

Assignment #18

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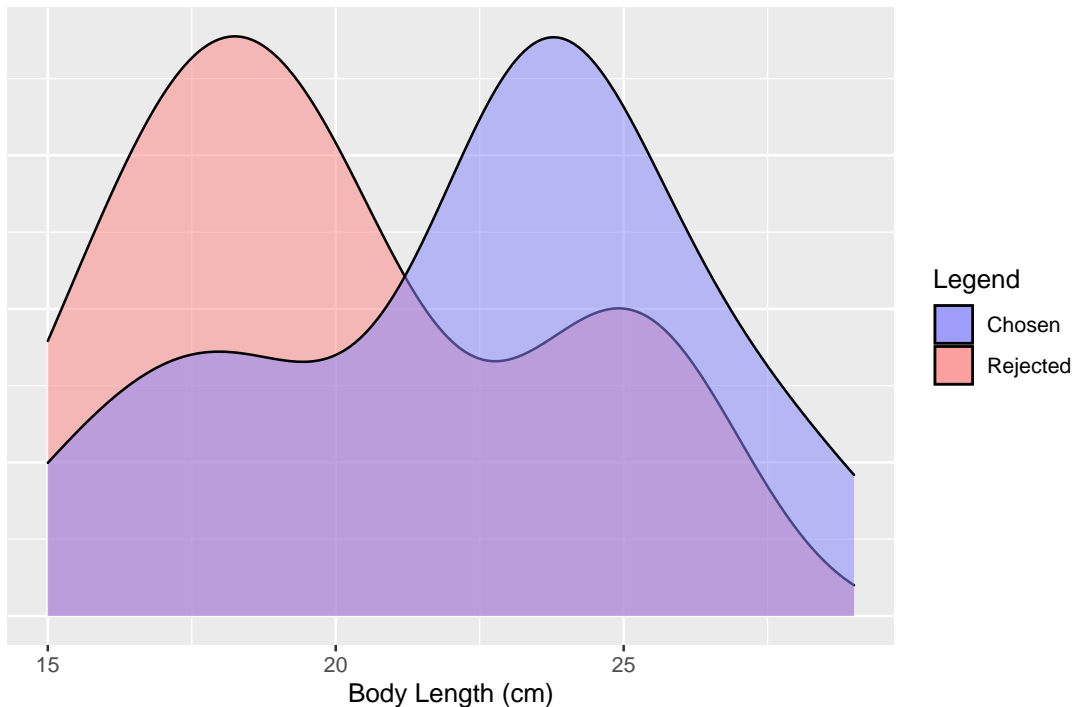
2023-01-20

Task #1

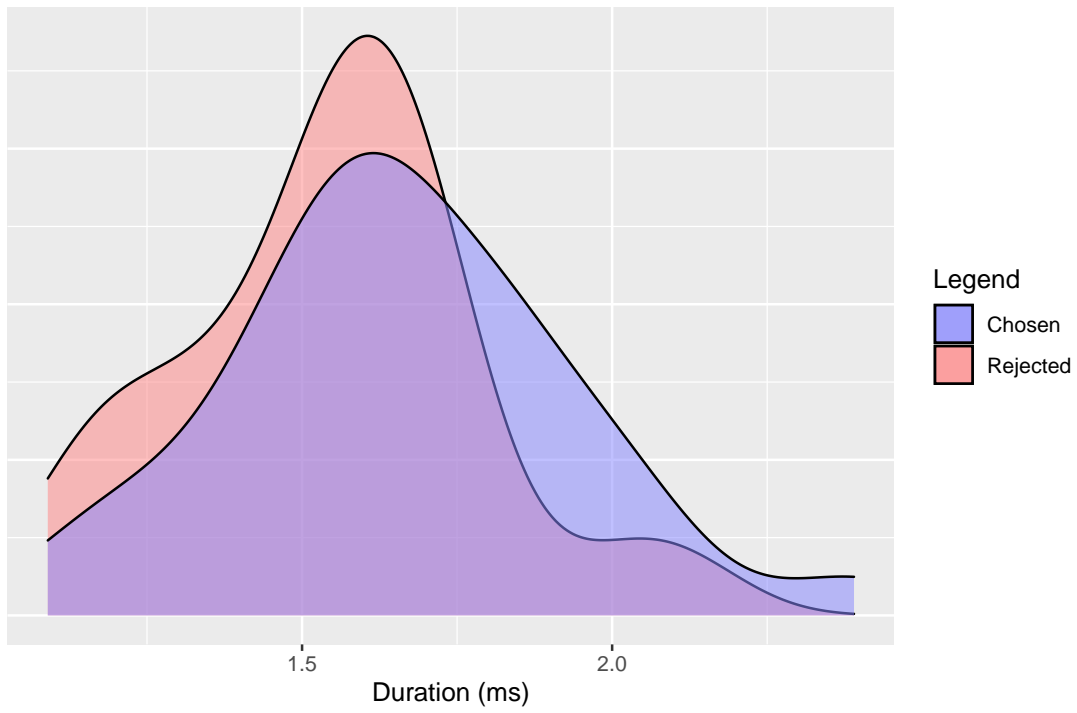
Construct and describe graphical displays of your choice which easily compares the distributions of the differences in body length, waveform duration, and waveform amplitude of the chosen vs. rejected males. What differences, if any, do you see in these distributions? You should end up with three different comparisons, or six separate graphs. Please include titles, labels, and colors. When discussing differences in distributions, make sure you state in context differences in center, shape and spread of the distributions using comparative language. Make sure you are using calculated statistics in your contextual descriptions.

