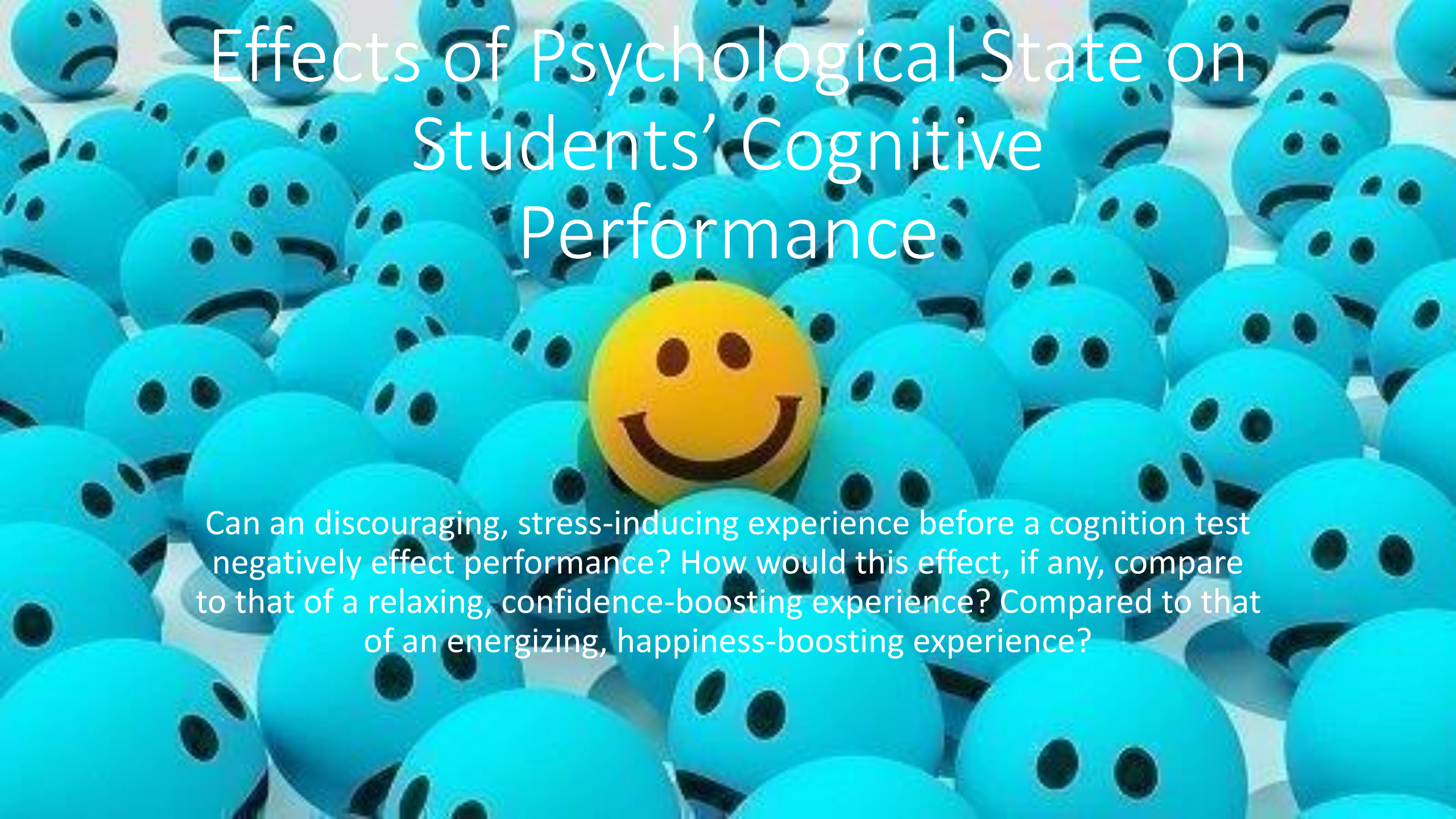
Effects of Psychological State on Students' Cognitive Performance



Can an discouraging, stress-inducing experience before a cognition test negatively effect performance? How would this effect, if any, compare to that of a relaxing, confidence-boosting experience? Compared to that of an energizing, happiness-boosting experience?

