Effect of stress management programs on college students' performance

Experimental Methods Course

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Abstract

This study examines the effectiveness of a stress management program on the academic performances of college students. The experiment was conducted over two semesters in several colleges in Germany and involved three groups of students. The supervised group received online stress management classes, the unsupervised group had access to weekly exercises to reduce stress on their college page, while the control group received no intervention. The results showed that only the supervised stress management program had a significant positive effect on academic performance. To understand the treatment efficiency, the study also explored the potential impact of stress and cortisol levels on academic performance but found no statistically significant results. Furthermore, using surveys, the study shows that stress management classes helped students to work more efficiently but has no visible effect on confidence or focus. Finally, it also analyses the place of the programs among other student characteristics to explain their academic performances.

1 Introduction

Stress is a widespread issue among students and has various sources. One of the main contributors is academic factors, such as the fear of failing, excessive workload, competition among peers, problems with time management, familial pressures, and exams. Besides academic stressors, non-academic factors also have an impact, including financial worries, adjusting to a new living environment, health concerns, relationships with friends and family, and romantic relationships (Reddy et al., Barbayannis et al., Karyotaki et al.)[1]. It affects students' overall anxiety and mental well-being and is linked to mental disorders (Karyotaki et al.). It also impacts students differently depending on their gender or grade level (Barbayannis et al.).

We draw on the psychological field to define stress. A global definition could be the following: "[The] process in which environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological or biological changes that may place people at risk for disease" (Cohen, Kessler & Gordon, 1997). There are several approaches to stress, including environmental, psychological, and biological. From a psychological perspective, i.e. the perspective where the focus is put on how people perceive and assess potential stressors, the Lazarus and Folkman model of 1984 states that stress is experienced when a stimulus is perceived as a threat and the person feels that they do not have the resources to cope with it. How the person assesses their ability to cope is thus important in defining stress.

Stress and more precisely academic stress is likely to have effects on the academic performances of students. Psychological and sociological studies help to understand how stress can affect students' grades. First, psychological studies have already shown that stress is a factor that impacts the academic results of students. Pascoe, Hetrick, and Parker in "The impact of stress on students in secondary school and higher education" (2020) discuss in a narrative review format academic-related stress and its impact. They show that it has a negative impact on students' grades as well as their sleep, substance use, ability to learn, and physical and mental health. These latter aspects also have consequences on students' academic success and thus

1. Cited in Reddy et al., who cited Fairbrother & Warn, 2003, Byron; Brun & Ivers, 2008; Chernomas & Shapiro, 2013; Goff, 2011; Jimenez, Navia-Osorio & Diaz, 2010 and Moscaritolo, 2009)

stress indirectly affects students' grades through these channels. The 2015 PISA study, which involves 15-year-old students, is also interesting to understand students' academic stress. It shows that academic stress is quite significant among students. On average in OECD countries, more than 50% of students say they are stressed before a test, even if well-prepared. Furthermore, the study finds that anxiety is negatively correlated with academic results. Finally, we can also consider the possibility that stress is a factor pushing students to work more and be more effective, thus having a positive effect on grades. This effect is likely not predominant.

Based on the assumption that stress decreases students' academic performance, it is interesting to examine the effect of stress management programs on students' grades. Indeed, reducing stress through these programs can lead to better grades and better mental health for students. We are interested in finding out what type of program can best help students and how it helps them. In particular, we want to see if the programs help students work better and be more focused and confident. Indeed, we can make the hypotheses that stress undermines students' learning abilities, focus, and confidence. Thus a program that aims at reducing stress could work through those channels.

We carry out a randomized experiment to explore the efficacy of two stress management programs on college students. The experiment is conducted over two semesters in several colleges in Germany. Two programs are being implemented. A supervised one consists of online stress management classes and an unsupervised one allows students to access weekly exercises to reduce stress. Our focus is on four areas. The main one is to evaluate the success of the programs. In particular, we will measure their impact on students' grades. Second, we want to test the relationship between stress and grades. Stress will be measured in two different ways, using a perceived stress survey and cortisol measurements. Third, we will test the hypotheses we have formulated to understand the potential effectiveness of the treatment. Finally, we will examine other predictors of student grades to put programs in a broader perspective.

2 Experimental design

2.1 Setting

We are conducting an experiment to examine the impact of a stress management program on the academic performances of college students. With this experiment, we seek to understand if and how a stress management course in colleges could be useful in decreasing stress and thus increasing students' academic performance.

The experiment takes place in several colleges in Germany. We chose colleges that allowed us to access student transcripts. The experiment lasts two semesters, which is a total of 10 months as we exclude the vacations. The classes are held for one hour every two weeks and include stress management techniques and personal advice. Sessions are held online, as this is more convenient for the organization and allows students at each college to choose their preferred time slot. Furthermore, the online format allows students to practice stress relief exercises quietly at home. A second treatment is also proposed, where exercises to reduce stress will be made available weekly on students' personal college pages, allowing them to follow the exercises when they need to. We aim to determine if this less costly, unsupervised program can also lead to reduced stress levels and improved academic performance of students.

Students can register to participate in the program. When the applications are received, we randomly divide the students into three groups: the treatment groups and the control group. Each group consists of approximately 1600 students or more. This number was determined through a power analysis (see below). We collect initial information from the students, including their gender, age, state of residence, current GPA, economic status, parents' status, job, and parents' level of education. In the next paragraph, we explain in detail what students in the treatment and control groups will do.

1. First treatment group:

    (a) One hour of class every two weeks, led by a sophrologist or another competent person.

(b) Short and long-term stress relief method are taught and practiced.

(c) The main focus is put on academic stress management, but not exclusively.

2. Second treatment group:

   (a) Unsupervised program: students will receive advice on how to reduce stress.

   (b) A new note will be made available to the students on a weekly basis.

