Final Project w241: Meditation impact on Navy student's anxiety levels

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Research Question

Does a one-hour transcendental meditation class reduce anxiety for Reserve Officers' Training Corps (ROTC) scholarship and United States Naval Academy students over the course of 5 days?

Abstract

Naval officers come from the United States Naval Academy (USNA) and from the Reserve Officers' Training Corps (ROTC). Both groups of students receive the same credentials to be Naval officers in a variety of roles when they graduate college. USNA students experience a rigorous and highly regimented existence in their university setting with a slow process of receiving personal freedoms back through a merit system. ROTC students experience a fairly normal college experience with very limited military training. These young students become the backbone of leadership throughout the entirety of the U.S. Navy. The purpose of this study was to first explore the stress levels these students experience in their daily lives as measured by the psychiatric industry standard Generalized Anxiety Disorder (GAD-7) test for both ROTC and USNA students. With this information, the study further explored the short term efficacy of Transcendental Meditation(TM) classes on the stress levels of the students. We found a statistically significant impact of TM classes on the stress levels of students. There is evidence that the impact of TM classes on USNA students, though statistically significant, is less than that of ROTC students. Though the difference in the effects between both populations of students is not itself statistically significant, the results still lead to a recommendation to explore whether the USNA institutionalized method of education creates a population of students more resistant to the positive effects of TM training in a future study.

Introduction & background

Every year Reserve Officers' Training Corps (ROTC) students graduate with full scholarships paid for by the U.S. Navy. In exchange for these scholarships, these students serve as Naval Officers in a variety of roles all with one theme in common, leadership. These students are charged with leading the Navy's enlisted forces. Similarly, the United States Naval Academy (USNA) also trains the future leaders within the Navy. Although both of these groups of students ultimately execute the exact same roles within the force, their education experience varies greatly. ROTC students experience the closest thing to a typical university life. They are fully integrated with their civilian student population. The only differences include regular drug testing and one day of military classes a week. On the USNA side, the students experience a highly regimented existence. For the majority of their education, they are only permitted to wear military uniforms. Dating is highly restricted and all of their extra curricular activities are monitored.

Suicide rates continue to plague the Department of Defense (DoD).[1] Recent events onboard the U.S. Navy aircraft carrier, USS George Washington have highlighted possible issues with resilience training, mental health awareness, and the effects of the unique operational environments sailors live under.[2] The future leaders of these sailors need the highest levels of training and character development in order to provide the support needed by these young and malleable sailors. For both the ROTC and USNA students, their first exposure to a less structured and regimented military level of training is their summer after freshman year. During this summer, they are exposed to the career fields from which they can choose. During their one week of exposure to Naval Aviation which is one of those possible fields, they are integrated with naval aviators. This week of training has the highest propensity for flexibility in modules. This led to a randomized field experiment where two major things are measured, the students' levels of stress as measured by the Generalized Anxiety Disorder (GAD-7) test and the effect of a Transcendental Meditation class at the beginning of the week on their stress as measured at the end of the week.[3] The study began with the

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[1] Department of Defense Annual Suicide Report: https://www.defense.gov/News/Releases/Release/Article/2793835/department-of-defense-releases-calendar-year-2020-annual-suicide-report/

[2] USS George Washington Deaths: https://www.businessinsider.com/3-us-navy-sailors-uss-george-washington-found-dead-2022-4?utm_source=copy-link&utm_medium=referral&utm_content=topbar

[3] Generalized Anxiety Disorder (GAD-7) item anxiety scale: https://www.uofmhealth.org/sites/default/files/healthwise/media/pdf/hw/form_abn2339.pdf

TM treatment on ROTC students over a period of 3 weeks. As the experimental process was fine tuned, those lessons learned were utilized to run the experiment with USNA students for another 4 weeks.

It is important to note, our collection of demographic data was hampered by the careful balance of insight with privacy. Both populations of students, ROTC and USNA, have a very small minority of women, people of color, and members of the LGBTQIA+ community. Most students are STEM majors. Any attempt to use gender or majors for collection endanger the students' ability to remain anonymous. GAD-7 questions can reveal quite a bit regarding the stress and anxiety students experience and as thus, protecting anonymity becomes absolutely critical in providing accurate results.

At this point it is important to note one other critical fact. Our study starts with a basic investigation into the effect of meditation on student stress with ROTC subjects. As we fine tuned our experiment and data collection we transitioned to USNA students. For these students we were able to add covariates of interest therefore enhancing our findings. Despite this, there were very interesting findings regarding the differences between ROTC and USNA students that will result in future studies.

Experiment & Hypothesis

Our null hypothesis at the heart of our models is:

A one hour transcendental meditation class has no effect on anxiety and stress reduction over the course of a week on college students in a military scholarship program.

Enrollment & Recruiting Process

We executed the study in two stages. The first stage was three weeks long and involved 80-90 ROTC students per week with a total of 251 subjects. This stage only measured the effect of meditation on anxiety. The second stage was with 70-80 USNA students per week over four weeks for a total of 297 subjects. This second stage also measured the effect of meditation on anxiety but additionally measured a series of covariates.

Measurement Metrics

The General Anxiety Disorder (GAD-7) test asks the following 7 questions:

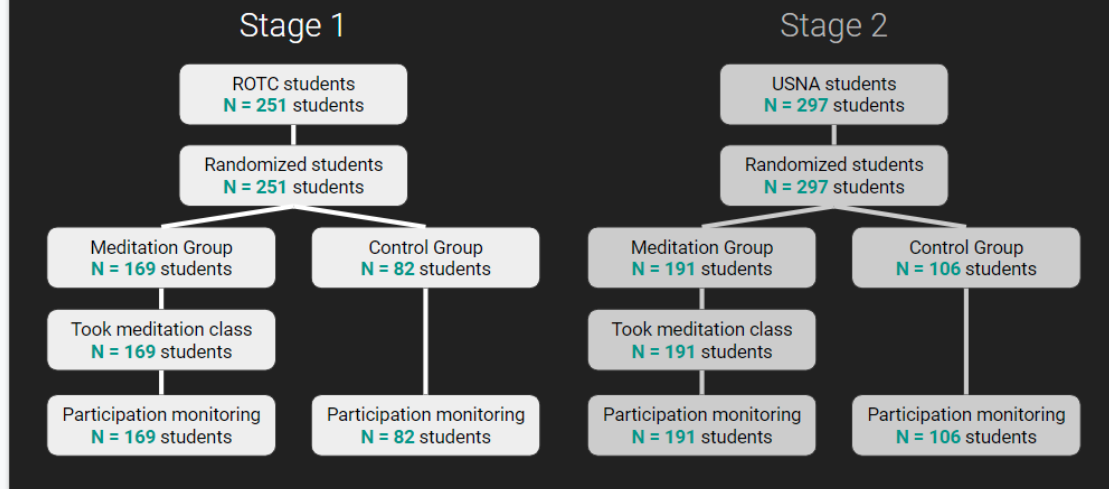Over the past week, how often have you experienced:
1. Nervousness or anxiety
2. A persistent sense of worry
3. An unusually high level of worry
4. Difficulty relaxing
5. Restlessness, making it difficult to even sit still
6. Feeling easily annoyed or irritable
7. Feeling a deep sense of fear

Each question allows the participant to answer between 0 times and 3 times. This cumulative score ranges in value from 0 to a max score of 21. A score of 0 shows very little evidence of anxiety. A score of 21 would show a very high level of anxiety. This range gives us the ability to measure our values using a logarithmic scale and thus be able to measure percentage of change. This will be discussed more thoroughly below.