The Experimental Design

- Experimental Design: Randomized block design[1]

$$y_{ij} = \mu + \tau_i + \beta_j + \epsilon_{ij}$$

- Factor of interest: Experience of student before a 4 minute difficult mental arithmetic test. 3 treatment types randomly assigned to be applied before test: Receive a laceration, Receive a Swedish Massage, Eat 50 g of milk chocolate.
  - The following results were found in some preliminary testing* experiments:
    - Laceration Level: Lacerations cause Islanders to become very angry, discouraged and unhappy, while also reducing their feelings of self-worth and confidence.
    - Swedish massage Level: Swedish massages cause Islanders to become less tense and anxious, while also increasing their feelings of self-worth and confidence.
    - Milk Chocolate level: Eating milk chocolate causes Islanders to become less tense and anxious, more energetic, and happier, while slightly boosting their feelings of self-worth and confidence.
    - *Preliminary testing == Surveying Islanders before and after applying a a treatment level
- Block factor: Age group of student. 5 blocks: Ages 5-8 (primary school grade level), ages 9-11 (Elementary school grade level), ages 12-14 (middle school grade level), ages 15-18 (high school grade level), and ages 19-23 (college grade level).
- Outcome variable: Student's score on the 4 minute test.
- Sample size & Power: 3000 Islanders total, 5 blocks & 3 treatments. So each block had 600 Islanders and 200 Islanders per treatment. Power is ~1 with a effect size of 0.1
- Exp Method: I created a bot with Python to collect all of the Islanders' URLs and basic info, ask them for consent, and, if they accepted, add them to my contacts. Then I sorted the Islanders into the aforementioned age groups, within which the smallest group contained 600 Islanders. Then, so that the design remains balanced, I randomly selected 600 Islanders from all of the other groups to arrive at 5 blocks with 600 Islanders in each block. Then, in each block, I randomly assigned 200 Islanders to each of the three treatments.

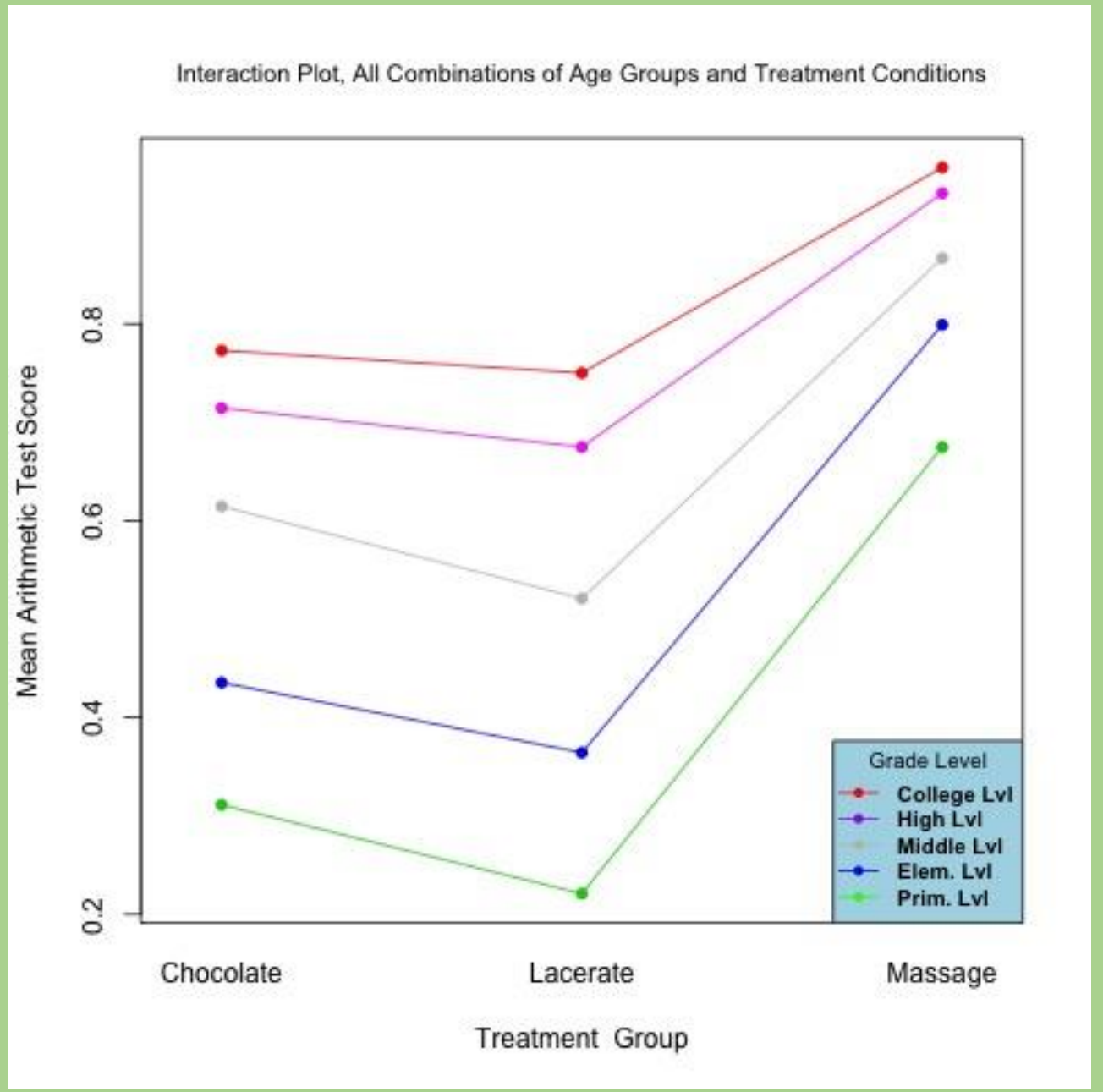
Block 1: 5-8 y.o.	Block 2: 9-11 y.o.	Block 3: 12-14 y.o.	Block 4: 15-18 y.o.	Block 5: 19-23 y.o.
200 massages	200 massages	200 massages	200 massages	200 massages
200 lacerations	200 lacerations	200 lacerations	200 lacerations	200 lacerations
200 chocolates	200 chocolates	200 chocolates	200 chocolates	200 chocolates