3. Control group: there will be no organized stress management program or unsupervised program provided.

2.2 Stress measurement

To measure the effectiveness of the program, students in each group complete a monthly questionnaire, widely used to measure stress among young people: the Perceived Stress Survey of Cohen et al. (PSS-10). This survey is then used to calculate a perceived stress score from 0 to 40. Furthermore, we measure cortisol levels, which is the stress hormone, of all students in the program three times throughout the year to provide a biological measure of stress (one test before the program, one during, and one at the end). This allows us to have a stress measure that is not subject to biases we can find in surveys (like the social desirability bias). We chose this time frame to measure cortisol because it allows us to observe the evolution of stress before, during and at the end of the treatment. It is also too expensive to do a cortisol test every month. This measure is made with the Salivette cortisol kit and we compare it with normal levels of cortisol to classify the level of stress. The details of the questionnaire and cortisol measurement are included in the appendix.

2.3 Hypotheses measurement

It is possible to hypothesize how the stress management program can positively affect student success. We can single out a couple of channels. The first one is that the stress management program increases students' learning abilities because it helps them feel better,

less affected by the fear of failing, and therefore be more focused. To measure this outcome, we can add this question to the monthly survey: “In the past month, how often have you felt that your stress was preventing you from working well?” (answer from “Never” to “Very Often” as in the Perceived Stress Survey). The second one relates to confidence and academic self-efficacy. Knowing how to deal with academic stress can boost a student’s confidence and more specifically their confidence to succeed in their academic tasks. An increase in students’ confidence can then help him/her to be more successful. In ”Self-Efficacy, Stress, and Academic Success in College,” sociologists Zajacova, Lynch, and Espenshade cannot find a significant association of GPA with stress level. However, they were able to show that self-efficacy (i.e., how well a person perceives their ability to achieve something) and stress are negatively correlated. Self-efficacy can then be an interesting feature to look at. Indeed, it is embedded in the stress process since a person with high self-efficacy is less likely to think they cannot cope with the stressors. On the other hand, it can also be thought that stress negatively affects self-efficacy, resulting in lower grades. In the same way, we can add a question in the survey: “In the past month, did you feel confident that you will succeed in your academic task ?”. Finally, another channel from the stress management program to academic performance is the way a student feels during an exam. The program can help students to feel calmer during the exam and more focused. An assessment of this effect can be a measurement of the cortisol level around the exams or/and a last question in the survey: “How focused and calm did you feel during the exam?”.

To sum up, to measure the effectiveness of the program, we use a combination of methods. Firstly, we measure cortisol levels to obtain biological evidence of stress. Secondly, we use the Perceived Stress Survey, which is widely used in the field of psychology to measure stress among young people. We also include a few additional questions in the survey to investigate how the program impacts stress and academic performance. Finally, we will measure the final outcome, which is the mean grade per student per semester. We believe that the stress management program will help students to improve their learning abilities, increase their confidence, and feel calmer and more focused during exams.

2.4 Randomization

Once the colleges have been chosen, we propose to all the students a stress management class. We let them know that not everyone can get the course, but that they can otherwise benefit from the unsupervised program. We send emails to the students before the start of the semester, asking them to register for a lottery that would allow them to get the course. We send a couple of reminders, and twenty days later, we start the lottery. 1600 individuals are selected for the courses, 1600 receive the second treatment, and 1600 students are in the control group. These numbers are the lower bound. This randomization among the volunteers is done to avoid a low participation rate. The experiment allows us to measure the average effect of the treatment on students who want to receive stress management help. Therefore, it is not a global effect of the treatment, but a local effect, which is the most interesting for us, since the program is designed to help stressed students.

2.5 Prior power analysis

We carried out a power analysis to determine the number of observations needed for the experiment. We did the calculation for one treatment and one control group. We draw on John Hattie's work *Visual Learning*, 2009 and its updates to select an effect size. In our experiment, the effect size is calculated as the mean of the students' grades in the treated sample minus the mean of the students' grades in the control sample, divided by the standard deviation of grades in both samples (Cohen's d formula). Therefore, we assumed that the standard deviation of grades is equal in both groups. We set alpha at 0.05 (type 1 error) and beta at 0.2 (type 2 error) and conducted a power analysis based on the t-test with a two-tailed hypothesis. According to John Hattie's updated work of 2018, the expected effect size of the item "Lack of stress" for students is around 0.17. Our analysis shows that we need at least 545 students per group to likely obtain a significant result with a potential effect size of 0.17. However, we do not expect a large effect, and likely we will only see a reduction in stress rather than its complete absence. Therefore, if we lower the effect size to 0.10, we need 1571 students per group so roughly 1600.

It is more careful to choose the latter.

3 Results of the experiment

3.1 Data description

In this part, we explain the variables related to our analysis. We have ten surveys on stress levels, cortisol measurements, and a reported GPA twice per semester. We examine if the treatments have an effect on GPA by analyzing if the program affects stress and if stress affects grades.

1. Main Variables: These are the variables that directly affect our analysis model.
   (a) Outcome Variable: Students' GPA, twice per semester (mid-term exams and final exams).
   (b) Treatment Variable: whether the students are in one of the treatment groups or not.
   (c) Mediating Variables:
      - Perceived stress level of students over time. This is the score of the stress level survey.
      - Cortisol measure (classified into 5 levels). They are available three times during the program.
      - Question a: "In the past month, how often have you felt that your stress was preventing you from working well?"
      - Question b: "In the past month, did you feel confident that you will succeed in your academic task?", asked with the survey every month but independent of the survey score.
      - Question c: "How focused and calm did you feel during the exam?" Asked twice per semester, at the same period as the exams, to analyze the perceived stress specific to exams.

2. Additional Variables: There are also some other variables that can be used as control variables or to assess if the treatment is heterogeneous. These include gender, age, state of residence, economic status, parents' status, job status, and parents' education. Further information can be found in the tables 6, 7, 8, 9 (Appendix).