Experimental Design & Randomization

Each set of weekly students arrived for training and went through a short indoctrination module. During this indoctrination module, the students were split evenly into 10 groups. Each student announced sequential numbers from 1 to 10. The number defined the group the students would belong to. Since students that know each other tend to sit together, using sequential numbers to split the students up maximized the random assignment to each group. Once the students were split into 10 groups, each group flipped a coin to determine whether they would be part of the treatment or control group.

Flow diagram

Stage 1

ROTC students
N = 251 students

Randomized students
N = 251 students

Meditation Group
N = 169 students

Control Group
N = 82 students

Took meditation class
N = 169 students

Participation monitoring
N = 169 students

Participation monitoring
N = 82 students

Stage 2

USNA students
N = 297 students

Randomized students
N = 297 students

Meditation Group
N = 191 students

Control Group
N = 106 students

Took meditation class
N = 191 students

Participation monitoring
N = 191 students

Participation monitoring
N = 106 students

Once the groups were identified, both the treatment and control subjects traveled to a location where the proctor was waiting for them. The members assigned to control were told to wait 100 meters away from the treatment group. The TM instructor explained the following to the treatment subjects:

1. They are part of an experiment regarding the effects of meditation.

2. They have the option to opt out of the experiment and not attend the meditation class.

3. After the treatment is done, they will be released to a self guided tour of the surrounding neighborhood.

For the entirety of the experiment, none of the students chose to opt out of the experiment. After the instructor spoke to the treatment group, he then released the control group to execute a predetermined tour of the surrounding neighborhood. The treatment group would start the tour an hour after the control group had begun the tour. At that point the control group would be heading to their vans to depart the tour. This minimized the chance for conversation between the control and treatment group. From this point on, treatment subjects had a non overlapping schedule with control students and would not meet again until the last day of training when the survey was administered.
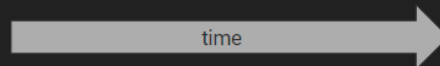
Power calculation

After executing an exhaustive power analysis using the collected data from the ROTC portion of the study and having an average treatment effect and a specified level of variance, we were able to explore a change in α.[4] We also explored less than optimal average treatment effects in preparation for that to happen as well as the addition of covariates. Maintaining α at 0.05, we concluded a N size for 80% power of 194 subjects. Thankfully we procured 251 ROTC students and 297 USNA subjects.

Covariates

We faced two challenges while determining which covariates to examine in our models. The first challenge was the survey logistics. Ideally, we would have had the subjects fill out the survey before treatment to give us baseline measurements for each subject and collect the covariate information we were considering pre-treatment. However, this was not possible because it was crucial to preserve the anonymity of the students. For baseline data, we would have needed an ID for each student to match their pretreatment survey responses to their post-treatment responses. The Navy did not accept this level of identification, nor did we want the students to think there was any way we could trace their survey responses back to them. Preserving the trust and confidentiality of the students was our top priority and essential because we wanted the self-reported responses to be honest and the students to feel secure. The second challenge we faced was regarding the sensitivity of the questions asked in the survey. Not only did the questions need to maintain student anonymity, but they also needed to be ethically aligned with not collecting sensitive information from the students.

To solve these challenges, we settled on collecting all information, including covariates, post-treatment. While this is not ideal, we carefully considered choosing variables that the treatment would not impact. We are confident the answers for the post-treatment covariates we chose would have been the same if we measured them pre-treatment. Below is a list of the covariates we examined in our model.

`meditation_practice`: Do you regularly practice meditation?

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[4]W241 Power Analysis: https://drive.google.com/file/d/1qIKsnk3VJ7lkTtMNT8iQ2N3lZ6qDcJfz/view?usp=sharing

Yes
No

`religion`: Religious affiliation:

Religious / Spiritual
Agnostic
Atheist

`parents`: Did either of your parents serve in the military?

Yes
No

`dog`: Did you grow up in a household with dogs?

Yes
No

`income`: What is your family's income?

Less than $40,000
$40,000-$100,000
$100,000-$200,000
Over $200,000

'region': What region of the country are you from?

West (including Hawaii)
Midwest
Southwest
Southeast
Northeast
Northwest (including Alaska)
International

It is important to note that we did not include covariates in our pilot experiment with the ROTC students. We introduced covariates into the surveys during our second stage of the experiment with Naval Academy students.

Ethical and Privacy Considerations (including impact on covariates)

The previously described covariates allow further insight into our sample population without allowing us to narrow down the identity of a subject. We will see the distributions of these variables in a section below. Beyond the importance of anonymity, we also implemented controls to allow the ability to opt into the study and allow the data to be utilized by our team.
Once the ability to opt out of the study is complete, the students have one more option. During the survey, the students have the option not to allow our team to use the data collected for the study. This option and the survey were explained to all the students before they filled them out. The subjects provided us with a 98.8% consent rate for ROTC students and a 98.3% consent rate for USNA students.

Survey Collection Method

We used "Google forms" for our survey collection. Our initial ROTC survey[5] allowed us to refine our question set into a better finished product with our USNA survey[6].