Graphs

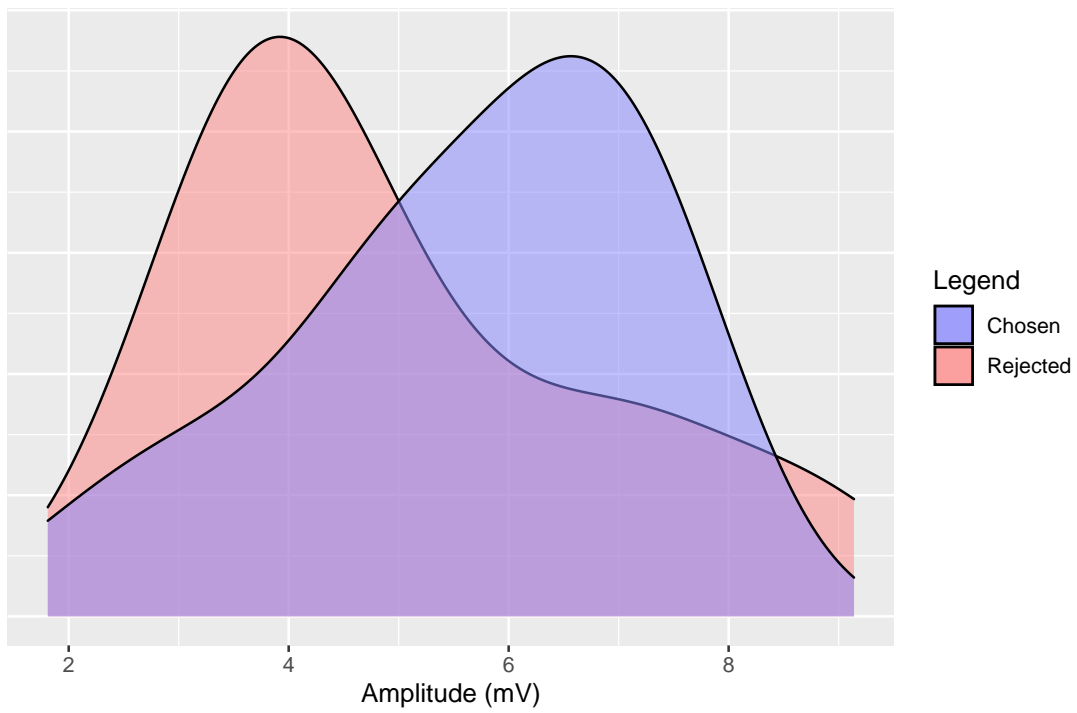
Comparison of Body Length of Chosen and Rejected Fish