The dataset used in this study includes information on approximately 4,800 individuals over a period of 10 months, captured on a monthly basis. The individuals are divided into three different groups: control, supervised, and unsupervised. The dataset contains data on GPA for months 3, 5, 8, and 10, as well as information on cortisol levels for months 1, 5, and 10. Additionally, data on perceived stress (question a) and confidence (question b) is available for all months, and data on focus (question c) is available for months 3, 5, and 8. Demographic information such as gender, age, economic status, parental education, state, parental marital status, and occupation is also available. Figure 3 shows a statistical summary of the dataset.

We conducted a graphical time series analysis to explore the temporal patterns of the variables in our dataset. Figure 4 presents the time series plots for the selected variables, which include the average GPA, stress level, cortisol level, and responses to questions a, b, and c. The first observation from the plots is that the average GPA of the control and unsupervised groups remains relatively constant over the ten-month period, while the other treatment groups show some fluctuations. Moreover, the average GPA of the control and unsupervised groups is higher than the other groups, which suggests that the supervised treatment might have a positive impact on academic performance.

Regarding stress levels, we observe that all groups exhibit similar levels of stress after the third month, which could indicate that the treatments did not have a significant effect on stress levels. The average cortisol level of the control group is consistently higher than the treatment groups over time, which could suggest that the stress experienced by the students is higher when no stress management program is being followed. Thus, the perceived stress survey indicates more consistent stress levels between groups, while cortisol levels suggest that students without programs are more stressed.

Finally, we examine the temporal patterns of the responses to questions a, b, and c. The

plots show that the average levels of these questions remain relatively stable over time, with some minor fluctuations. They are quite similar for each group, especially for b and c. These findings suggest that the treatments may not have a significant impact on the participants' confidence or focus levels. For the question (a) "In the past month, how often have you felt that your stress was preventing you from working well?", the mean answer is a little higher for the control groups (1 is Never and 5 is Very often), which suggest that stress is an obstacle to efficient work and that the treatments can act on this issue. Overall, the time series analysis provides insights into the temporal patterns of the variables in our dataset, which can help us better understand the effects of the treatments on the participants.

3.2 Main results

The experiment has been conducted and we now look at the results. We first look at the educational performances of the students, here synthesized by the GPA, and investigate the differences between the supervised, unsupervised, and control groups. The GPA goes from 1 to 5, 1 is the best grade.

3.2.1 Parametric tests

We want to know if the GPA differs between the three groups of students. We have for this purpose four different measures of the GPA over time. We study the mean differences of GPA for each month where the GPA is available. To identify significant changes, we first carry out parametric tests. Here we use an independent sample t-test where the null hypothesis is that there is no difference between the GPA means of the two selected groups. We used a two-sided t-test with equal variances between the groups (it is roughly the case with a variance of around 0.85). There are 12 tests in total. The results are summarized in the table 1.

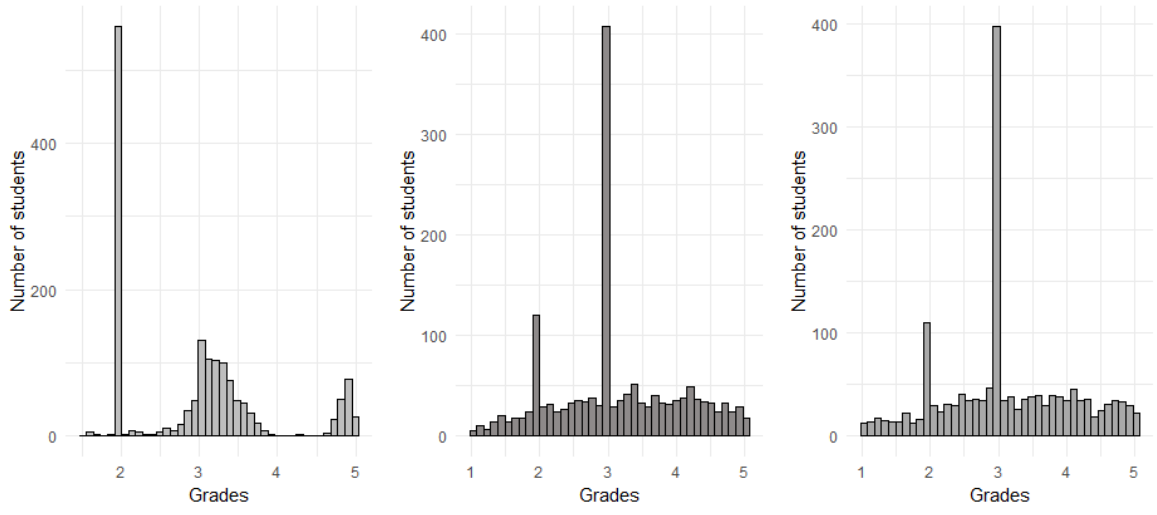
We reject the null hypothesis (no difference in average GPA between the samples) when the supervised group is being compared with another group. In addition, the mean GPA is lower for the supervised group (thus the grades are better). Therefore, for each month, we can draw the same conclusion: only the students in the supervised group have a better

Table 1: Results of the two-sided t-tests

Month	Supervised/Control	Unsupervised/Control	Supervised/Unsupervised
3	**Means** : 2.95 & 3.12 **P-value** : 2.802e-07	**Means** : 3.13 & 3.12 **P-value** : 0.6825	**Means** : 2.95 & 3.13 **P-value** : 2.098e-08
5	**Means** : 3.02 & 3.12 **P-value** : 0.003597	**Means** : 3.13 & 3.12 **P-value** : 0.6825	**Means** : 3.02 & 3.13 **P-value** : 0.0008552
8	**Means** : 2.98 & 3.12 **P-value** : 3.37e-05	**Means** : 3.13 & 3.12 **P-value** : 0.6825	**Means** : 2.98 & 3.13 **P-value** : 4.548e-06
10	**Means** : 2.92 & 3.12 **P-value** : 4.062e-09	**Means** : 3.13 & 3.12 **P-value** : 0.6825	**Means** : 2.92 & 3.13 **P-value** : 2.21e-10

GPA on average in comparison to both the unsupervised and the control group. Furthermore, there are no significant mean differences between the unsupervised and the control group. Therefore, for this particular test, we can observe that only the supervised treatment consisting of stress management classes seems to have an effect on the educational performances of college students.

