Can't Stress This Enough: Can Biofeedback Increase the use of Stress interventions?

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Abstract

Undergraduate students experience many stressors throughout their education. An abundance of stress coping methods exists to help students cope; however, many require a significant time investment (e.g., exercise, meditation). Some quick stress coping methods (e.g., deep breathing, cognitive reappraisal) are effective for coping with in-the-moment stressful situations, but students rarely use these coping methods. It is unclear whether this lack of use is due to lack of knowledge, lack of belief that the strategy is useful, or other factors. Our study examined the first two ideas by introducing deep breathing and cognitive reappraisal to the participants with and without biofeedback. We compared the effectiveness of a physiological technique (deep breathing) to a cognitive technique (cognitive reappraisal).

Contrary to our hypotheses, coping strategy and biofeedback did not increase the use of either coping strategy throughout the semester; however, participants across all groups reported using deep breathing and cognitive reappraisal more in Part 2 than Part 1. Aligning with our hypothesis, deep breathing, and cognitive reappraisal as a stress coping strategies lead to similar changes in our biofeedback measure and seem to lead to better mental control over the participant's stress reaction.

Keywords: biofeedback, deep breathing, cognitive reappraisal, stress coping, heart rate

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Can't Stress This Enough: Can Biofeedback Increase the use of Stress interventions?

Post-secondary education can be a stressful experience for students. Stress is physical and emotional tension created by the demands of the environment that exceed the resources the person experiencing stress holds to overcome the demand (Selye, 1993). Acute stress response activates the *fight-or-flight* response in the body (Lin et al., 2011). This response is associated with increases in heart rate and in stress hormones, like cortisol, in the body (Fink, 2010). Chronic stress refers to the state of the body, in which the physiological reaction causing acute stress continues over time, usually for 12 months (McGonagle & Kessler, 1990). Chronic stress has been associated with memory problems (McEwen, 2017), decreases in immune response (Lupien, 2018), psychopathologies like depression and anxiety (Chida & Steptoe, 2009), and physical illnesses like cardiovascular disease (Torsheim & Wold, 2001) and even death (Keller et al., 2012). Elias et al. (2011) found that most students experience moderate to high levels of stress throughout their university careers, with the levels increasing towards the end of their degrees.

Causes and Coping with Academic Stress

Students report experiencing moderate to high levels of stress due to the heavy workload of academic requirements (Murphy & Archer, 1996). Many different events at university contribute to both acute and chronic aspects of stress. Factors like constant evaluation and reformation of self-image based on the feedback received also cause stress in university students (Campbell et al., 1992). More specifically, students list receiving final grades, excessive homework, term papers, and examinations are the most stressful school events (Kohn & Frazer 1986). A more recent study by Elias et al. (2011) identified new stressors in the undergraduate population, such as starting a new semester, making friends, and talking in front of a class.

Students also often identify that the general lack of time to complete multiple tasks increases their likelihood of experiencing stress (El-Ghoroury et al., 2012).

High levels of stress experienced by students can impair their academic achievements. (Elias et al., 2011). For example, Struthers et al. (2000) investigated the relationship between academic stress and success on school assignments. They found a negative correlation between stress levels and grades, showing an association between high stress and lower grades. Higher stress levels were reported by students when they were faced with academic demands that they felt little to no control over their performance in the task (Aspinwall and Taylor, 1992). The physiological stress reaction can feel overwhelming and add to the feeling of loss of control, making the stress experience appear threatening (Jamieson et al., 2012). The vicious cycle of academic stress continues when students experience even higher amounts of stress due to falling grades (Kohn & Frazer 1986).

Academic stress has been labeled as a source of chronic stress (MacGeorge et al., 2005). Perhaps due to the well-known adverse effects of chronic stress, students use many coping strategies to cope with stress throughout academic semesters. El-Ghoroury et al. (2012) surveyed 438 students and found that students mainly cope with stress by seeking out family or peer support, psychotherapy, exercising regularly, or spending time on hobbies. In the same study, students listed lack of time, affordability of hobbies, general worries, and lack of energy as the most significant barriers to engaging in stress-reducing activities. The study used 20-item select scales and rated top results as the most used coping strategies and top barriers to stress coping. The study only included chronic stress coping strategies on the selection scale. It is unclear if chronic stress coping strategies are effective in combatting an acute stress reaction.