Comparison of EOD Duration of Chosen and Rejected Fish



Comparison of EOD Amplitude of Chosen and Rejected Fish



Analysis

Body Length

It appears as though the chosen fish typically have a greater body length than the rejected fish. The center of the distribution of body lengths of the chosen fish is greater than the center of the distribution of body length of rejected fish ($median = 23$ vs. $median = 19.25$). The two distributions appear to have the same shape, but mirrored. The distribution of body length is left-skewed for chosen fish, but right-skewed for rejected fish. They both have their own mode, and then another, smaller peak closer to the mode of the other distribution. I believe that this is caused by the design of the experiment, where the two fish in each trial had body lengths that differed by at least 4cm. The two peaks in each distribution correspond to the average body lengths of the longer and shorter fish. The smaller peaks correspond to when the smaller fish gets chosen or the larger fish gets rejected. The two distributions have very similar spreads ($IQR = 5.25$ for chosen vs. $IQR = 5.5$ for rejected).

EOD Duration

The centers of the distributions of EOD duration for the chosen and rejected fish have almost the same center ($median = 1.620$ for chosen vs. $median = 1.546$ for rejected). They both have a positive skew, and the skew is more extreme for the rejected fish than for the chosen fish. The spread of the distribution of the EOD duration for the chosen fish is greater than the spread for the rejected fish ($IQR = 0.345$ for chosen vs. $IQR = 0.303$ for rejected).

EOD Amplitude

The center of the distribution of EOD amplitude is greater for chosen fish than it is for rejected fish ($median = 5.985$ for chosen vs. $median = 4.3$ for rejected). As with body length, they have a similar shape, but mirrored, with the distribution for chosen fish being negatively skewed and the distribution for rejected fish being positively skewed. The distribution for chosen fish has a slightly greater spread than the distribution for rejected fish ($IQR = 2.243$ for chosen vs. $IQR = 2.657$ for rejected).

Task #2

Which, if any, of the above characteristic comparisons between the chosen and not chosen mates are statistically significant? Include hypotheses, test statistic values, and p-values only. Then summarize your findings in a paragraph.

Body Length

Let μ_d = the true mean difference between the body lengths of the fish in each trial

$$H_0 : \mu_d = 0$$

$$H_a : \mu_d > 0$$

$$t = 1.905$$

$$p = 0.03374$$

Duration

Let μ_d = the true mean difference between the EOD durations of the fish in each trial

$$H_0 : \mu_d = 0$$

$$H_a : \mu_d > 0$$

$$t = 1.6043$$

$$p = 0.06014$$

Amplitude

Let μ_d = the true mean difference between the EOD amplitudes of the fish in each trial

$$H_0 : \mu_d = 0$$

$$H_a : \mu_d > 0$$

$$t = 1.0498$$

$$p = 0.1516$$

Conclusion

Only the difference in body length was statistically significant at the 0.05 level, with a p -value of 0.03374. The differences for EOD duration and EOD amplitude had p -values of 0.06014 and 0.1516, respectively. The test that I ran was a matched pairs difference of means t-test.

Task #3

It is also possible that the female may be considering combinations of characteristics. For example, some combination of body length and EOD duration may be particularly attractive to the female. We are NOT going to run a multiple regression analysis (this time), but rather for each pair of characteristics (body length vs EOD duration, body length vs EOD amplitude, and EOD duration vs EOD amplitude) compare the chosen and rejected males using scatterplots of these pairs of variables as well as regression techniques. Include summary statistics of your linear regression models. (This means you will have three comparisons and six scatterplots/regression models.) To aid you as you compare and share your findings, results and conclusions with your peers and supervisor (me), make sure you use standardized scatterplots. Set up your scatterplots using these criteria:

