Intervals Data

```
> leveneTest(duration ~ condition, data = resting)

Levene's Test for Homogeneity of Variance (center = median)

      Df F value Pr(>F)
group  1  1.9086 0.1764
      33
```

For both sets of data, the p-values are greater than the significance level 0.05 - the probabilities of having homogeneous variance across the two factor groups are likely. We do not reject the null hypothesis. For the analysis, we assume that the variance across the fed and starved flies groups are not different.

3. One-Factor Analysis of Variance

The assumptions required for ANOVA are not 1) the distribution of the data is normal and 2) the variance across the factor groups are homogeneous. In the previous section, we showed that normality is not assumed but homogeneity is assumed. Therefore, we conduct the non-parametric alternative test - also known as, *Kruskal-Wallis* rank sum test - for ANOVA. We test the null hypothesis that the medians of two factor groups are equal.

Feeding Intervals Data

```
> kruskal.test(duration ~ condition, data = feeding)

Kruskal-Wallis rank sum test

data:  duration by condition
Kruskal-Wallis chi-squared = 0.69841, df = 1, p-value = 0.4033
```

Resting Intervals Data

```
> kruskal.test(duration ~ condition, data = resting)

Kruskal-Wallis rank sum test

data:  duration by condition
Kruskal-Wallis chi-squared = 4.6024, df = 1, p-value = 0.0319
```

For the feeding interval dataset, the p-value is greater than the significance level 0.05. We do not reject the null hypothesis; for feeding intervals, we do not reject the hypothesis that the median feeding duration of the fed and starved flies groups are equal. For the resting interval dataset, the p-value is smaller than 0.05, so here we reject the null hypothesis. In other words, we reject the hypothesis that the median resting duration of the fed and starved flies group are equal.

The result of the analysis can be compared with the boxplots on page 3. The difference in the resting intervals between the two groups seem significant, where as that of the feeding intervals do not seem negligible.

4. Sources of Error

Six flies were used to record the data. Three of those flies were "starved" and the other three were "fed" before conducting the experiment. In hindsight, exposing each fly to one condition and later, the other condition would have given better sets of data for comparison.

The definitions of "feeding" and "resting", and the time requirements result in drastically different conclusions. The assumptions associated with what is considered as a "true" feeding/resting interval also significantly affect the results. It is recommended to set a time requirement for *only* feeding interval so that the time spent other than feeding would, automatically, be considered as resting state. As demonstrated in the programming script, setting the time requirements for *both* feeding and resting intervals requires a more complicated algorithm to prepare the data for analysis. If the algorithm can be simplified, another potential source of error can be avoided.

Another source of error is the lack of data. After cleaning and preparing the data, 67 observations are obtained. Try

```
> length(compare_boxes$duration)
```

For a better representation of the distribution and variance of the data, it is recommended to collect more data.

Lastly, it should be noted that the interpretation of the tests are affected by the level of significance. For example, in the section One-Factor Analysis of Variance, the p-value for the resting intervals data is 0.03193. If the level were set at $\alpha = 0.01$, then the null hypothesis that the median resting duration of the fed and starved flies groups are equal would be accepted and we would conclude that there is no difference between the groups. Significance level represents the probability of Type I error, which is the probability of accepting the null hypothesis when the alternative hypothesis is true. It is desirable to avoid the error and so testing with $\alpha = 0.01$ may be preferred over $\alpha = 0.05$, depending on the researcher.

5. Appendix

Boxplots by individual flies