Blocking and Interaction Effects

There are some interaction effects between treatment groups and blocks. For example, for college age Islands scores fall very slightly when going from the chocolate group to the lacerate group, while for primary school level Islanders scores fall much more—by nearly 33.333%.

In general, as Islanders become older, they become more consistent and less vulnerable to external events and/or emotions. This is pretty intuitive and obvious—5 year olds are most likely to be less resilient and composed than 23 year olds--and was the logic behind blocking for age difference.

Therefore it seems to have been a good decision to block the confounding effect of age.



Results

Treatment Factor & Block Factor Mean Table

	Primary Block	Elementary Block	Mid. School Block	High School Block	College Block	Treat Means
Massage	0.67475	0.799	0.866625	0.932625	0.958875	0.846375
Laceration	0.220875	0.36425	0.52075	0.67475	0.75	0.506125
Chocolate	0.31125	0.435375	0.6145	0.714375	0.77275	0.56965
Block Means	0.4022917	0.532875	0.6672917	0.7739167	0.8272083	Gr mean: 0.64

ANOVA Table

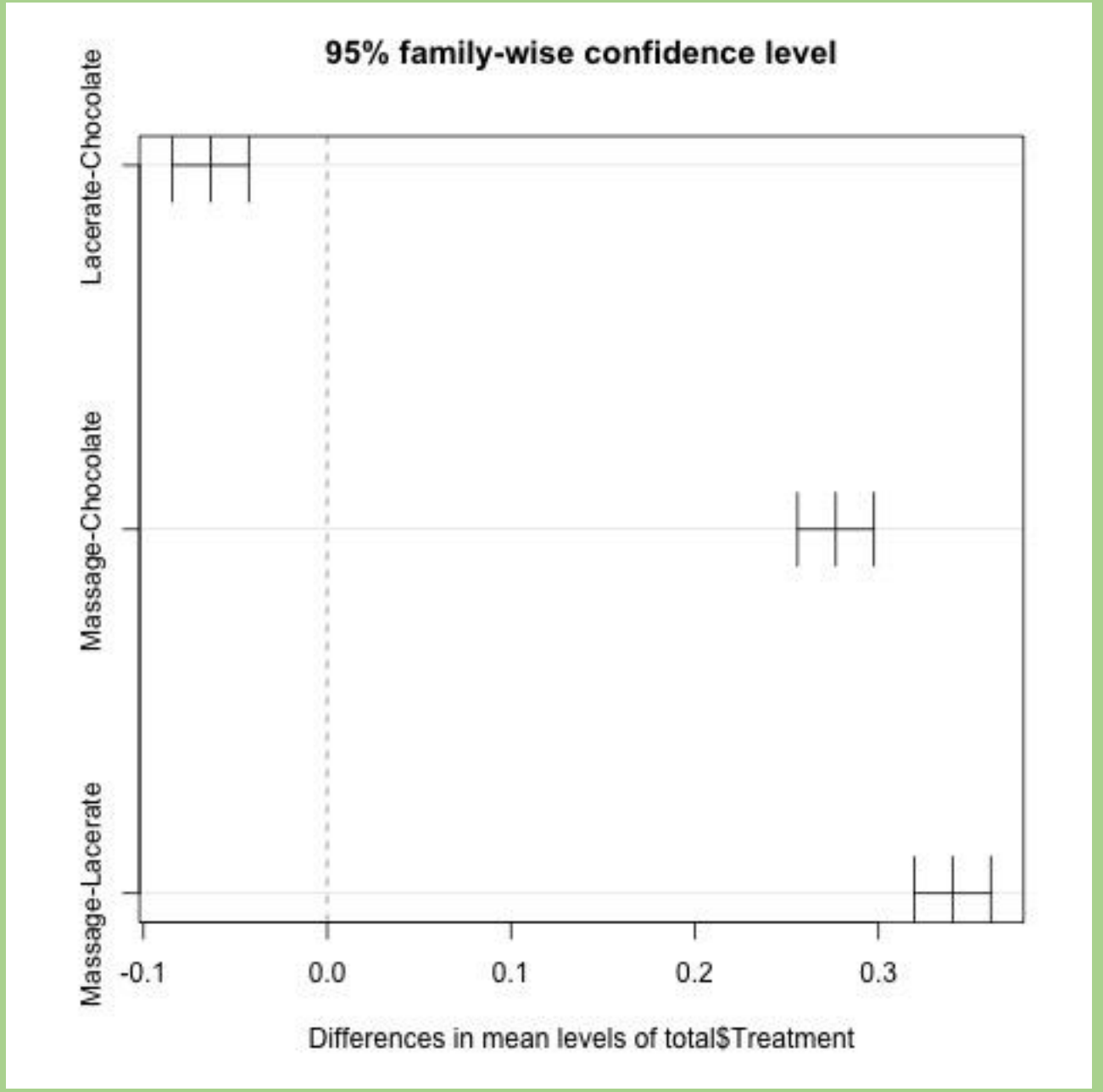
summary(aov(Score ~ Treatment+AgeGroup))