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[5]ROTC Students Survey: https://forms.gle/ip6LpZ4BMwtpA1zk8
[6]USNA Students Survey: https://forms.gle/xCZ8vUPaYQjFjDxy8

Data Analysis

Exploratory Data Analysis

We can see that the data is not really skewed. Note, meditation participation is binary, 0 for control, 1 for treatment. The correlation between GAD-7 and meditation participation is -.015. Which is important because as GAD-7 score goes down, meditation score goes up. This leads us to further analyze with regression to see if meditation is a good predictor of GAD-7 score.
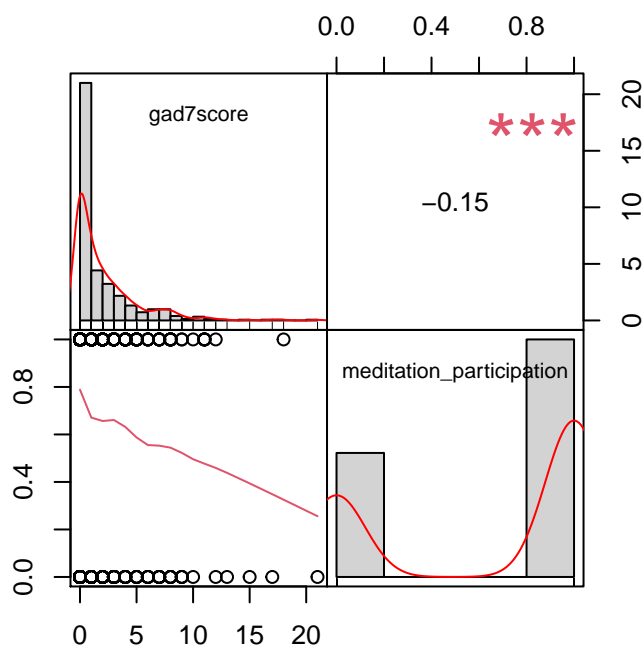
USNA GAD-7 distributions by category. These histograms give us the breakdown of specific GAD-7 question and the overall GAD-7 score distribution.
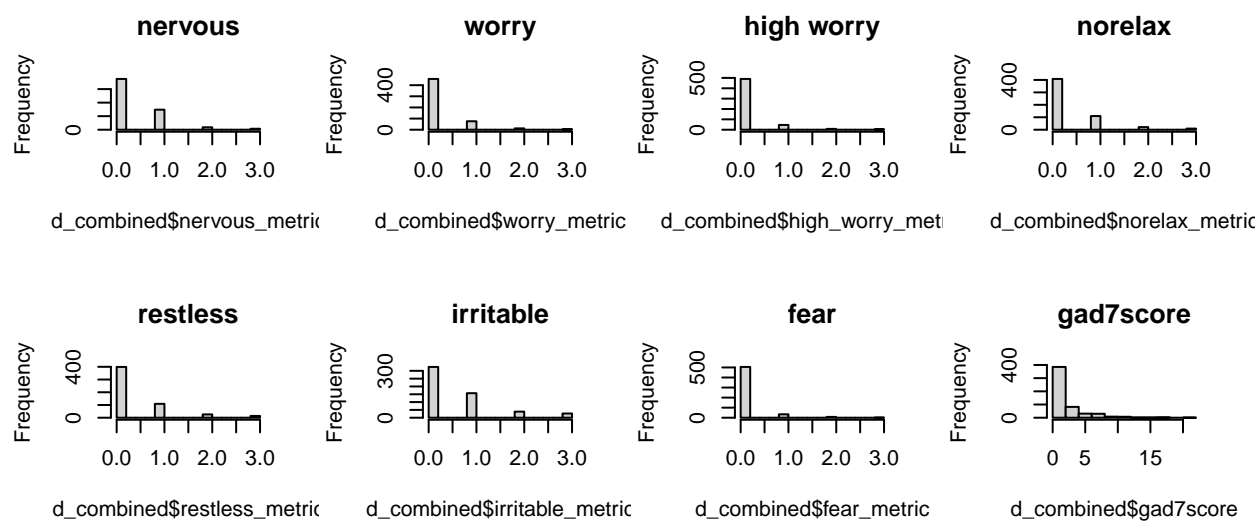
ROTC / USNA overall GAD-7 Distributions