Coping with Acute Stress

During moments of acute stress, the sympathetic nervous system is activated, which often initiates the fight or flight response (Lin et al., 2011). This response is adaptive to help the body respond to an immediate emergency. During acute stress, the sympathetic nervous system increases heart rate (Kingwell et al., 1994), resulting in more rapid breathing. Increases in blood pressure (Kimura et al., 2005) and decreases in heart rate variability (HRV) (Cheng et al., 2019). These physiological changes in the body mobilize energy to deal with an in-the-moment challenge. That challenge can be physical, such as fleeing from an attack, or cognitive, such as facing a difficult task or exam. For example, aspects of the acute stress response, like increased heart rate and blood pressure, are often induced in laboratory settings using cognitive tasks. Examples of these cognitive tasks include the Stroop task (Renaud and Blondin, 1997), giving a speech to a non-responsive audience (Feldman et al., 2004), or solving timed tasks, like math questions (Bement et al., 2010).

There are many helpful stress coping techniques specifically targeted to reduce the physiological effects of the acute stress response. Two examples are deep (or diaphragmatic) breathing (Perciavalle et al., 2017) and cognitive reappraisal (Jamieson et al., 2012), which have both been shown to mediate the negative impacts of acute stress. Deep breathing has been shown to increase heart rate variability (Cheng and Croarkin, 2019) and lower heart rate (Perciavalle et al., 2017) and blood pressure (Mori et al., 2005). Because deep breathing activates the parasympathetic nervous system, it automatically mediates physiological stress symptoms (Kim et al., 2018), making it a powerful tool against the physical and mental effects of stress. Being able to exert conscious control over the physiological symptoms of stress should make stress seem more manageable and less threatening to students.

Cognitive reappraisal of stress response attempts to alter the negative interpretation of stress symptoms into either neutral or positive ones. This is reached through a cognitive exercise that outlines the evolutionary necessity and physical benefits of the stress response (Jamieson et al., 2012). Cognitive reappraisal targets stress reactions through a mental exercise, leading to a decrease in physiological stress reaction (Jamieson et al., 2013). Cognitive reappraisal of stress symptoms relies on the Cognitive Transaction Model introduced by Lazarus and Folkman (1987). According to their model, a situation is first perceived as either a threat or not. If the situation is perceived as threatening, the activation of the sympathetic nervous system (SNS) is imminent. Cognitive reappraisal of the activation of SNS changes the interpretation of the stress reaction from harmful to helpful Often, the physiological stress symptoms that arise in a stressful situation (e.g., an exam) are interpreted as a sign of incompetence or inability to overcome the threat faced (Jamieson et al., 2012). This negative interpretation of stress symptoms can then lead to maladaptive behaviour and impairment in performance.

Reappraisal of these physiological stress symptoms as positive and helpful (e.g., as mobilizing energy to effectively meet the demands of the challenging task), as reported by Jamieson et al. (2013), can effectively mediate the adverse effects of stress in the moment. Crum and Achor (2013) suggested that the mindset over stressful events impacts the appraisal of the stress symptoms, which ties into the cognitive reappraisal of stress symptoms. When a cognitive reappraisal intervention was introduced to participants, they performed better in stressful tasks, like obtained higher scores in the GRE (Jamieson et al., 2013). As well as reducing the psychological effects of stress, physiological stress such as cardiovascular reactivity symptoms were also mediated by cognitive reappraisal (Jamieson et al., 2012).

Biofeedback

Biofeedback refers to technology that allows humans to observe the involuntary physiological changes in their bodies in real-time (Ratini, 2020). Biofeedback could include measures of heart rate, heart rate variability, and blood pressure. Therapies that use biofeedback as a part of the intervention highlight the connection that the patient can make between their physiological reaction to their mental state or bodily sensations. Meuret et al. (2001) combined biofeedback with their intervention for panic disorder. For example, their biofeedback targeted the breathing patterns of the patients at times when a panic attack was settling in, asking the participant to take deeper breaths. They found that when biofeedback was included as a treatment tool, the patients recorded less frequent and intense panic attacks. Participants using biofeedback did comply with treatment, but there was not enough evidence to claim that biofeedback increases treatment compliance.

Stress symptoms have also been mediated by biofeedback in combination with rhythmic or deep breathing (Lemaire et al., 2011). However, biofeedback is relatively new in the field of health research and does not have conclusive evidence to support its effectiveness in stress management (De Witte et al., 2019). Which makes in an interesting area of research.