However the t-test rests upon the hypothesis that the samples have a normal distribution. As shown in Figure 1, it is not the case because the values of the GPA are concentrated around 2 or 3. To address this issue, we can use non-parametric tests which don't assume any underlying distribution.



(a) Supervised group (b) Unsupervised group (c) Control group

Figure 1: GPA distribution (month 3)

3.2.2 Non-parametric tests

After the comparison of the mean GPA between groups with t-tests, we can compare its distribution with the Wilcoxon-Mann-Whitney rank sum test (two-sided). When comparing two samples, the null hypothesis is that they are drawn from the same distribution. We are testing the data according to the same process as before. In table 2, the p-value and W the statistic of the test are shown.

Table 2: Results of the two-sided Wilcoxon-Mann-Whitney rank sum test

Month	Supervised/Control	Unsupervised/Control	Supervised/Unsupervised
3	**W** : 1148303 **P-value** : 4.221e-06	**W** : 1318953 **P-value** : 0.6372	**W** : 1137850 **P-value** : 6.393e-07
5	**W** : 1176035 **P-value** : 0.0004279	**W** : 1318953 **P-value** : 0.6372	**W** : 1168376 **P-value** : 0.0001497
8	**W** : 1135670 **P-value** : 3.642e-07	**W** : 1318953 **P-value** : 0.6372	**W** : 1128130 **P-value** : 4.846e-11
10	**W** : 1097398 **P-value** : 4.062e-09	**W** : 1318953 **P-value** : 0.6372	**W** : 1089435 **P-value** : 6.922e-12

The tests show that the distribution of the GPA in the unsupervised group and the control group is similar for every month. However, we can reject the hypothesis that the GPA of the supervised group has the same distribution as the GPA of the other two samples (control and unsupervised). Knowing that on average, the students following the stress management class have a better GPA, then only the supervised treatment has a positive and significant effect on the grades of students. The second treatment to reduce stress appears to be ineffective in helping students achieve a higher GPA.

3.2.3 Regression model

To complete the analysis, we estimate the effect of the treatments through OLS regressions. We carry out the same regression model for each month with a GPA available:

$$GPA_i = \beta_0 + \beta_{t1} * supervised_i + \beta_{t2} * unsupervised_i + \epsilon_i \quad (1)$$

Thanks to the randomization, it is probable we can identify a causal effect of the treatments with an OLS regression. In addition, we checked that the variables on the students' characteristics were evenly distributed among the groups to control the randomization (cf. Appendix). The results of the regressions are displayed in table 3.

Table 3: Results of the OLS regressions: GPA on treatment

	Dependent variable:			
	GPA			
	(Month 3)	(Month 5)	(Month 8)	(Month 10)
Supervised	-0.169^{***}	-0.100^{***}	-0.142^{***}	-0.198^{***}
	(0.033)	(0.034)	(0.034)	(0.033)
Unsupervised	0.013	0.013	0.013	0.013
	(0.032)	(0.033)	(0.033)	(0.033)
Constant	3.119^{***}	3.119^{***}	3.119^{***}	3.119^{***}
	(0.023)	(0.024)	(0.024)	(0.023)
Observations	4,800	4,800	4,800	4,800
Adjusted R^2	0.008	0.002	0.005	0.010
Note:				*p<0.1; **p<0.05; ***p<0.01

The regressions' results confirm that only the supervised treatment has a positive effect on the GPA of students. Being in the supervised group decreases the mean grade of students of -0.17, -0.10, -0.14, and -0.20 respectively for the months 3, 5, 8, and 10 in comparison to the students in the control group. Therefore, the grades for the students attending the stress management class are better by 0.10 points to 0.17. The effects of the unsupervised treatment are not significant. To explain the last point, we can hypothesize that the fact that stress management is not supervised leads students to drop out of the program. Alternatively, there are more chances that a student in the supervised group follows the advice given during the class. Furthermore, the presence of a sophrologist in class allows the student to have more personalized advice.

We made the hypothesis that the stress management class may improve the educational

performances of students by increasing their learning ability, their confidence, and their focus. We'll look into those assumptions in a later section. First, we discuss the potential heterogeneous effects of the treatments on the students and we further analyze the supervised treatment's effectiveness.

3.3 Further analyses

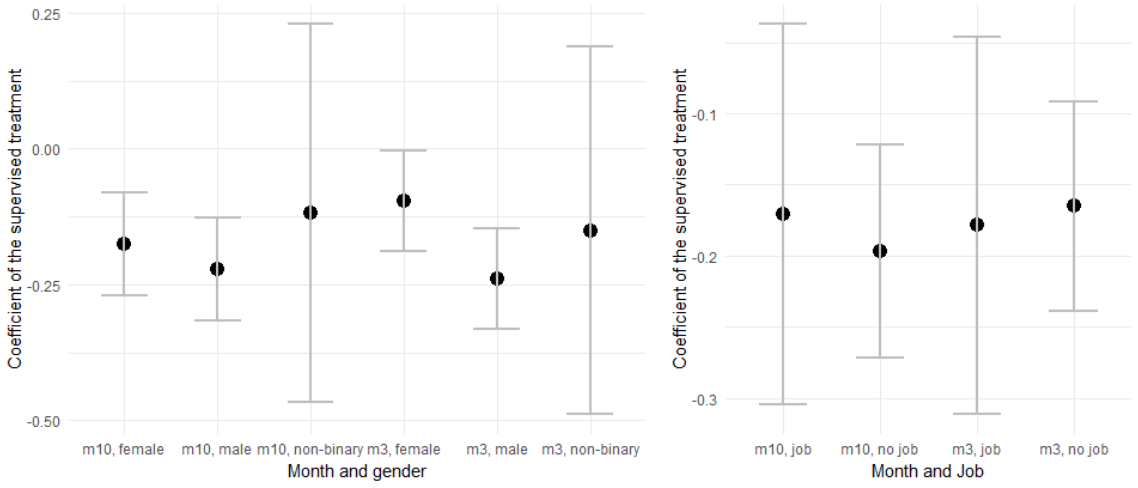
3.3.1 Heterogeneous effects

The first treatment is effective since it improves the educational performances of the students. However, the effect could be different according to students' characteristics. For example, we can focus on the gender of students and whether or not they are employed[2]. Indeed, stress reactions and thus responses to the treatment can be different across genders. As for employment, having a job can be a source of additional stress.