	Deg Free.	Sum Squares	Mean Sum Sq.	F value	Pr(>F)
Between Treatments	2	65.46	32.73	830.4	<2e-16 ***
Between Blocks	4	73.02	18.26	463.2	<2e-16 ***
	2993	117.96	0.04		

Given a P-value of <2e-16 for between treatment groups, we can reject the null hypothesis that there isn't a significant difference in the mean scores for all three treatment groups. Given the same P-value of <2e-16 for between blocks, we can reject the null hypothesis that there isn't a a significant difference in the mean scores for all the blocks. Because we aren't interested in the blocking variable, this mostly just confirms that blocking was an effective strategy. You can infer these results given the mean table, considering how vastly different the row and column means are.

Post-hoc Results

- Tukey's test indicates that the means between all of the treatment groups have statistically significant differences. The massage treatment group's mean is, relatively, much greater than those of both the laceration and chocolate groups but the mean of the chocolate group is slightly greater than that of the laceration group.



Overall Remarks about Experiment Results

- This experiment's results are pretty intuitive and confirm reasonable suspicions. We see that, as students get older, their arithmetical test scores tend to increase and also seem to become more resilient to external forces effecting mental state. These findings are consistent with a basic understanding of adolescent brain growth and development.
- We also see differences in performance affected by external forces immediately prior to the examinations. Students given a Swedish massage prior to the exam scored much higher than all of the other students, while those suffering lacerations scored slightly less than those given chocolate.
    - Massages cause Islanders to become less tense and anxious, while also increasing their feelings of self-worth and confidence, lacerations cause Islanders to become very angry, tense, and unhappy, while also reducing their feelings of self-worth and confidence, and eating milk chocolate causes Islanders to become less tense and anxious, more energetic, and happier, while slightly boosting their feelings of self-worth and confidence.
        - Given the different effects of each treatment on the psyche, the differences in performance may be attributed to differences in self-confidence, differences in energy, differences in anxiety levels, differences in happiness levels, or some combination of multiple differences.

Future Testing and Limitations

- It might be useful to formally experiment on the effects of the treatments on survey results for happiness, anxiety, energy, and confidence with more treatment types and also re-run the experiment with the added treatment types.
  - In some preliminary tests, it was very clear that there are consistent and noteworthy differences between the groups but a formal test to find more exact magnitudes of the differences could help draw connections between one or more specific emotions and testing results. Currently we just know the general effects of each treatment on emotional state, and the effects of each treatment on arithmetical testing aptitude, but we don't know which emotions, specifically, effect the arithmetical testing aptitude. However, if we introduced treatment types that had all of the different combinations of effect in terms of happiness, anxiety, energy, and confidence, we could isolate specific emotions and their individual influences.
  - For example, some exercise-related treatment probably has all of the same effects as does chocolate, except for the effect on energy-–eating chocolate increases energy while exercise decreases energy—so if we see a significant difference in test score between exercise and chocolate treatments then we might be able to identify the influence of energy specifically.
- It would be extremely helpful to have partners or assistants for testing. Aside from the contribution of ideas and labor, a second computer would double the power of my Python script and the number of Islanders that can reasonably be tested on at once. Dwight Scales gave me the login credentials to his Island account and I tried to test on both his Islanders and my Islanders simultaneously but it became very messy to do on a single computer as the mechanized browser that's called in the Python program would often be logged in to the wrong account. If I had two computers, though, so that one could be responsible for each account, it would work very well.