Group 2's Consulting Report

Kuangyou Chen, Yanbing Chen, Rose Determan, and Biyao Zhang

Introduction

Razan came to us with questions about her study of the impact of exercise on brain activation. She had three main questions.

1. Are there differences in brain region activation before and after the exercise intervention?
2. Is there a correlation between fitness and brain region activation?
3. Are there differences between the control group and the treatment group?

Due to participant drop-out, there were 15 individuals in the study. This small sample size is a limitation, since many statistical tests would lack sufficient power to confidently make conclusions. If, for example, we ran an ANOVA test, we would risk having either a type I or type II error where we reject a hypothesis that is the true hypothesis. Below, we have completed an exploratory data analysis (EDA) with several figures that illustrate the data, but we do not make strong conclusions about relationships between variables.
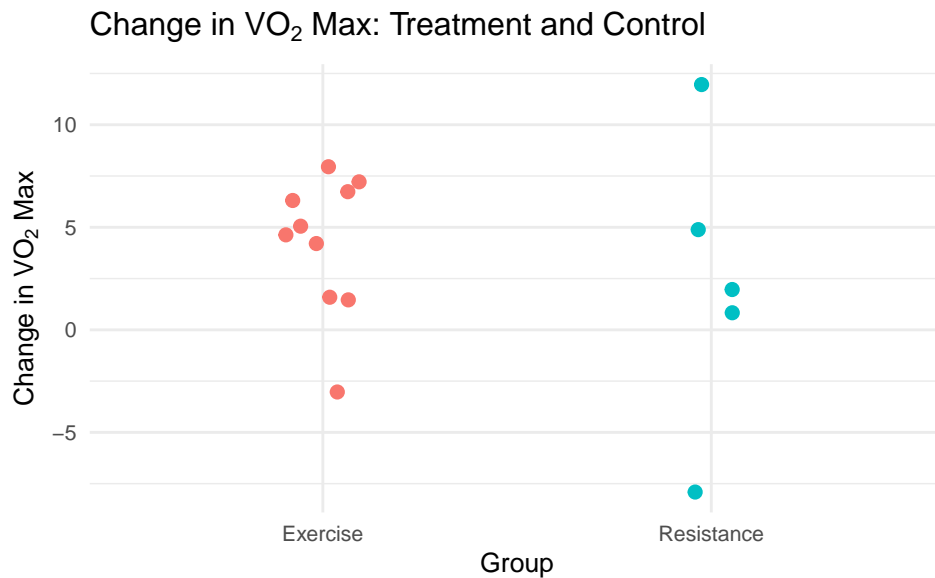
Change in VO_2 Max

Figure 1: We can see the differing spreads in the treatment and control groups. The minimum and maximum change of VO_2 max in the control group is each more extreme than the minimum and maximum in the treatment group. In both groups, most participants have a positive change of max VO_2.

The treatment group performed an aerobic/endurance exercise training program for 12 weeks (n=10). The control group performed a resistance training program for 12 weeks (n=5), since resistance training has been shown to not impact cardiopulmonary fitness.

Change in VO$_2$ Max and Brain Activation

The abscissa of each point in the below figure shows the change of VO$_2$ max, and the y axis shows the change in brain region activation (Figure 2). The data are mainly distributed in the first and fourth quadrants. Based on the plot the range of VO$_2$ max in the control group is greater than that in the treatment group.
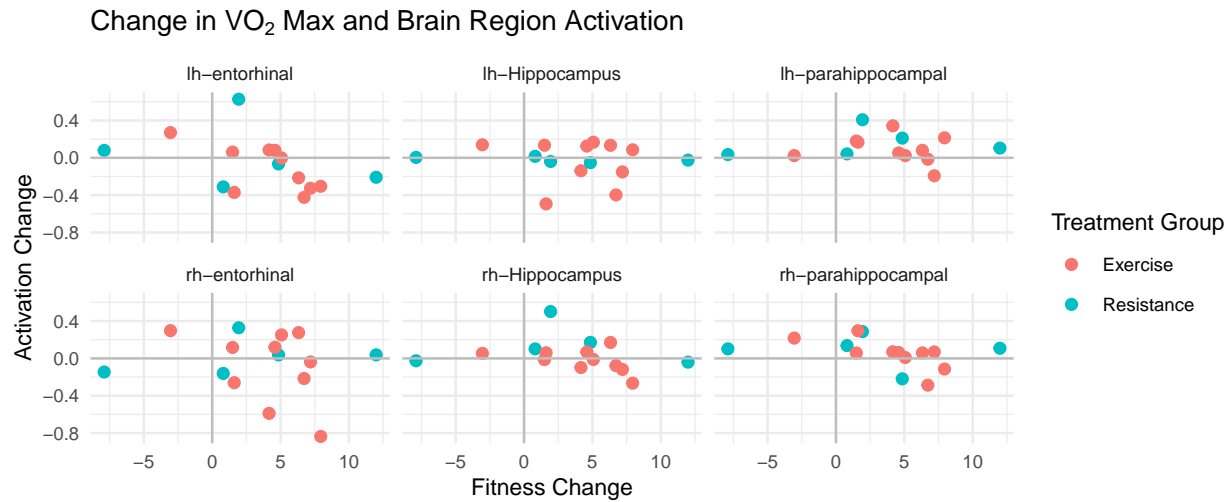