We subset the students into three groups for gender: male, female, and no-binary students and two groups for employment. For each group, we run the regression from before with control variables in addition: age, state, economic status, parental status, and parents' education and gender or the job's dummy variable when the data set is not split according to the variable. Indeed, even if the students' characteristics have the same distribution in the three groups thanks to the randomization, adding control variables is helpful to approach a causal effect this time since we only take a subset of the data. We carry out the regression for months 5 and 10 which are the months of the final exam for each semester on each subgroup.

Figure 2 shows that for the two months, there is no significant difference in the coefficient of the supervised treatment (β_{t1}) if we run the regression model only on male, female, or non-binary students. The same conclusion applies to employment status. We can't observe the heterogeneous effect of the first treatment.

2. We could have focused on other characteristics like the parental level of education or economic status. These variables have however many categories, some with a few numbers of students and it's then more delicate to analyze.



(a) Different effects according to the gender

(b) Different effects according to the employment status

Figure 2: Heterogeneous effects

3.3.2 Effects of the stress on grades

In this section, we try to assess how stress affects grades. Indeed, our hypothesis is that the treatments reduce stress and thus increase educational performance. Table 12 presents the results of a fixed effect analysis examining the impact of stress level and cortisol level on GPA. There is both individual and time (month) fixed effect. The regression ”Stress level FE (time dummies)” allows seeing the monthly fixed effects. Based on the coefficients and standard errors provided in the table, several observations can be made about the association between stress and GPA and between cortisol levels and GPA. For both ”Stress level FE” and ”Stress level FE (time dummies),” the coefficient for ”stress index” is insignificant suggesting that we cannot say if higher levels of stress are associated with worse grades.

The inclusion of time dummies in the second dependent variable (”Stress level FE (time dummies)”) appears to improve the model’s explanatory power. Moreover, the coefficients for ”Month 5,” and in ”Stress level FE (time dummies)” is positive and significant, suggesting that stress levels were higher in this month relative to the omitted reference month (10th month).

Additionally, we can’t say if a higher level of cortisol is associated with a higher GPA

because the coefficients are not statistically significant. The constant term is also statistically significant for all three dependent variables, indicating that there is a significant intercept even when all the independent variables are zero. However, the lack of adjusted R-squared value for any of the models limits the ability to make definitive statements about the overall fit of the models.

3.3.3 Variable importance based on decision tree and random forest

The previous analysis showed us that stress does not seem to influence greatly grades. We can check which variables have a strong impact on grades with a variable importance analysis. Variable importance analysis is a technique used to understand the relative importance of different variables in a regression model. It can be used to identify which variables are most strongly associated with the outcome variable, and which variables can be safely ignored. There are several methods for conducting variable importance analysis, but two of the most popular methods are based on decision trees (DT) and random forests (RF).

The importance score in a DT and RF model reflects the degree to which each variable contributes to the accuracy of the model. A variable with a high importance score is one that has a strong relationship with the outcome variable and significantly impacts the model's predictions. In decision trees and random forests, the feature importance score represents the reduction in the impurity of the target variable (in this case, GPA) that can be attributed to a particular feature at each split. The impurity of a node is measured by a splitting criterion such as information gain.

Table 4 presents the feature importance obtained from the decision tree and random forest regression models for predicting GPA based on a set of control variables. The results show that the top three most important variables for both models are "state," "parent education," and "age," with similar scores for both models. The next important variables are "economics status," "parent status," "gender," and "job," with relatively lower scores. "Treatment" has the lowest score in both models, indicating that it has the least impact on the variation of the dependent variable.

Table 4: Variable importance scores

	DT importance score	RF importance score
State	0.20	0.24
Parents' education	0.24	0.21
Age	0.22	0.21
Economic status	0.12	0.12
Parental status	0.07	0.08
Gender	0.08	0.08
Job	0.06	0.05
Treatment	0.01	0.01

The supervised treatment has a positive impact on grades, albeit a minor one, as indicated by the OLS regressions and consistent with prior research. Furthermore, we were unable to establish a correlation between stress levels and academic performance. Moving forward, our analysis will further investigate into the efficacy of the treatment by examining the stress, confidence, and focus channels.

3.3.4 Treatment's effectiveness

The plot analysis (Figure 4 in the Appendix) suggested that on the three channels we investigate i.e. the learning ability, the confidence, and the focus during exams, only the first one stands out to explain the effectiveness of the stress management class.

Question A on stress and learning ability: "In the past month, how often have you felt that your stress was preventing you from working well?"

Regressions in table 5 show that in a treatment group, it is less likely that a student will be prevented by stress from working well. The effect is quite large, from 0.5 for unsupervised treatment to about 1.5 for supervised treatment, on a scale of 1 to 5. Thus, this shows that the treatment helps to reduce stress when students are working. The relationship between stress and grades was not clearly established by the previous panel analysis. Here, this relationship can be made clearer since stress is likely to negatively influence students' attention to work and thus their grades.