Current study

Given that stress is prevalent in University students and negatively impacts mental and physical health and achievement outcomes, it is important to develop successful interventions for students to better manage stress. Student's report using strategies to manage chronic stress but don't often report the same uptake of strategies to deal with acute stress. It is unclear why this is the case. It may be that students 1) Do not know about these quick use coping methods, 2) Do not believe they are useful, or 3) Do not use these coping methods for some other reason. In

addition, it is yet unclear whether deep breathing and cognitive reappraisal are different in the ways that they impact physiological stress response.

The current study focuses on the experiences of acute stress and stress in general in the undergraduate population. With biofeedback's help, we hope to show our participants that the two coping methods of deep breathing and cognitive reappraisal are effective at mediating the physiological stress response and encourage students to use either stress coping method at times of acute stress. We also hypothesized that:

1) Students who were exposed to biofeedback (measuring their heart rates) used the stress intervention they were taught more throughout the semester than students who were not exposed to biofeedback.

2) Deep breathing and cognitive reappraisal produce similar changes in the physical stress response, such as heart rate.

3) Both deep breathing and cognitive reappraisal as stress coping methods increase the participants perception of control over their stress reaction.

Methodology

Participants

192 MacEwan University undergraduate students (60% female, 38% male, and 2% non-binary) participated in this study. Ages ranged between 17 – 52 (M = 21.63; SD = 5.1). Data were collected between October 2020 and March 2021. The participants were mainly first year students (60%). Participants were offered a 4% psychology course credit as compensation for their time. MacEwan Research Ethics Board approved the study in October 2020 (Approval

number 101894). Ten Participants were excluded from the final data analysis (See Data Analysis) from part 1 of the study. 78 Participants completed part 2 of the study.

Experimental Design

All participants completed baseline questionnaires and were then randomly assigned to one of five different groups (1: control; 2: deep breathing intervention (DB); 3: cognitive reappraisal intervention (CR); 4 deep breathing intervention + biofeedback (DB + BF); or 5: cognitive reappraisal + biofeedback (CR + BF) (see Table 1 for groups and their tasks).

Table 1

Experimental Design Breakout Parts 1 and 2.

Control (1)	Deep Breathing (DB) (2)	Cognitive Reappraisal (CR) (3)	DB + Biofeedback (4)	CR + Biofeedback (5)
		Part1		
PSS	PSS	PSS	PSS	PSS
SMM	SMM	SMM	SMM	SMM
Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings
			HR Measure	HR Measure
	Stress Task 1	Stress Task 1	Stress Task 1	Stress Task 1
			HR Measure	HR Measure
	Deep Breathing	Cognitive Reappraisal	Deep Breathing	Cognitive Reappraisal
	Stress Task with Intervention	Stress Task with Intervention	Stress Task with Intervention	Stress Task with Intervention
			HR Measure	HR Measure
		Part2		
PSS Short	PSS Short	PSS Short	PSS Short	PSS Short
SMM	SMM	SMM	SMM	SMM
Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings	Stress Experience Ratings

Materials & Procedure

This study was conducted online in two parts: initial experiment and follow up survey. Participants could use a device of their choice to complete both parts of the study. Before beginning part 1, definitions of stress and stress coping were presented to the participants. They then completed the baseline questionnaires.

Part 1: Baseline Questionnaires

Participants filled out three baseline questionnaires. These questionnaires consisted of: 1) a demographic questionnaire; 2) the Perceived Stress Scale (Cohen et al., 1994) which measures how stressful the participant views their life to be; 3) the Stress Mindset Measure (Crum et al., 2013) which measures how enhancing or debilitating the participant views their stress to be; and 4) Stress Experience Ratings, which enquired about the participants use of stress coping, and their experiences, and perceived control over their stress reactions (See Appendix A for Part 1 Surveys questions for stress experiences). After completing the baseline questionnaires, participants were randomly assigned to one of the five groups described below.

Control Group

The control group finished part 1 after completing the baseline measures. They saw an end screen thanking them for their participation and informing them they would receive a follow-up survey later in the semester.