Figure 2: In the entorhinal, hippocampus and parahippocampal regions of the left and right brains, a small number of data in the control group and treatment group had a negative change in VO$_2$ max, and the rest are positive.

Figure 3 shows the individual's changes in brain region activation before and after treatment and color coded by treatment group.

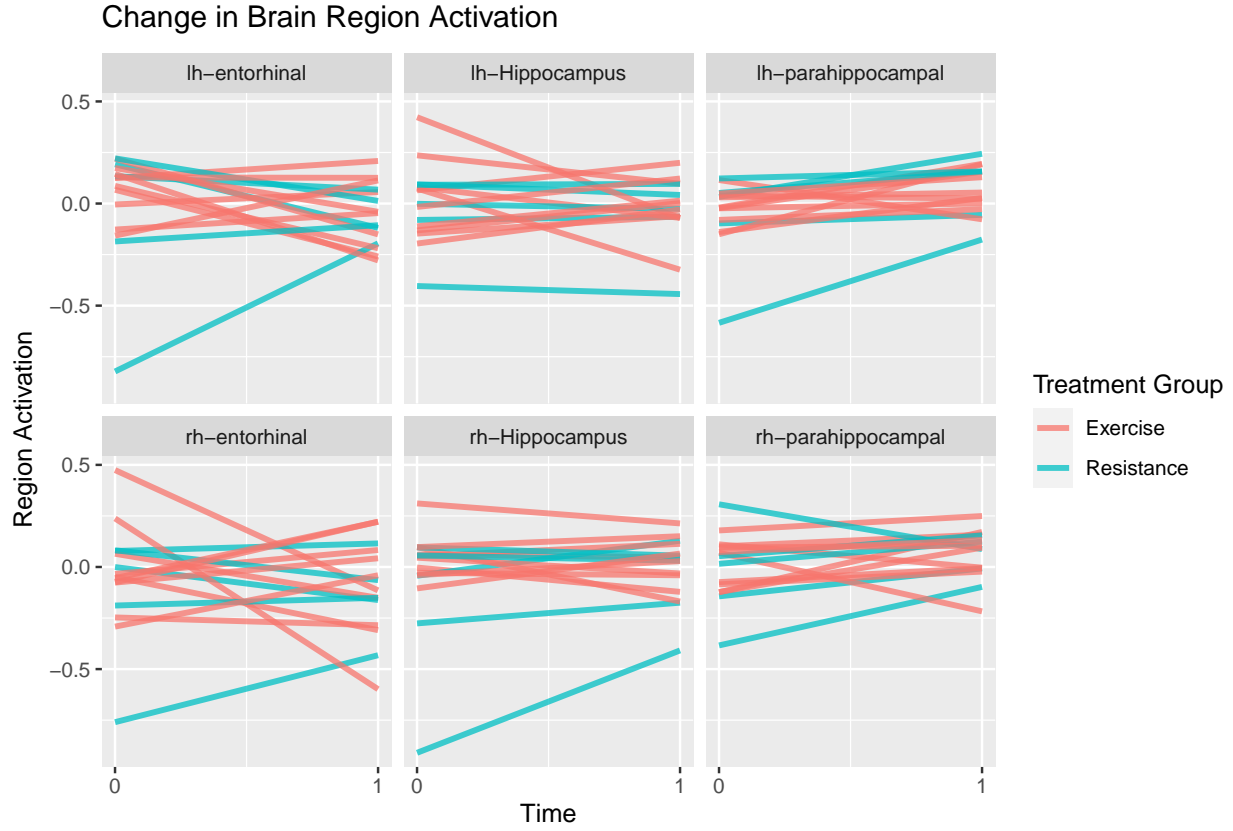**Change in Brain Region Activation**

Figure 3: We can see that, in general, participants had a slight increase in region activation , regardless of treatment group, although we also see that some had a decrease.