Table 5: OLS regressions on question (a)

	Dependent variable:			
	Question a - from 1: Never to 5: Very often			
	(Month 3)	(Month 5)	(Month 8)	(Month 10)
Supervised treatment	-1.185^{***}	-1.492^{***}	-2.611^{***}	-1.567^{***}
	(0.029)	(0.031)	(0.023)	(0.031)
Unsupervised treatment	-0.645^{***}	-0.479^{***}	-2.452^{***}	-0.417^{***}
	(0.028)	(0.030)	(0.023)	(0.031)
Constant	4.282^{***}	4.046^{***}	4.433^{***}	3.915^{***}
	(0.020)	(0.021)	(0.016)	(0.022)
Observations	4,800	4,800	4,800	4,800
Adjusted R^2	0.265	0.340	0.773	0.362
Note:				*p<0.1; **p<0.05; ***p<0.01

Question B on confidence and Question c on focus:

"In the past month, did you feel confident that you will succeed in your academic task?" & "How focused and calm did you feel during the exam?"

The same regressions are made for the two other questions. Table 10 shows the results for question (b). The coefficients for the supervised program are either non-significant for month 10 or slightly significant (at the 10% level). They indicate that being in the first treatment group decreases very slightly the confidence in success. Therefore, we do not observe an increase in confidence by following a stress management class. The results for question (c) are in table 11. The coefficients are insignificant except for month 8 for both treatments. They are negative, which is not expected. However, they are quite small. Students in the treatment groups did not tend to be more focused during exams following the stress management sessions. Therefore, the treatments do not appear to contribute to increased confidence or concentration during exams.

4 Conclusion

This study investigates the effectiveness of two stress management programs on the academic performance of college students. The findings indicate that only the supervised stress management program was effective in improving students' academic performance. The OLS regression analysis revealed a positive effect on students' GPAs, while the unsupervised treatment had no significant effect on grades. The study also explored the potential impact of stress and cortisol levels on GPA, but no statistically significant results were found. Furthermore, according to the survey and the questions on stress, confidence, learning efficiency, and focus, the treatment works because students are less prevented by stress in their work and are thus more efficient. The stress management classes do not have an effect however on confidence and focus. Finally, the study used variable importance analysis to identify the most important variables in the regression model, which could guide future studies. The analysis can be continued to investigate the effect of the programs on students' well being. Also, future studies could investigate deeper the potential interaction between stress and other factors such as motivation, study habits, and social support and how they can influence the educational performances of college students. Furthermore, because the relationship between stress and grades has not been convincingly demonstrated, other measures can be taken to accurately describe this relationship and thus more directly assess the effect of programs on students' grades.

5 Citations

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Websites

- Hattie effect size list - 256 Influences Related To Achievement (visible-learning.org)
- Perceived Stress Scale (PSS-10) (corc.uk.net)

6 Appendix

6.1 Perceived stress level

- Perceived Stress Scale (PSS), from Cohen et al. (1983) is presented here:

For each question choose from the following alternatives:

0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often

1. In the last month, how often have you been upset because of something that happened unexpectedly?
2. In the last month, how often have you felt that you were unable to control the important things in your life?
3. In the last month, how often have you felt nervous and stressed?
4. In the last month, how often have you felt confident about your ability to handle your personal problems?
5. In the last month, how often have you felt that things were going your way?
6. In the last month, how often have you found that you could not cope with all the things that you had to do?
7. In the last month, how often have you been able to control irritations in your life?
8. In the last month, how often have you felt that you were on top of things?
9. In the last month, how often have you been angered because of things that happened that were outside of your control?
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

To answer how we calculated the perceived stress score, We sum each answer (0 - never 1 - almost never 2 - sometimes 3 - fairly often 4 - very often) except for questions 4, 5, 7, and 8 where we reverse the score (4 - never 3 - almost never 2 - sometimes 1 - fairly often 0 - very often). A high score means a high level of perceived stress. The highest score is then 40 and the smallest is 0. Also, here is information about questions a,b, and c:

(a) "In the past month, how often have you felt that your stress was preventing you from working well?"

(b) "In the past month, did you feel confident that you will succeed in your academic task ?"

(c) "How focused and calm did you feel during the exam?"

We take the same scale of answers (Never, almost never, sometimes, fairly often, very often) for the two first questions. For the second, we inverse the scale. The questions are studied apart from the main stress score. They are used to understand how the students feel about the effect of the program.

6.2 Variables

In this section, a summary of the time scale and the measures are presented (Tables 6, and 7). Moreover, the initial data file should have two datasets. The first one has 9 columns and 4800 rows and gives the information on the students (Table 8). The other dataset gives the GPA and the stress measures as well as the mediating variables, and GPA for all months. For each student_id we have 10 rows (Table 9).

Table 6: Variable informations

Variable	Description	Temporality	Encoding
GPA	Mean per student of the grades of the mid-term exams and the final exams	Twice a semester, month 3,5,8,10	From 1 to 5
Treatment variable	In which group is the student?	Once	0: Control, 1: Supervised treatment, 2: Unsupervised treatment
Perceived stress score	Result of the PSS-10	Every month (10 times)	from 0: Not stressed at all, 40: Very stressed
Cortisol measure	Classification of the cortisol measure into 5 levels	4 times in the program : month 1,5,10	1: Low 2: Quite low 3: Normal 4: Quite high 5: High
Question a: "In the past month, how often have you felt that your stress was preventing you from working well?"	Question a) to investigate the ability to work and learn channel	Every month	Never, almost never, sometimes, fairly often, very often
Question b: "In the past month, did you feel confident that you will succeed in your academic task ?"	Question b) to investigate the confidence channel	Every month	Never, almost never, sometimes,fairly often,very often
Question c: "How focused and calm did you feel during the exam?"	Question c) to investigate the peace of mind of students during the exams	Month 3, 5, 8, 10 during the exams	Never, almost never, sometimes, fairly often, very often
Gender		Once	0: Male, 1: Female, 2: Non-binary/Other
Age		Once	
State of residence	One of the 16 states of Germany	Once	1 to 16 by alphabetical order
Perceived economic status	How students feel their economic status is	Once	1 to 4 and 4 is the highest
Job		Once	0: no job 1: job
Parental status		Once	0: not separated 1: separated 2: monoparental family
Parents' level of education	ISCED 2011 level	Once	0: Early childhood education 1: Primary education 2: Lower secondary education 3: Upper secondary education 4: Post-secondary non-tertiary education 5: Short-cycle tertiary education 6: Bachelor or equivalent 7: Master or equivalent 8: Doctorate or equivalent