Deep Breathing Intervention (DB.) Group

After completing the baseline questionnaires, this group completed Stress Task 1. This task consisted of 10 relatively challenging scrambled words that participants had to unscramble (Regit, or Plea for example). Words were presented one at the time with a 20-second timer counting down per word. The timer was visible on the screen. We used timed word scramble

problems as a tool to elicit stress. Previous studies have shown that timed math questions elicit stress in participants (Bement et al., 2010). However, as the current study was completed fully online, we did not use a math task since we could not prevent the participants from using their calculators to solve math problems. "Did you feel a physiological stress reaction during the word scramble task?" was used as a manipulation check after each stress task for all experimental groups.

Next, DB participants watched a 4-minute video describing the stress coping technique of deep (or diaphragmatic) breathing. The video demonstrated how to do deep breathing effectively and described physiologically why deep breathing is effective for calming the body during stress. The video encouraged students to keep the stress intervention in mind and practice deep breathing at times of stress. At the end of the video, participants were encouraged to use deep breathing when they faced stressful situations in the future. All videos used in this study were embedded in the surveys and were locked so participants could not fast-forward or skip past the videos.

After the video, DB participants completed Stress Task 2. This task was similar to Stress Task 1, but the timed word scramble task was made harder by using five more words that were more difficult (e.g., Geegotbud, and Ujrrciong) and reducing the time limit to 15 seconds per word. Before beginning the stress task, participants were reminded to use the deep breathing intervention they had just learned if they felt stressed during the task. Participants were asked again at the end of the stress task if they felt stressed during the task.

Upon completing Stress Task 2, DB participants were finished part 1 of the study. They saw an end screen thanking them for their participation and informing them they would receive a follow-up survey later in the semester.

Cognitive Reappraisal Intervention (CR.) Group

Participants in the CR group underwent the same procedure as participants in the DB group, except instead of a video about deep breathing, they watch a 3-minute video describing the stress coping technique of cognitive reappraisal. The video gave an example of a negative reappraisal of a thought that might appear when one experiences stress (e.g., "I must not be prepared for this exam because my heart is beating so fast, which means I'm nervous.") and how to turn that thought into a positive or neutral thought(e.g., "My heart is raising because my body is trying to move more oxygen to my brain so I can do my best in this exam.". The video also described previous research showing cognitive reappraisal is an effective stress intervention (Jamieson et al. 2013). Like the deep breathing video, the cognitive reappraisal video ended with encouragement to use this stress coping method when under stress. CR participants were encouraged to use the cognitive reappraisal technique they just learned if they felt stressed during Stress Task 2.

Deep Breathing Intervention + Biofeedback (DB + BF.) Group

After completing the baseline questionnaires, participants in the DB + BF group watched a 3-minute video describing how to measure and record their heart rate. Heart rate was the biofeedback measure used in this study. After watching the video, DB + BF participants were asked to measure and record their heart rate three times (30 second intervals each time). The three heart rate readings taken at this point in the study were averaged and used as the baseline biofeedback measure.

Next, DB + BF participants completed Stress Task 1 (see above). After Stress Task 1, participants were again asked to measure and record their heart rate as instructed earlier. These heart rate measures served as the biofeedback response to the first stress task. DB + BF

participants then watched the same deep breathing video as the DB group and completed Stress Task 2. After Stress Task 2, participants were again asked to measure and record their heart rate. These heart rate measures served as biofeedback to participants regarding the effectiveness of the stress intervention they just learned during a stressful experience.

Upon completing their third set of heart rate measurements, DB + BF participants were finished part 1 of the study. They saw an end screen thanking them for their participation and informing them they would receive a follow-up survey later in the semester.

Cognitive Reappraisal Intervention + Biofeedback (CR + BF) Group

Participants in the CR + BF group underwent the same procedure as participants in the DB + BF group, except instead of a video about deep breathing, they watch the video about cognitive reappraisal.

Part 2: Follow-Up Surveys

Part 2 of the study consisted of a follow up survey sent out to all participants during the last weeks of both semesters. Participants in the control group received one survey about general stress coping techniques, and participants in the 4 experimental groups received a different survey about the specific stress coping technique they were taught during Part 1. The follow-up survey (See Appendix B for part 2 stress related experiences) for both groups included some repeated questions from the baseline questionnaire from part 1, the full SMM, short version of PSS, and questions of their perceived control over the physical and mental stress reactions. Additional questions were added to the follow-up survey to target specific research questions. For example, the follow-up survey included the question "how often did you use the stress coping method you were taught in the first part of the study throughout the semester?" to test the hypothesis whether biofeedback can increase the utilization of stress coping methods, and the

question "how in control do you feel of your mental stress reaction?" to test the hypothesis of either stress interventions ability to increase the participants perceived control over their stress reaction.

