MEMORANDUM

To: Dr. Karen Bangs

From: Andrew Harlow

Date: June 4, 2022

Re: Cal Poly IME Ergonomics Grip Strength Experiment Statistical Analysis

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The purpose of this memo is to describe the statistical methods and findings from an analysis of your Ergonomics data. I hope that this information helps you address your research project questions:
1. *Results and interpretations of an analysis of this data that determines how different palm grip directions and auditory stimuli affects grip strength.*
2. *Advice about how the student team could improve their experiment in the future. For example, should they modify the experimental design in some manner or should they change the number of participants included in the experiment?*

This memo is organized into two sections.
1. The second section, "**Statistical Methods and Scope of Inference**," describes an analysis approach for your consideration and the population I can generalize the findings to. (page 1)
2. The fourth section, "**Results and Discussion**," describes the results from an analysis for your consideration. (pages 1-2)

I.   <u>**Statistical Methods and Scope of Inference**</u>

I decided to move forward with an ANOVA Generalized Linear Model for the statistical analysis method for research question one. The model assumptions for this analysis were all met. You should proceed with caution with these results because there is an uneven amount of participants across treatments. Also, I found that observation 3 and 59 were outliers in the data. Both of these findings affect the accuracy of the results. For the second research question I used a sample size estimation based on a 95% Confidence Interval to determine the minimum number of participants needed for this experiment. A 95% Confidence Interval represents an interval where you would be 95% confident that the true force value of Maximum Recorded Grip Strength is between two force values in pounds. The margin of error helps calculate this by representing the specified difference in lbs between the true value and one of the endpoints of the interval. Therefore, if you multiply this margin of error by 2 you would have the range of your 95% Confidence Interval. I will be using different margin of error values to provide you options of sample sizes based on how much error you are willing to accept. All of the assumptions for this analysis were met. The population I can generalize this to is only female and male Cal Poly students because it was a combination of IME students and their friends who participated in the experiment.

II.   <u>**Results and Discussion**</u>
Research Question #1

The response variable in this experiment was the Maximum Recorded Grip Strength (lbs) while the explanatory variables were Auditory Stimulus, Grip Direction, and Gender. I included the 4 total combinations of factors to see if any combinations were significant.The statistical analysis found that Auditory Stimulus, Grip Direction, and all of the combination of factors are not statistically significant predictors of Maximum Recorded Grip Strength when Gender was in the model. Without Gender in the model the analysis still found these variables to be insignificant. However, Gender was a statistically significant predictor of Maximum Recorded Grip Strength as seen in *Figure 1*. When a random participant is female, I expect the Maximum Recorded Grip Strength to decrease by 17.97 lbs, on average, after adjusting for the other variables in the model.
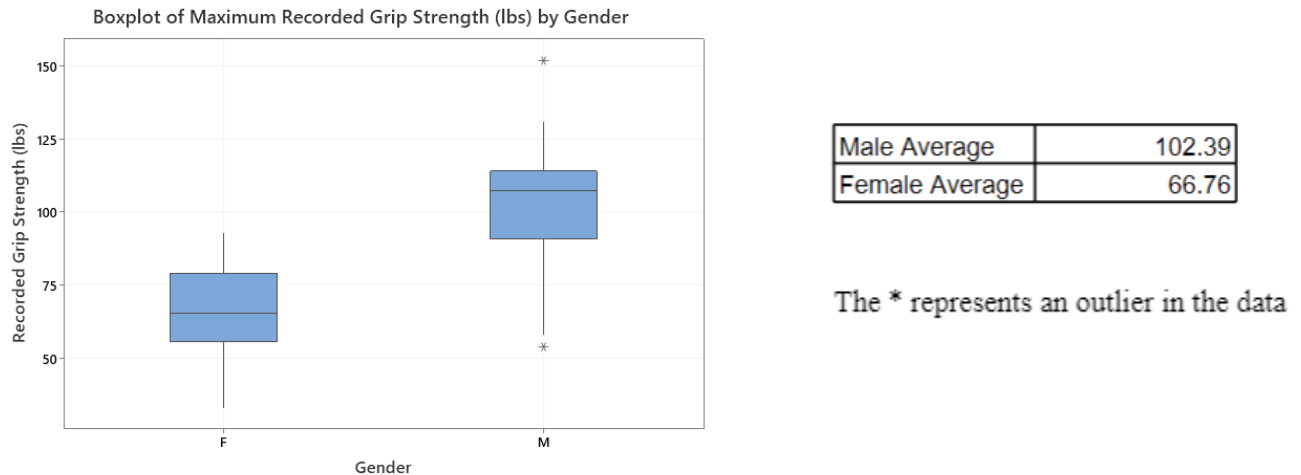

| Male Average | 102.39 |
| Female Average | 66.76 |

The * represents an outlier in the data

Figure 1:Boxplot of Maximum Recorded Grip Strength by Gender and Table of Averages (lbs)

Research Question #2
I have 2 recommendations on how the student team can improve their experiment in the future:
1. Random Assignment with Blocks: I noticed that there were an uneven amount of participants across treatments. To better improve the experiment, it would be helpful to first make sure you have an even amount of participants across treatments. Also, to have an even amount of replicates of all treatment combinations across Gender would be very beneficial. Both of these ensure accuracy in the results. Because Gender proved to be a significant factor, it would be helpful to block on Gender by using a Randomized Complete Block Design so you could accurately measure the effects of the other factors.
2. Minimum Required Sample Size: Based on how much error you are willing to accept and the number resources and participants you have, I can find the minimum required sample size for this experiment. As seen in *Figure 2*, if you are satisfied with a difference of 5 lbs from the true value of the Maximum Recorded Grip Strength (or a range of 10 lbs for the interval), the minimum required sample size is 100. As the margin of error increases the minimum required sample size decreases.

Margin of Error (lbs)	Required Sample Size
4	155
5	100
6	70

Figure 2: Table of Options for Margin of Error and the Corresponding Sample Size