Table 7: Timeline

Month	Cortisol level measure	Stress level	GPA	Additional questions
1	Yes	Score of the PSS + two additional questions a and b		
2	No	Score of the PSS + two additional questions a and b		
3	No	Score of the PSS + two additional questions a and b	GPA (mid-term exam)	Question on stress during the exams
4	No	Score of the PSS + two additional questions a and b		
5	Yes	Score of the PSS + two additional questions a and b	GPA (final exam)	Question on stress during the exams
6	No	Score of the PSS + two additional questions a and b		
7	No	Score of the PSS + two additional questions a and b		
8	No	Score of the PSS + two additional questions a and b	GPA (mid-term exam)	Question on stress during the exams
9	No	Score of the PSS + two additional questions a and b		
10	Yes	Score of the PSS + two additional questions a and b	GPA (final exam)	Question on stress during the exams

Table 8: Students' information

student_id	Treatment	Gender	Age	State	econ_status	parents_status	job	parents_edu
0001	0	0	23	4	3	0	0	4
...	1	1	25	16	4	0	1	4
...	2	1	19	5	1	1	0	3
4800	1	2	20	1	2	0	0	2

Table 9: Treatment information

student_id	month	GPA	PSS -10 score	cortisol level	Question a)	Question b)	Question c)
0001	1	-	20	4	Never	Fairly often	-
	2	-	18	-	Almost never	Never	-
	3	1.8	28	-	Never	Sometimes	Fairly often
	4	-	23	-	Sometimes	Sometimes	
	5	1.7	22	5	Very often	Never	Sometimes

Table 10: OLS regressions on question (b)

	Dependent variable:			
	Question b- Never: 1 to Very often: 5			
	(Month 3)	(Month 5)	(Month 8)	(Month 10)
Supervised	-0.049^{*}	-0.048^{*}	-0.055^{**}	-0.035
	(0.028)	(0.025)	(0.022)	(0.021)
Unsupervised	-0.006	-0.010	-0.018	-0.003
	(0.028)	(0.025)	(0.022)	(0.021)
Constant	2.098^{***}	2.195^{***}	2.306^{***}	2.356^{***}
	(0.020)	(0.018)	(0.016)	(0.015)
Observations	4,800	4,800	4,800	4,800
Adjusted R^2	0.0003	0.0004	0.001	0.0003
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 11: OLS regressions on question (c)

	Dependent variable:		
	Question c - Never: 1 to Very often: 5		
	(Month 3)	(Month 8)	(Month 10)
Supervised	0.011	-0.069^{***}	0.022
	(0.024)	(0.024)	(0.024)
Unsupervised	-0.020	-0.059^{**}	0.004
	(0.024)	(0.024)	(0.024)
Constant	3.053^{***}	3.048^{***}	3.019^{***}
	(0.017)	(0.017)	(0.017)
Observations	4,800	4,800	4,800
Adjusted R^2	-0.0001	0.002	-0.0002
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 12: Fixed effect model - stress level and cortisol on GPA

	FE Stress Level	FE Stress Level (time dummies)	FE Cortisol Level
stress level	0.00243	0.00243	
	(0.00208)	(0.00208)	
cortisol level			0.00988
			(0.00840)
Month 3		0.00844	
		(0.01120)	
Month 5		0.03193^{**}	
		(0.01118)	
Month 8		0.01828	
		(0.01118)	
Constant	2.99731^{**}	2.98264^{**}	3.04288^{**}
	(0.06570)	(0.06588)	(0.02787)
Observations	19,200	19,200	9,600
Adjusted R^2	0.0001	0.0007	0.0003
Note:			*p<0.1; **p<0.05; ***p<0.01