Data Analyses

Before data analysis, participants with problematic data were excluded. Six participants were excluded because they responded with the same answer to all PSS or SMM questions, including reverse-scored items. These responses indicated participants were possibly not paying attention to the study. Two participants were excluded for incorrectly recording their heart rates. Two participants were excluded because they did not attempt to participate in the stress task. 182 participants were included in the final analysis.

The Perceived Stress Scale (PSS) was scored following the procedure outlined in Cohen et al. (1983). Word responses were assigned number values (Never = 0, Almost Never = 1, Sometimes =2, Fairly Often = 3, Very Often = 4) and questions 4, 5, 7, and 8 were reverse scored. The PSS short version was used in Part 2 of the study and contained only questions 2, 4, 5, and 10 (Cohen et al. 1994). Higher scores on the PSS indicate higher amounts of perceived uncontrollable, unpredictable, and overloading stress in the life of the participant.

The Stress Mindset Measure (SMM) scores were obtained as instructed by Crum et al. (2013) by assigning number values to word responses (Strongly Disagree = 0, Disagree = 1, Neither Agree nor Disagree = 2, Agree = 3, Strongly Agree = 4), reverse scoring items 1, 3, 5 and 7, and dividing the total by 8. The same 8 item scale was used for both parts of the study. Higher scores on the SMM indicate that participants view stress as enhancing, while lower scores suggest that participants view stress as harmful.

Difference scores were calculated to compare the change in outcomes from either baseline to post-stress task #2 or part 1 to part 2 of the study (i.e., part 2 value – part 1 value). Variables for which difference scores were calculated included: 1) difference between baseline heart rate and post stress task #2 heart rate; 2) PSS short version; 3) SMM; 4) perceived control of one's physical stress reactions; 5) perceived control of one's mental stress reaction; 6) perceived strength of one's physical stress reaction.

Similar word-to-number conversions were done for all scales that included word answers (e.g., Strongly Agree). See Appendix C for all conversion scales and questions.

Data were analysed using IBM SPSS version 26 (IBM Corp., Armonk, NY, USA) via MacEwan Virtual Machine ware Horizon Version 5.4.0. (2020, VMware, Inc., USA).

Results

Preliminary Analyses

Two one-way ANOVAs were used to confirm no difference in baseline PSS or SMM scores across groups. These ANOVAs revealed no significant effect of group on PSS scores ($F(4,177) = 1.656$, $p = .162$) or SMM scores ($F(4,177) = 0.835$, $p = .504$), indicating there was no difference in perceived stress or stress mindset across groups prior to any intervention. An independent sample t-test was used to confirm there was no difference in baseline heart rate between the two biofeedback groups (deep breathing with biofeedback: $M = 38.17$, $SD = 9\ .67$; cognitive reappraisal with biofeedback: $M = 35.83$, $SD = 5\ .54$; $t(69) = 1.254$, $p = .214$), indicating there was no difference in the biofeedback measure of interest prior to any intervention.

Participants were able to complete part 1 of the study throughout weeks 7-10 of the fall semester of 2020 and the first 8-10 weeks of the winter semester of 2021. Days between part 1 and part 2 of the study varied between 7 and 90 days ($M = 47$, $SD = 33$). Pearson correlations revealed no significant relationship between time elapsed between parts 1 and 2 of the study and how often participants reported using the stress coping technique they were exposed to during the study for any group (all rs <.122; all ps >.111). Therefore, the time elapsed between parts 1 and 2 of the study was not included in subsequent analyses.

Part One Analyses

Qualitative Measures

Qualitative measures of the leading causes of stress, main stress coping strategies, and main reasons for not using stress coping methods such as deep breathing and cognitive reappraisal can be seen below (Figures 1, 2, and 3). The majority (61%) of our student sample reported school as their main cause of stress (see Fig. 1). The most common stress coping methods students reported using included humor, watching TV, sleeping, and eating (see Fig. 2). Neither deep breathing nor cognitive reappraisal were listed as common practices for coping with stress. For the main reasons why, students do not engage in stress coping strategies, 29% of participants recorded that they were unaware that coping strategies existed, 24% said they forgot to use them in times of stress, and 17% noted that stress coping methods take too much time (see Fig. 3).