The impact of GAD-7 scores is smaller with USNA students as compared to the ROTC students.
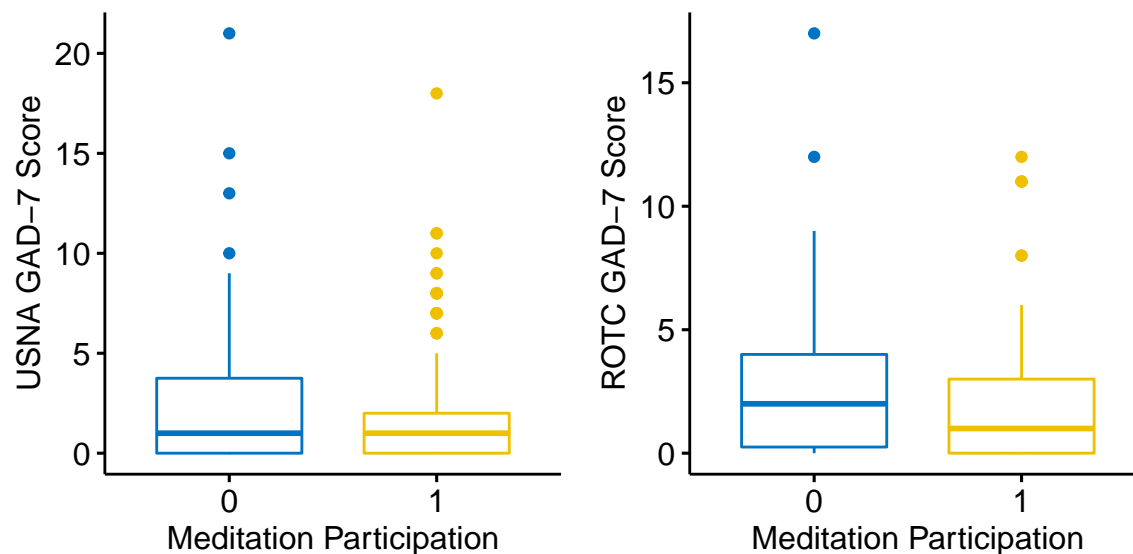
We can further see a slightly higher mean GAD-7 Score, though not statistically significant with a difference in means p-value of 0.55, between USNA students and ROTC students.
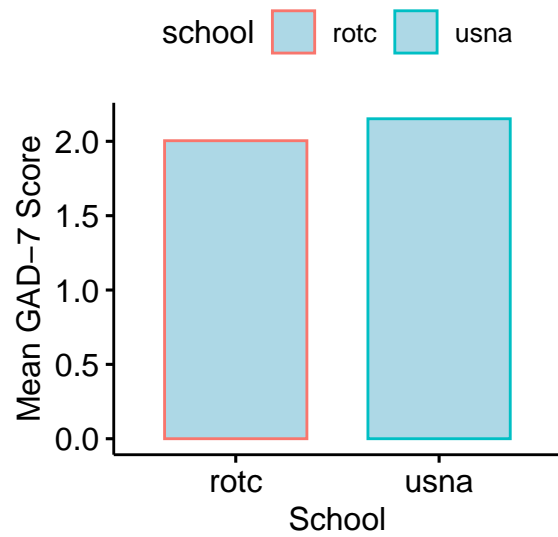
USNA covariate distributions - we plotted some of the interesting covariate distributions during our data analysis. We found the relatively even distribution across the United States to be interesting as well as the disproportionate distribution of religious view across the students.
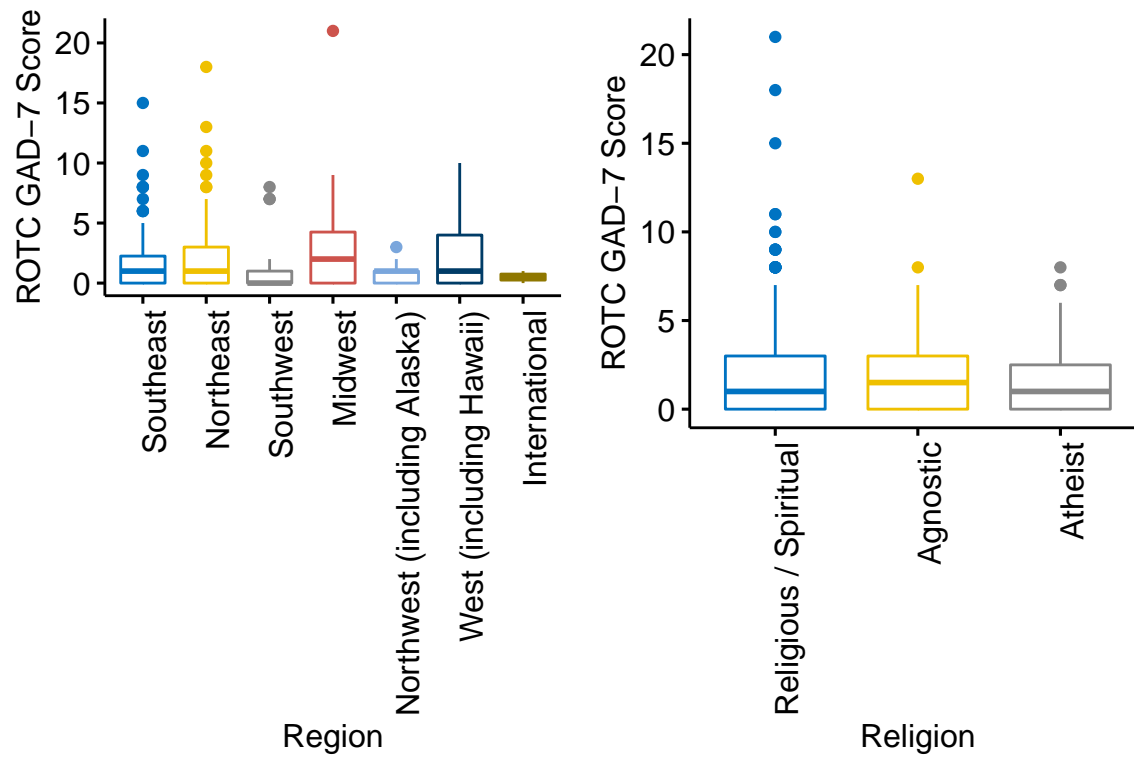
Limitations and Considerations

Omitted Variable Bias

We explored omitted variable bias (OVB) by determining the theoretical impact of the following variables on both the baseline dependent and independent variables.

1. Trust in the proctor: Is it possible that a high level of affinity is built with regards to the relationship the subjects have with the proctor? If so, there would be no real effect on the stress levels the student is feeling. It would have an effect on meditation participation effect, but the stress levels would remain unchanged regardless of how much trust is placed on the meditation teacher. The OVB would could be considered minimal but away from 0. But we also recognize the importance of trust in the proctor to believe the data collected to be truly anonymous. Furthermore, this level of trust is critical to having the subjects provide true and honest responses to fairly sensitive questions regarding mental health.

2. Effect of being on the tail end of training and knowing you have to go back to the "grind": As you reach closer to the end of training, and the reality that school is right around the corner again could increase the stress and thus the GAD-7 score. But it would have little to no effect on the impact of meditation. Therefor the OVB would be considered minimal but away from 0. When we break out the meditation effects week by week, we might be able to see the effect of this in a below section.

3. Location of meditation class. The class is held by the ocean on a rocky seaside cliff. This has the propensity to lower stress levels while making meditation more appealing. The effect would be temporary, only during the length of the class. As the week progresses, the setting of the class will have little effect on the overall anxiety or stress levels of the subject therefore having little OVB by the time the survey is taken. It could however have a positive effect on the quality of the meditation and as such, have a small effect away from 0.

Non Compliance Considerations

Our experiment ran the risk of one-sided non compliance. We were not concerned there would be Defiers because the students in the control group would have no way of receiving the treatment, the meditation class. This is because the students are on a strict schedule each day, and it was not possible for someone from the control group to "sneak" into the treatment group. We could have had Non-compliers that were students in the treatment group who did not actively participate in the meditation class or practice meditation daily during the week. The first possibility was controlled because Luis ensured all the students who were in the class participated. The second scenario was harder to control, and we had to trust the subjects to "take their treatment".

All students in the treatment group were given the option to not participate in the meditation class; however, no one chose to forego the treatment. If we did experience non-compliance, we would have adjusted our model to analyze the intent-to-treat (ITT) and the Complier Average Causal Effect (CACE).