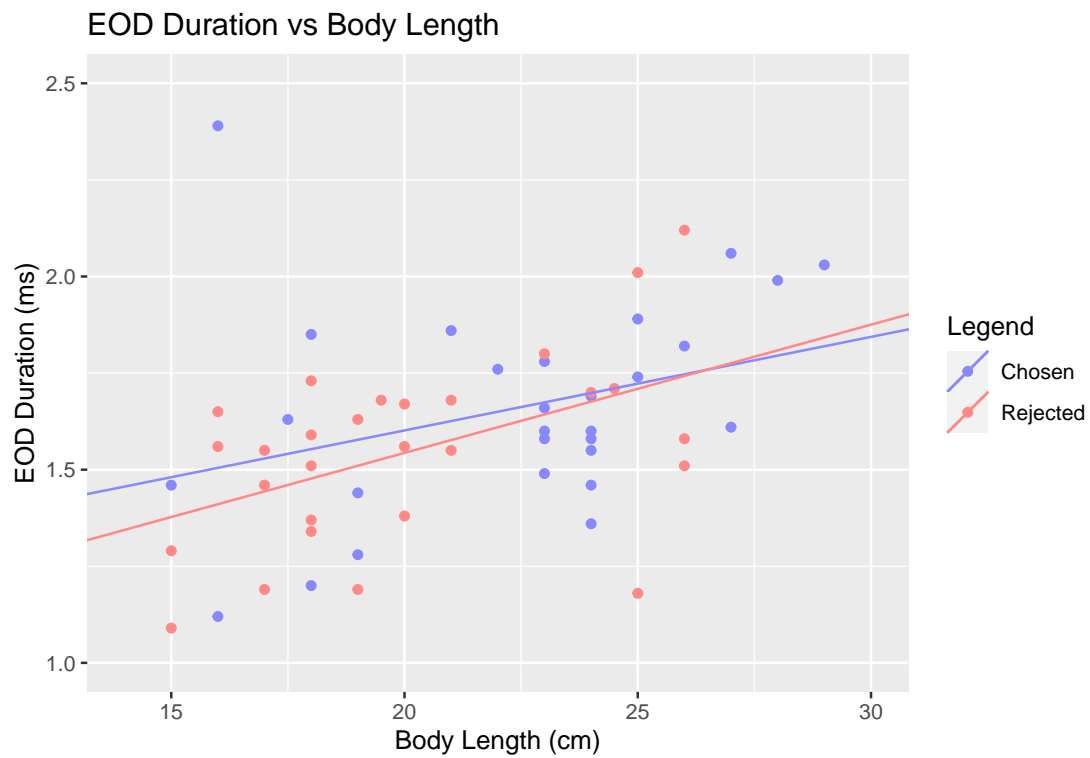
- Put body length on the horizontal axis; when comparing the two EOD measurements, put EOD duration on the horizontal axis. (Pay attention to this, and how it influences how you run a regression using R code.)*
- Use a scale of 14 to 30 cm for the body lengths; a scale of 1.0 to 2.5 ms for EOD duration; and a scale of 1 to 10 mV for amplitude.*

What differences, if any, do you see in your bivariate analysis of these pairs of variables?

We recognize that differences between the chosen and the rejected males that we may detect – either those that are obvious by inspection or more subtle differences we would detect with our statistical hypothesis tests – may or may not correspond to differences the female pintail knife fish may detect or even care about. But, for the sake of this assessment, let us suppose that the female pintail can detect every difference that we can notice.