Figure 1

Main Causes of Stress in Our Sample.

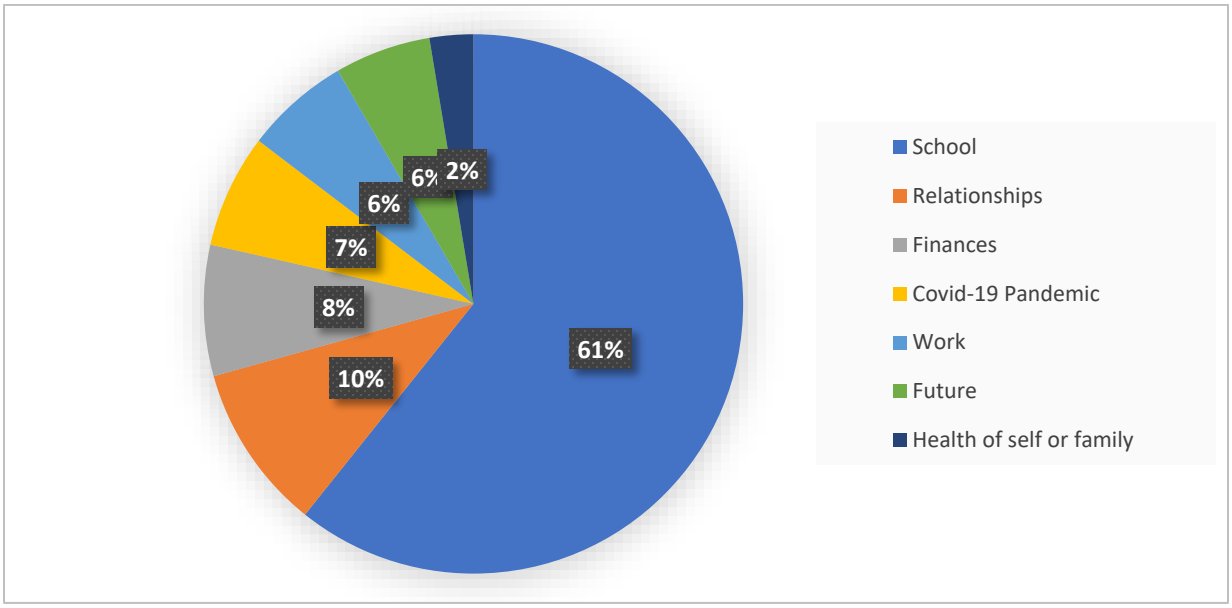
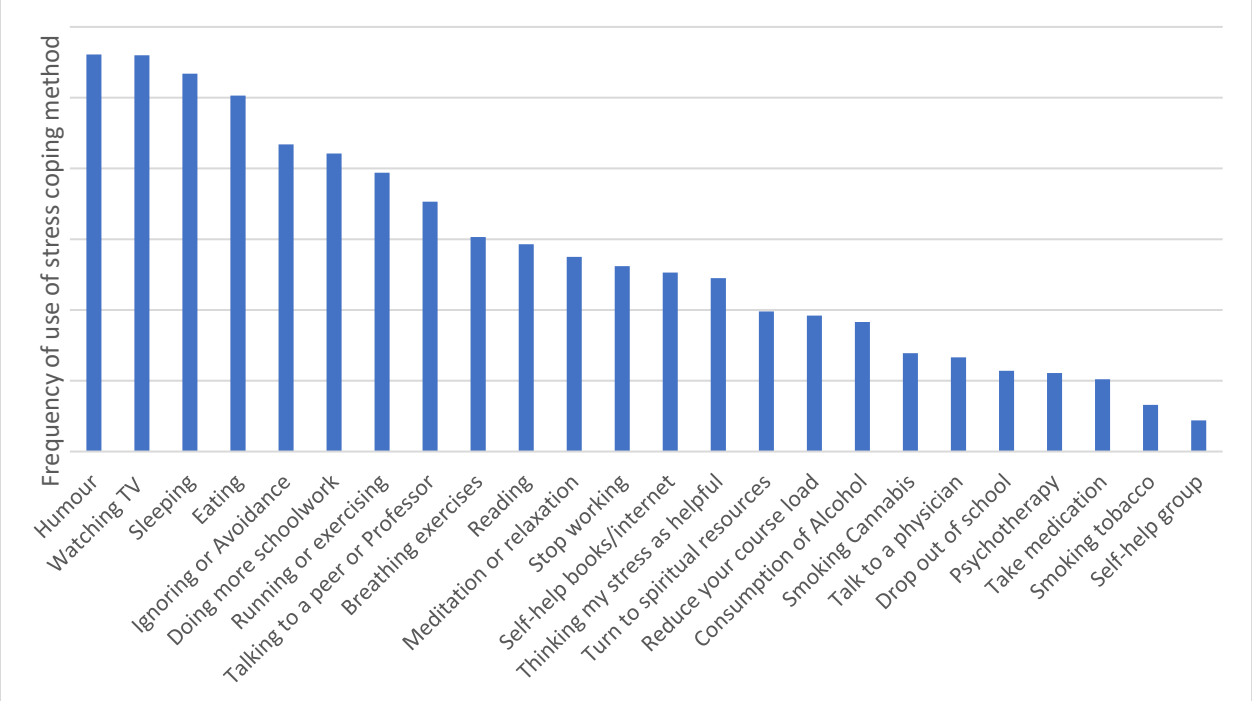