Attrition Considerations

Students were allowed to opt-out of the survey, meaning their survey responses would not be used in our study. For these students, we remove them from our final data set. Since students do not leave the week of training, and everyone is required to fill out the survey, choosing that your results not be used in the experiment was the closest we came to attrition. With this, less than 2% of subjects (5 students) did not provide consent for their survey results to be used. To determine if there was a significant difference in the consent numbers for the treatment and control group proportions, we ran a T-test.

```r
# Run proportions difference test to ensure
# difference in group sizes aren't significant
proportions_difference_test <- d[ , lm(meditation_participation ~ consent)]

coeftest(proportions_difference_test, vcovHC)
```

```
##
## t test of coefficients:
##
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.600000   0.273861  2.1909  0.02924 *
## consentYes  0.043836   0.275301  0.1592  0.87360
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

In our data set, we do not have NAs for `meditation_participation` or `consent`; however, to ensure that our experiment did not have a significant difference in the number of subjects in the control group who did not consent (2) and the number of subjects in the treatment group who did not consent (3), we ran a T-test. We failed to reject the null hypothesis that the difference in group numbers was significant, so we continued with our analysis feeling confident in the randomization of our treatment and control groups.

Since the number of students who attrited was so small, and the difference in group proportions was not statistically significant, we did not feel it was necessary to complete an extreme value bounds analysis. Furthermore, excluding the 5 students from our data set still left us with more subjects than our power analysis suggested we needed, so we did not want to make assumptions with our data when we did not have to (such as calculating and using extreme value bounds).

Spillover Considerations

In our experiment, there might be spillover. Spillover could happen if a treatment group student conversed with a control group student and discussed the meditation class. The treatment group student could have shared the skills and techniques they learned in the class, and the control group student could practice these methods, thereby altering their stress levels by the end of the week. This could cause a bias in our estimated treatment effect. We would expect spillover to cause us to underestimate the treatment effect because a student in the control group learned new skills to lower their anxiety levels; however, there is also the chance that this could go the other way. We cannot rule out the possibility that the student in the control group could try meditating and end up feeling frustrated or more stressed because they did not have formal meditation training. This could then lead to an overestimation of the treatment effect.

Statistical Modeling & Results

ROTC base model construction

The base model for ROTC students is:

$$gad\_7\_score = \beta_0 + \beta_1 meditation\_participation + \epsilon$$

With ROTC students, this results in homoskedastic errors but non-normally distributed residuals. Homoskedasticity is shown in the Scale-Location plot with its horizontal blue line. The Q-Q plot shows residuals disbursed well outside of the dashed line, hence non-normally distributed residuals. The result of the Breusch-Pagan test also shows that the null hypothesis of homoskedasticity is not rejected:
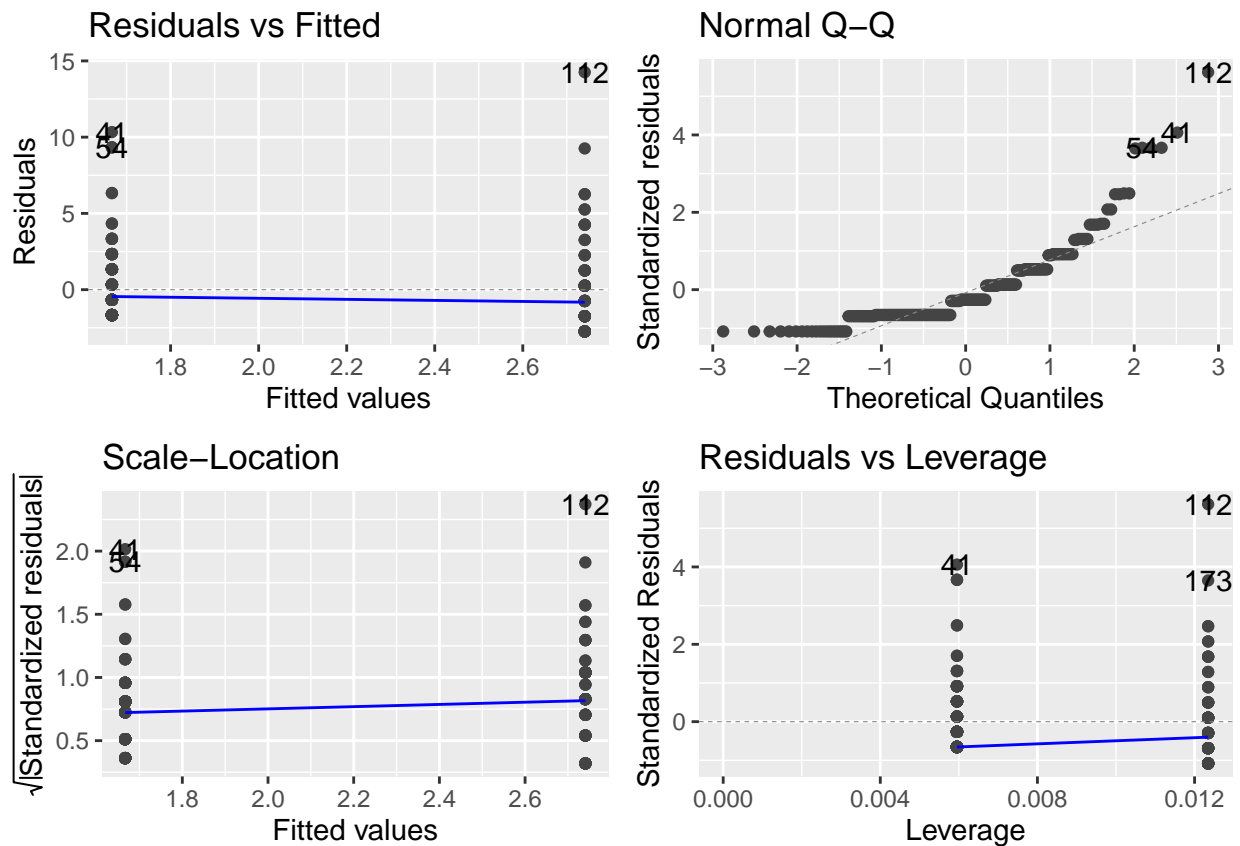