Figure 4, similarly to Figure 4 illustrates individual's changes before and after treatment. Figure 5 shows separate plots for the exercise group and the resistance training group. In most cases there was a slight increase in fitness.

Table 1: Summary of Exercise and Resistance Groups Before and After Treatment. At an alpha level of 0.05, there is not a statistically significant difference in the means of VO_2 max before and after treatment, or between groups.

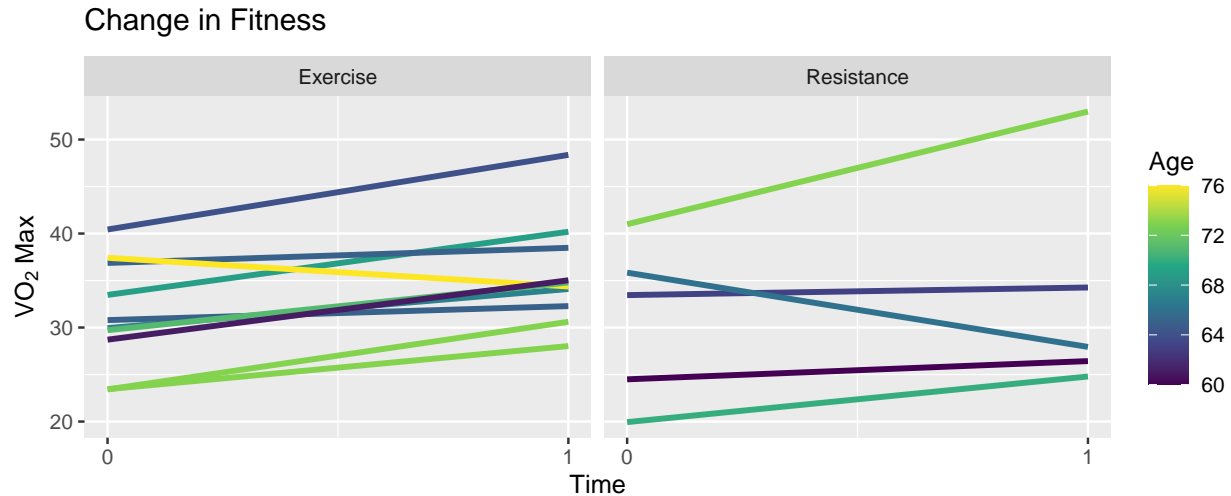| Group	time	Mean	Standard_Deviation	Lower_CI_of_Mean_95	Upper_CI_of_Mean_95
ET	0	31.4	5.7	27.3	35.5
RT	0	30.9	8.6	20.3	41.6
ET	1	35.6	5.7	31.6	39.7
RT	1	33.3	11.6	18.9	47.7

Figure 4: This figure aligns with the below table. In this figure each subject is a line, and the color represents their age, since we could expect older individuals to have a different response than younger participants. Time 0 represents pre-treatment and time 1 represents post treatment.

Below is a summary of two linear regression models that fits estimated VO_2 max with a predictor of time. Based on the standard errors and p-values of the time coefficients, at the 95% confidence level, there is not a statistically significant difference between fitness before and after treatments.

Resistance Group

```
##
## Call:
## lm(formula = vo2max ~ time, data = vo2, subset = Group1 == "Resistance")
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -11.002  -6.750  -2.180   4.301  19.700
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   30.942      4.557   6.791 0.000139 ***
## time           2.338      6.444   0.363 0.726137
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.19 on 8 degrees of freedom
## Multiple R-squared:  0.01619,    Adjusted R-squared:  -0.1068
## F-statistic: 0.1316 on 1 and 8 DF,  p-value: 0.7261
```

Exercise Group

```
##
## Call:
## lm(formula = vo2max ~ time, data = vo2, subset = Group1 == "Exercise")
##
## Residuals:
```

```
##    Min      1Q Median     3Q    Max
## -8.001 -2.869 -1.045  3.283 12.745
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   31.421      1.798  17.474 9.77e-13 ***
## time           4.204      2.543   1.653    0.116
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.686 on 18 degrees of freedom
## Multiple R-squared:  0.1318, Adjusted R-squared:  0.08359
## F-statistic: 2.733 on 1 and 18 DF,  p-value: 0.1156
```