EOD Duration as a Function of Body Length

Graph



Chosen

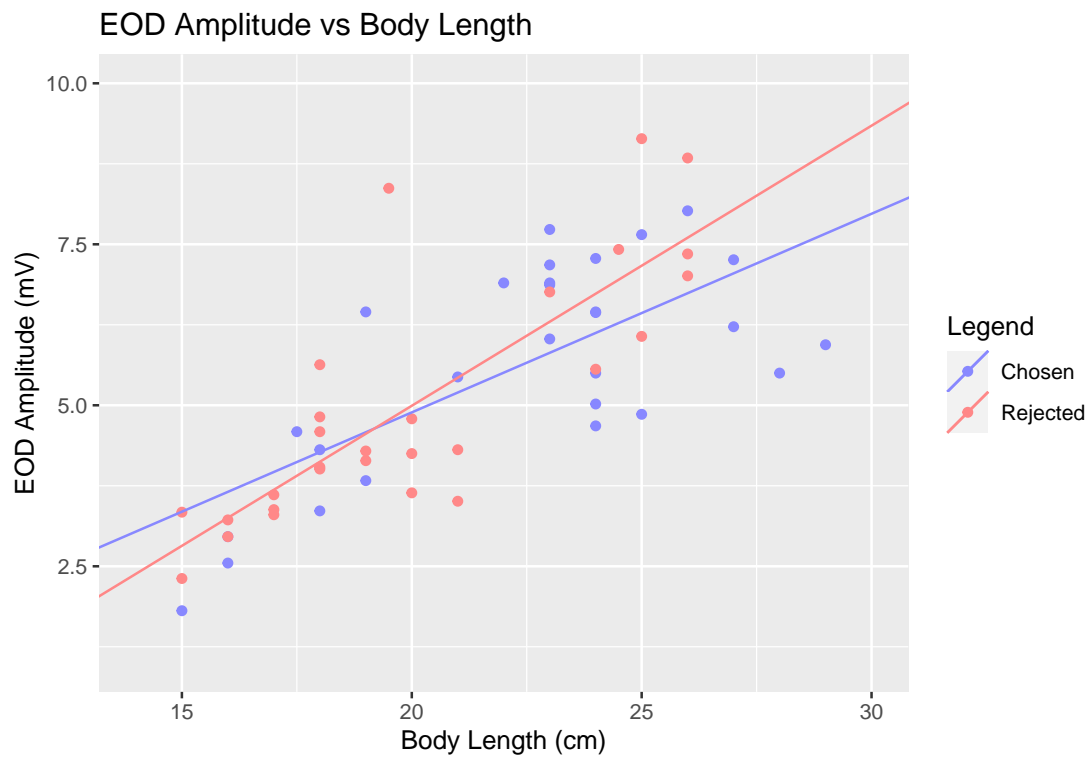
$$\widehat{Duration} = 1.11736 + 0.02421(BodLen)$$
$$r^2 = 0.11, r^2(adj) = 0.07574$$

Rejected

$$\widehat{Duration} = 0.87955 + 0.03319(BodLen)$$
$$r^2 = 0.2409, r^2(adj) = 0.2117$$