```
##
##  studentized Breusch-Pagan test
##
## data:  model_rotc_base
## BP = 2.63, df = 1, p-value = 0.1049
```

By adding a logarithmic transformation to the dependent variable we end up with the following model which provides normally distributed residuals. We will continue with this model. We also continue ahead with the more conservative robust standard errors in all calculations since we have no way of knowing if every future case of data collection will have homoskedastic errors.

$$log(gad\_7\_score) = \beta_0 + \beta_1 meditation\_participation + \epsilon$$

14
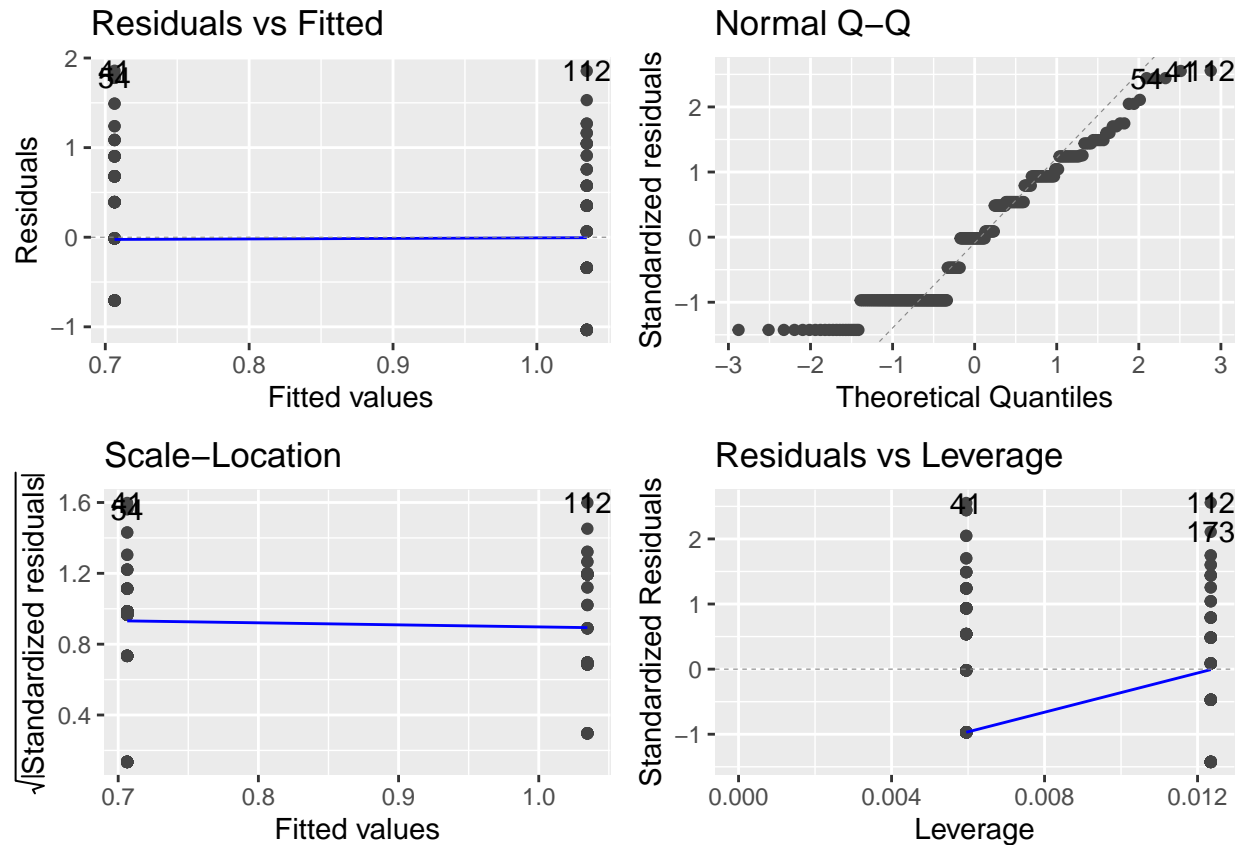
The stargazer output of the logarithmic transformation on the gad7score dependent variable is:

```
## 
## =====================================================
## 					Dependent variable:
## 				-----------------------------
## 					gad7score_log
## -----------------------------------------------------
## meditation_participation 		-0.328*** (0.102)
## Constant 					1.035*** (0.085)
## -----------------------------------------------------
## Observations 						249
## R2 								0.043
## Adjusted R2 						0.039
## Residual Std. Error 			0.730 (df = 247)
## F Statistic 				11.037*** (df = 1; 247)
## =====================================================
## Note: 				*p<0.1; **p<0.05; ***p<0.01
```

It is important to note, in order to glean the percentage change in anxiety with only a dependent variable undergoing a log transformation one must calculate it as follows: $e^{(\beta_1)} - 1 * 100$

The result of the base model is a statistically significant reduction in anxiety from meditation of 38.85% and a p-value of 0.00.

ROTC Week to Week Analysis

For our ROTC students we ran the experiment over 3 weeks. We can see in the week to week results how meditation consistently has a negative effect on stress with varying degrees of statistical significance. The last week the students are in San Diego, having the greatest level of significance.