Change in Brain Region Activation

Figure 5 shows change in brain region activation for each measured region. If a point falls in the first or third quadrant, their activation remained either positive or negative for both readings, but if a point is in the second or fourth quadrant, the activation changed from either
1. negative in the first reading to positive in the second reading or
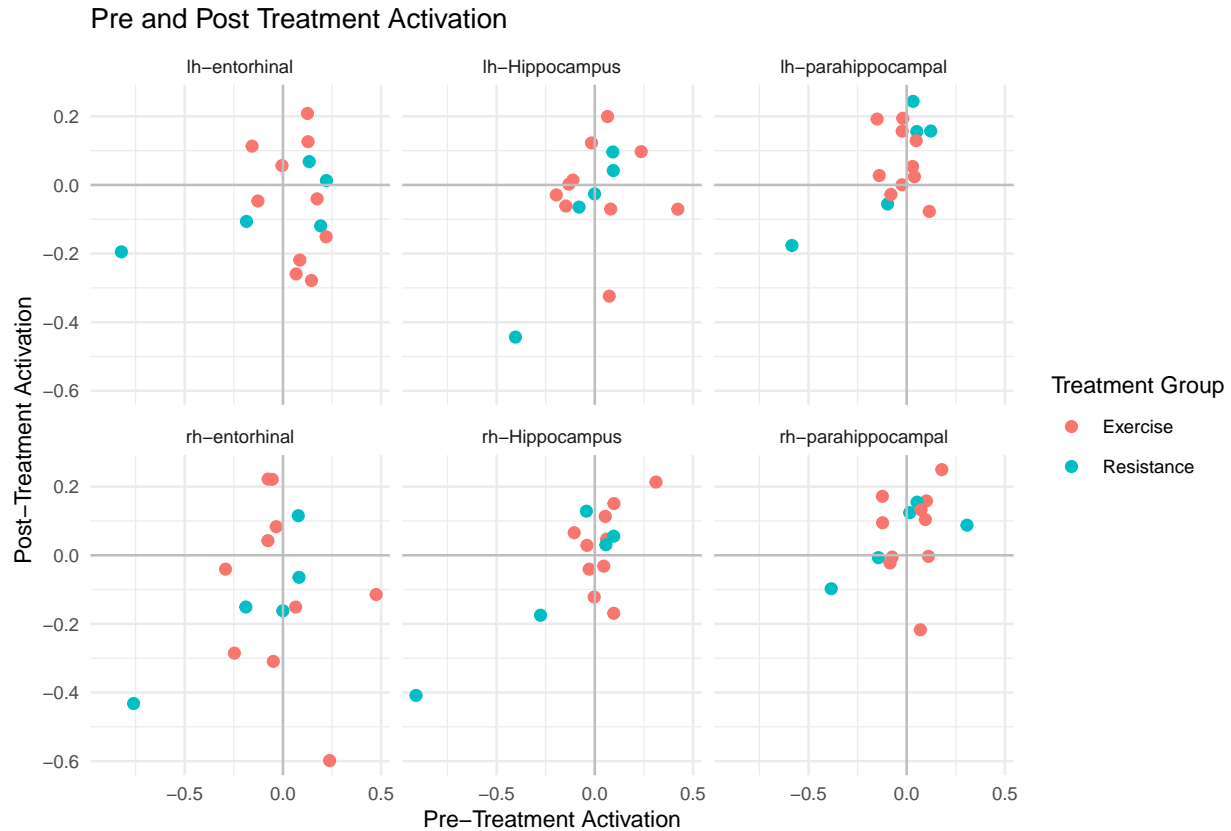2. positive in the first reading to negative in the second reading.

Figure 5: The x-axis shows the pre-treatment level of activation and the y-axis shows the post-treatment level for the same participant. Each region shows a slightly different pattern of points, but no single plot stands out as having a distinct pattern.

Conclusion

Based on the provided data, the exercise intervention leads to impacts of varying degrees depending on the individual. Based on our EDA, there is not a detectable linear relationship between fitness and brain region activation.The differences between control and treatment groups follow a similar pattern and we were not able to detect a significant difference. In future studies we would recommend a larger sample size. We would be happy to consult on suggested sample sizes for future projects.