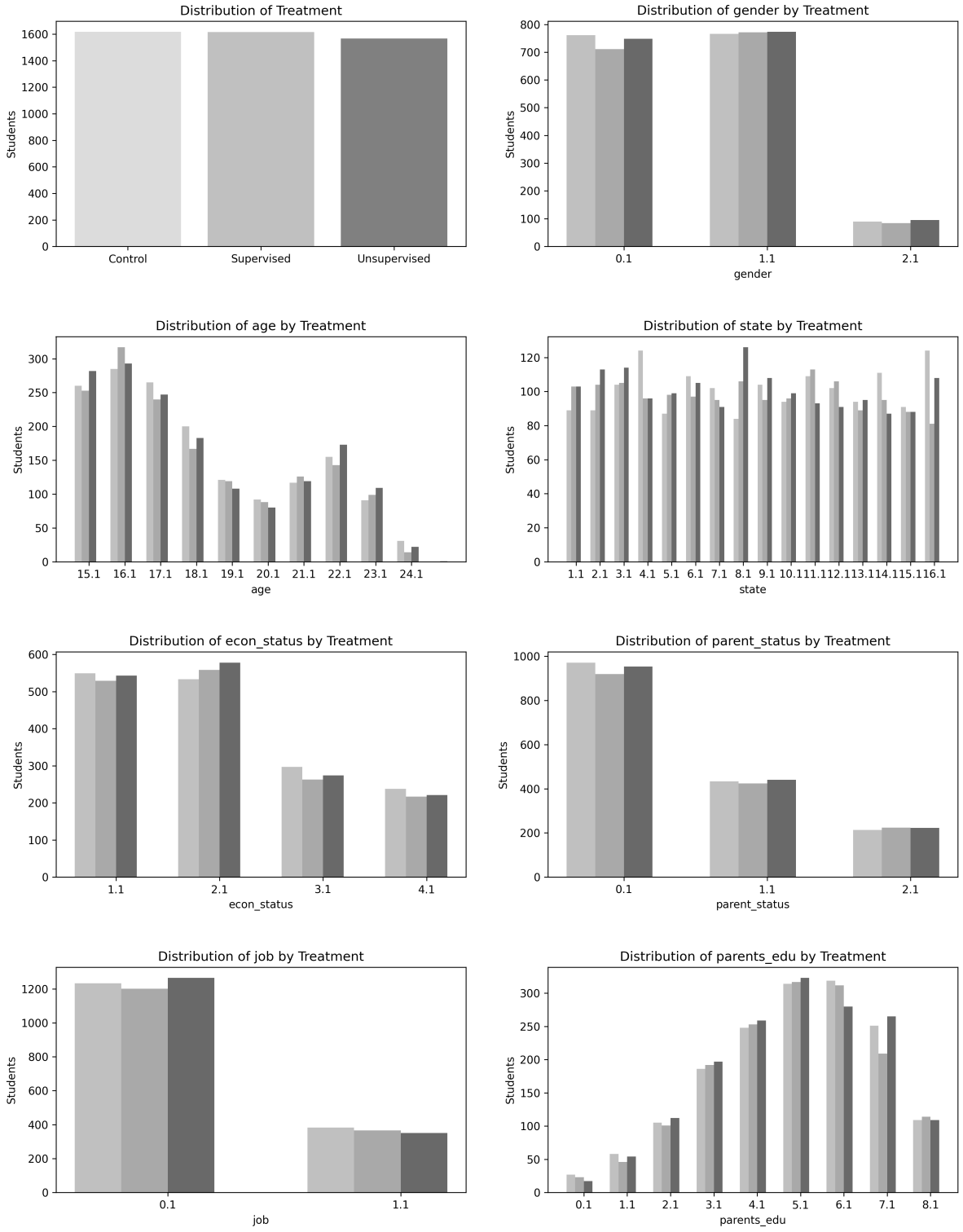

Figure 3: Dataset statistical insights

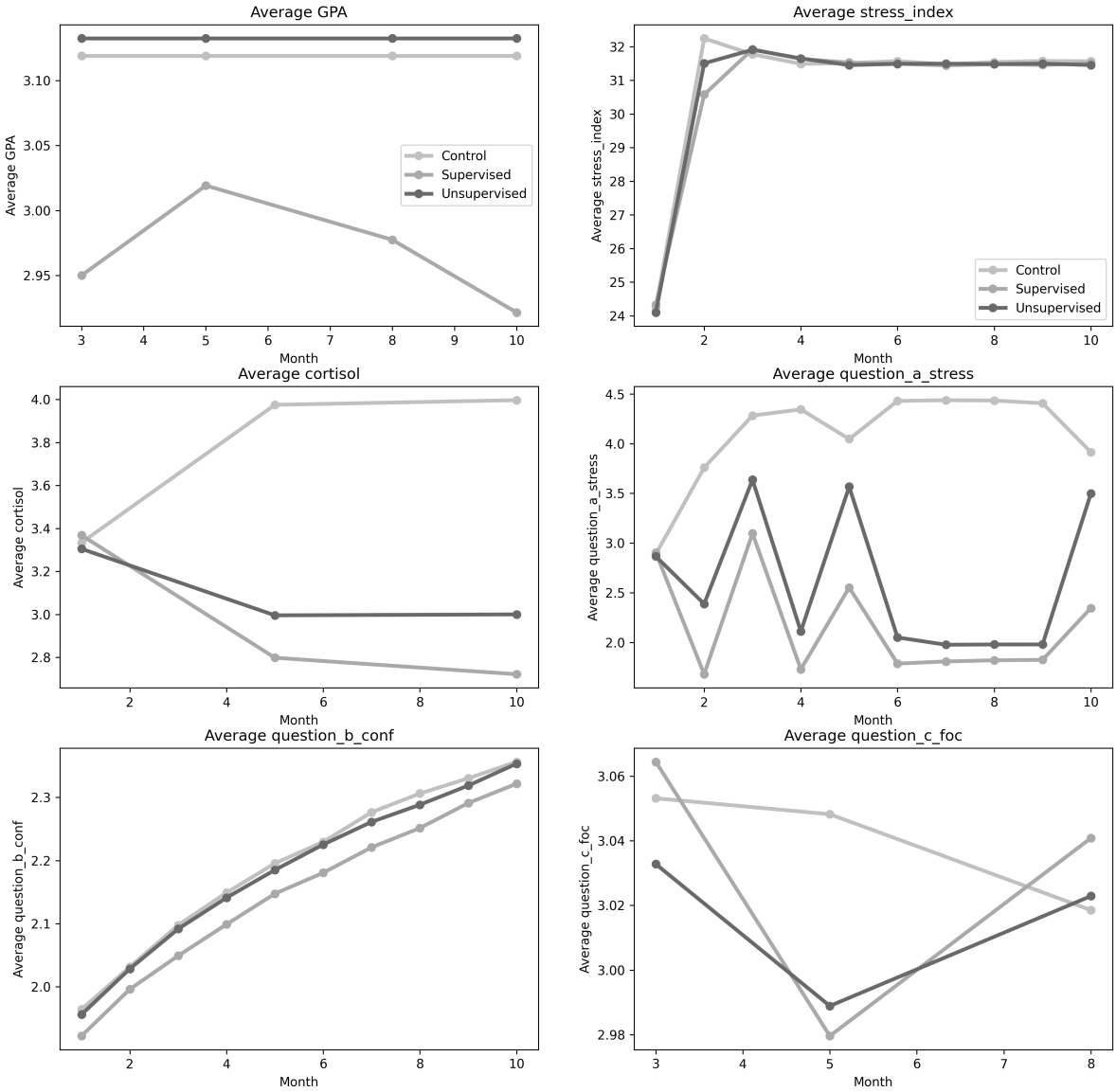

Figure 4: time series analysis