```
##
## ===============================================================================
##                                     Dependent variable:
##                         ---------------------------------------------------
##                                           gad7score_log
##                              (1)              (2)              (3)
## -------------------------------------------------------------------------------
## meditation_participation  -0.550 (0.335)    -0.227 (0.181)    -0.250* (0.151)
## Constant                  1.134*** (0.325)  1.049*** (0.146)  1.018*** (0.112)
## -------------------------------------------------------------------------------
## Observations                    75                88                86
## R2                             0.025            0.019            0.032
## Adjusted R2                    0.012            0.008            0.020
## Residual Std. Error       0.682 (df = 73)  0.800 (df = 86)   0.697 (df = 84)
## F Statistic               1.875 (df = 1; 73) 1.668 (df = 1; 86) 2.764 (df = 1; 84)
## ===============================================================================
## Note:                                        *p<0.1; **p<0.05; ***p<0.01
```

USNA base model construction

The base model for both USNA students is:

$$gad\_7\_score = \beta_0 + \beta_1 meditation\_participation + \epsilon$$

With USNA students, this results in homoskedastic errors but non-normally distributed residuals. Homoskedasticity is shown in the Scale-Location plot with its horizontal blue line. The Q-Q plot shows residuals disbursed well outside of the dashed line, hence non-normally distributed residuals. The result of the Breusch-Pagan test also shows that the null hypothesis of homoskedasticity is not rejected:
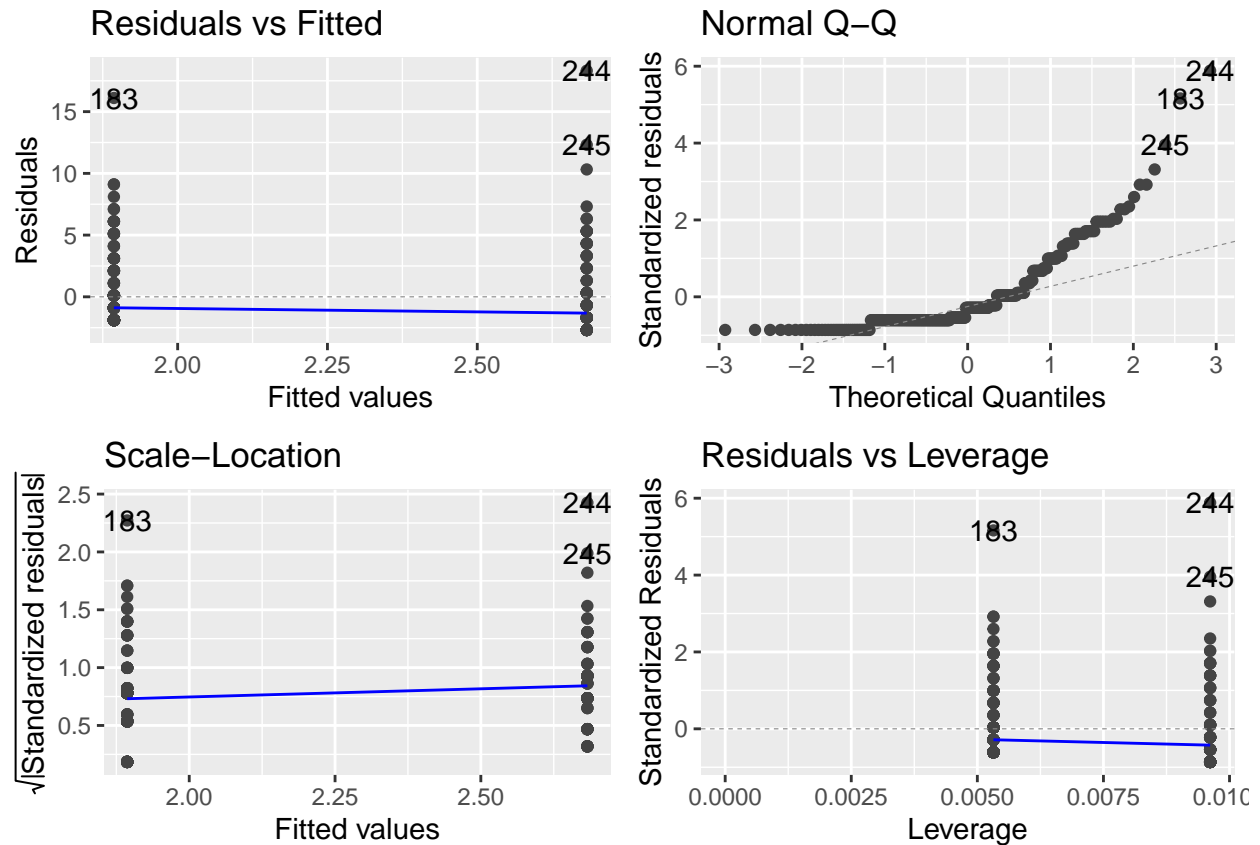
```
##
##  studentized Breusch-Pagan test
##
## data:  model_base
## BP = 2.1243, df = 1, p-value = 0.145
```

Once again, we add a logarithmic transformation to the dependent variable to end up with the following model which provides normally distributed residuals. We will continue with this model. We also continue ahead with the more conservative robust standard errors in all calculations since we have no way of knowing if every future case of data collection will have homoskedastic errors.

$$log(gad\_7\_score) = \beta_0 + \beta_1 meditation\_participation + \epsilon$$
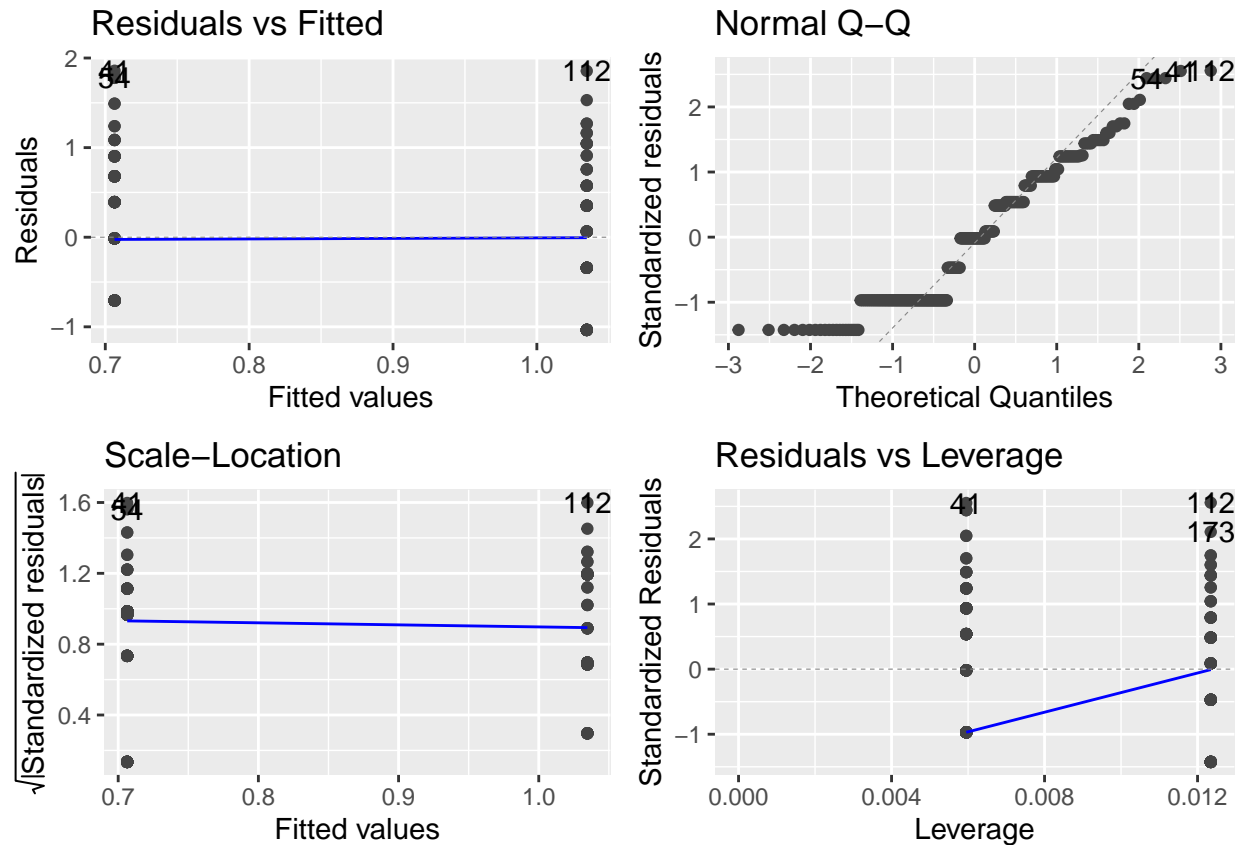
The stargazer output of the logarithmic transformation on the gad7score dependent variable is:

```
## 
## ====================================================
## 				Dependent variable:
## 				----------------------------
## 				gad7score_log
## ----------------------------------------------------
## meditation_participation		-0.211** (0.101)
## Constant						0.928*** (0.083)
## ----------------------------------------------------
## Observations					292
## R2							0.015
## Adjusted R2					0.012
## Residual Std. Error			0.808 (df = 290)
## F Statistic					4.549** (df = 1; 290)
## ====================================================
## Note:				*p<0.1; **p<0.05; ***p<0.01
```

It is important to note, in order to gleam the percentage change in anxiety with only a dependent variable undergoing a log transformation one must calculate it as follows: $e^{(\beta_1)} - 1 * 100$

The result of the base model is a statistically significant reduction in anxiety from meditation of 23.44% and a p-value of 0.03.

USNA Week to Week Analysis

For our USNA students we ran the experiment over 4 weeks. We can see in the week to week results how meditation has sporadic effects on anxiety in weeks 2 and 3. We also note that none of the weeks are by themselves statistically significant. It is only when the 4 weeks of data are aggregated that we see significant results.