EOD Amplitude as a Function of Body Length

Graph



Chosen

$$\widehat{Amplitude} = -1.27921 + 0.30844(BodLen)$$

$$r^2 = 0.4976, r^2(adj) = 0.4782$$

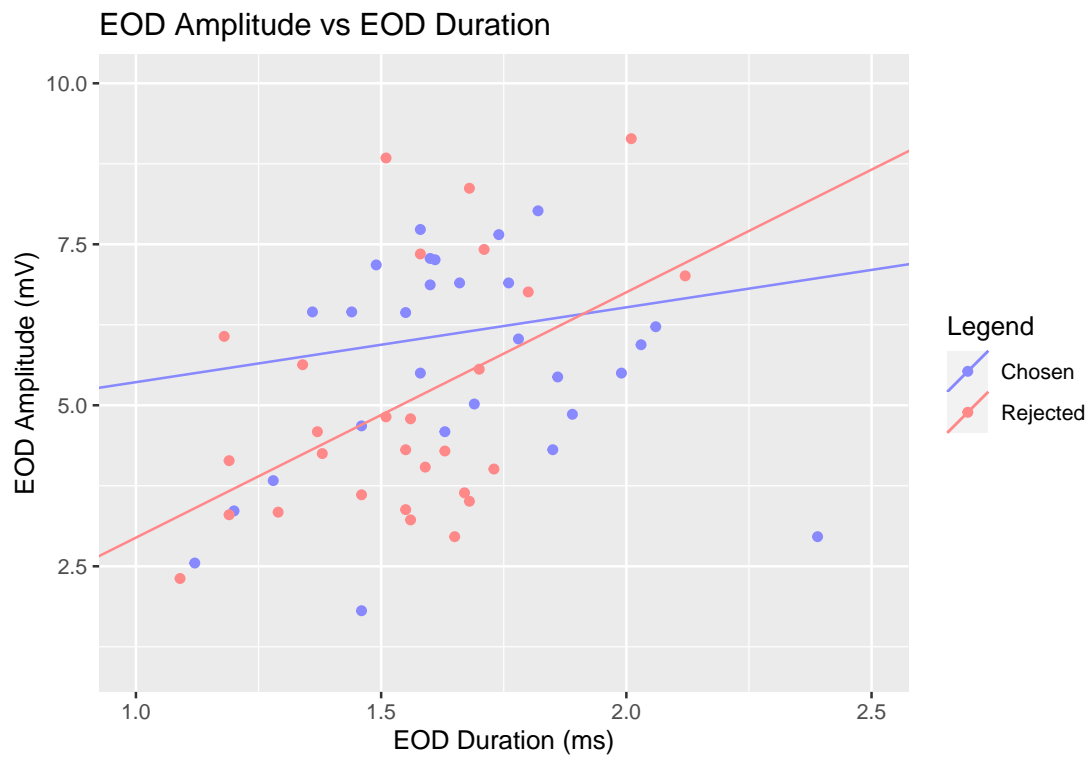
Rejected

$$\widehat{Amplitude} = -3.70646 + 0.43495(BodLen)$$

$$r^2 = 0.6569, r^2(adj) = 0.6437$$

EOD Amplitude as a Function of EOD Duration

Graph



Chosen

$$\widehat{Amplitude} = 4.1968 + 1.1621(Duration)$$

$$r^2 = 0.02088, r^2(adj) = -0.01678$$

Rejected

$$\widehat{Amplitude} = -0.8657 + 3.8100(Duration)$$

$$r^2 = 0.2305, r^2(adj) = 0.2009$$

Conclusion

One difference I noticed was that, typically, the chosen males have less correlation between the variables than the rejected males. This could indicate that there is some other characteristic that differentiates the chosen males from the rejected ones. This is because the lower r^2 value means that less of the variation in the predicted variable is explained by the predictor variable, which indicates that something else is explaining the variation. Another thing that I noticed was that body length seemed to be a good predictor of both EOD amplitude and EOD duration. This indicates that body length could be a good predictor of whether a fish gets chosen or not because it likely has an effect on the other two variables.

Task #4

Consider the characteristics you have compared above (referencing problems 1, 2, and 3). What single characteristic difference between chosen and rejected males do you feel is ‘most different’ or ‘most easily detected’? Why do you feel this characteristic, more than the others, separates the rejected and chosen males?

I think that body length is the most different characteristic. This is because the fish that was selected in each trial was almost always the one with the greater body length. If you look at the graph in Task #1 comparing the body lengths of chosen and rejected males, you can see that, in general, the body length of chosen fish is greater than that of rejected fish. More evidence for this claim can be found in Task #2, where of the 3 t-tests conducted, the one comparing body length for chosen and rejected males had the greatest t -value and the lowest p -value. Finally, in Task #3, the linear regression models using body length as a predictor had higher r^2 values than the one that did not. This indicates that body length has an influence on the other two variables as well, which means that the higher body length typical of the chosen males would result in more extreme (in this case, greater) values for the EOD duration and EOD amplitude, which would make a fish even more likely to be chosen in the experiment.

Task #5

What is the explanatory variable in this experiment? What must we assume happened in the experimental design described above? From the results of your analysis above, do you feel a conclusion that body length ‘causes’ the female mate selection is justified? Why or why not? Please be thorough in your response.

The explanatory variable in this experiment was body length. As explained in Task #4, body length’s influence on the other variables means that it has a greater effect on whether a fish gets chosen or not. Because of this, the males with a greater body length still got chosen far more often than the ones with a shorter body length, even though the experiment was set up so that the females could not see the males until it was time to choose, which means that the choice was mostly directly influenced by the EOD attributes (i.e. duration and amplitude). However, in Task #2, it was shown that the difference in body length between the chosen

and rejected males was the most significant. In Task #3, it was shown that body length was a good predictor of the EOD attributes. Using these two facts, we can deduce that body length's influence on duration and amplitude "carried over" to being an influence on the female's choice. Based on this analysis, I believe that it is reasonable to conclude that a change in body length would cause a change in the likelihood that the fish is chosen. Since it is an experiment, the results indicate causation rather than just correlation.