```
##
## ===============================================================================
##                                       Dependent variable:
##                      -----------------------------------------------------------
##                                          gad7score_log
##                          (1)             (2)             (3)             (4)
## -------------------------------------------------------------------------------
## meditation_participation  -0.257          0.238          -0.013          -0.237
##                          (0.187)         (0.238)         (0.182)         (0.224)
##
## Constant                0.909***         0.311          0.925***        1.086***
##                          (0.155)         (0.219)         (0.127)         (0.171)
##
## -------------------------------------------------------------------------------
## Observations               80              65              79              68
## R2                       0.025           0.013           0.0001          0.017
## Adjusted R2              0.013           -0.002          -0.013          0.002
## Residual Std. Error  0.768 (df = 78)  0.681 (df = 63)  0.812 (df = 77)  0.916 (df = 66)
## F Statistic          2.009 (df = 1; 78) 0.855 (df = 1; 63) 0.005 (df = 1; 77) 1.141 (df = 1; 66)
## ===============================================================================
## Note:                                             *p<0.1; **p<0.05; ***p<0.01
```

USNA vs. ROTC Results

The difference in percent effect between USNA and ROTC students is immediately noticeable. USNA students are 15.41% less affected by the meditation class. We can take a moment to check if this difference is statistically significant.

The difference in the effect of meditation on the ROTC vs. USNA students is not statistically significant with a p-value of 0.89. As a result of this, we can comfortably continue in our research study with added covariates and USNA only subjects knowing we will gleam insights that could very well affect both USNA as well as ROTC students.

Base Model Using Aggregate USNA and ROTC Data

Before we continue with the USNA model including added covariates, we take one last look at the effect of meditation class on the aggregate of USNA and ROTC students.

The stargazer output of the logarithmic transformation on the gad7score dependent variable is:

```
## 
## =====================================================
##                            Dependent variable:
##                       -----------------------------
##                              gad7score_log
## -----------------------------------------------------
## meditation_participation     -0.262*** (0.072)
## Constant                     0.975*** (0.060)
## -----------------------------------------------------
## Observations                        541
## R2                                 0.025
## Adjusted R2                        0.024
## Residual Std. Error         0.773 (df = 539)
## F Statistic              14.054*** (df = 1; 539)
## =====================================================
## Note:                   *p<0.1; **p<0.05; ***p<0.01
```

The result of the base model is a statistically significant reduction in anxiety from meditation of 30.02% and a miniscule, highly significant p-value of 0.00, much less than 0.05.

USNA Modeling with Additional Covariates

Our complete model includes all of the covariates collected with our USNA participants.

$$\log(gad\_7\_score) = \beta_0 + \beta_1 meditation\_participation + \beta_2 dogs\_in\_household + \beta_3 military\_parents$$

$$+\beta_4 navy\_pilot\_before + \beta_5 religion + \beta_6 income\_bracket + \epsilon$$

Covariate Impact on Base Model and F-Test

```
## 
## ==========================================================================
##                                   Dependent variable:
##                           ------------------------------------------
##                                       gad7score_log
##                                  (1)                   (2)
## --------------------------------------------------------------------------
## meditation_participation   -0.211** (0.101)      -0.222** (0.105)
## dogsYes                                           0.083 (0.110)
## parentsYes                                        0.088 (0.106)
## navy_beforeYes                                   -0.013 (0.105)
## religionAtheist                                  -0.136 (0.196)
## religionReligious / Spiritual                    -0.150 (0.145)
## 100,000                                          -0.019 (0.132)
## 40,000                                            0.028 (0.236)
## 200,000                                          -0.113 (0.115)
## Constant                   0.928*** (0.083)      1.020*** (0.205)
## --------------------------------------------------------------------------
## Observations                      292                   292
## R2                               0.015                 0.028
## Adjusted R2                      0.012                -0.003
## Residual Std. Error       0.808 (df = 290)      0.814 (df = 282)
## F Statistic               4.549** (df = 1; 290) 0.913 (df = 9; 282)
## ==========================================================================
## Note:                                   *p<0.1; **p<0.05; ***p<0.01


## Anova Table (Type II tests)
## 
## Response: gad7score_log
##                           Sum Sq  Df F value  Pr(>F)
## meditation_participation   3.213   1  4.8487 0.02848 *
## dogs                       0.377   1  0.5683 0.45155
## parents                    0.491   1  0.7411 0.39004
## navy_before                0.011   1  0.0158 0.89991
## religion                   0.682   2  0.5143 0.59849
## income                     0.804   3  0.4042 0.75011
## Residuals                186.891 282
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

We can see from the comparison between the base model and the one including all covariates, as well as through an "F" test analysis that none of the covariates add statistically significant value to the base model. We can also see how the coefficient for meditation participation changes only slightly. We would like to see the standard error reduce as we add covariates. Unfortunately, we did not see that, but thankfully the change in standard error was also negligible.

Conclusion and Next Steps

This study measured the very short term impact of a meditation class on a cohort of ROTC and USNA students. The students experience very similar levels of stress with varying results of statistically significant reduction in stress. Though the data is promising, consideration must be given to the underlying structure of the experiment:

1. The exploration of two populations of students (ROTC and USNA) with non-statistically significant differences in results. It cannot be ignored that they remain two very different sets of experiences for students. More research should be done into how to isolate covariates to better examine these differences.

2. The class was 1 hour long with no follow up all the way to survey 5 days later. Although a carefully thought out randomization method was used, that would hopefully remove the impact of outside covariates to the overall effect of meditation, so many other factors remain that could have affected the students level of stress. From the impact of outside news, including a tragic school shooting in the middle of the experiment, to the impact of other possible omitted variables, to the possible impact of spill over as students had the chance to communicate about the class, a more carefully executed experiment could mitigate these factors and create more accurate measurements.

3. The fact the impact on stress varied so much more during USNA weeks than ROTC weeks, leaves a lot left to explore. Despite the fact that the results between the two academic systems is not statistically significant, there are very real differences that should be explored.

Finally, we look forward to running this experiment next year. With all of the additional lessons learned, and as we explore the correct methods for ethical review, we are interested in continuing to explore the results and the impact the students can have via meditation.