Figure 2

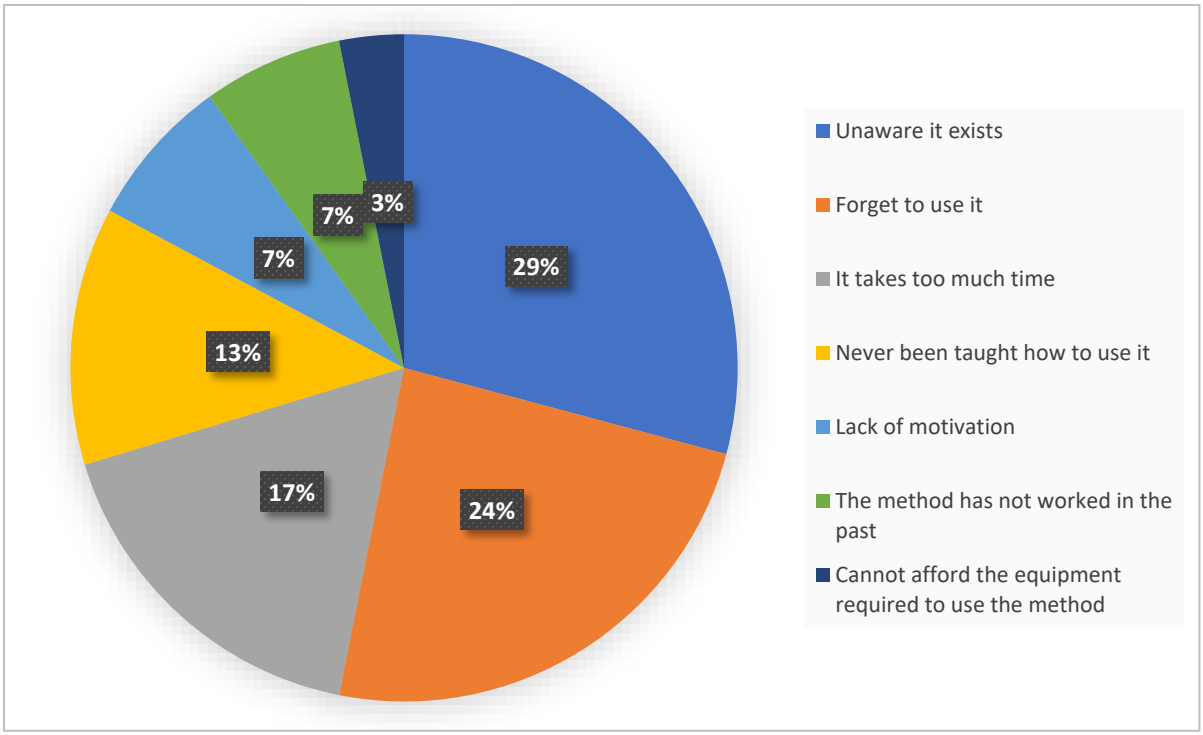
Most Common Stress Coping Strategies.



Note. Students reported the frequency of use of these stress coping methods on a selection scale (See Appendix D) Values on y-axis are sums of participant ratings of frequency of use of the coping methods.

Figure 3

Main Reasons Why Students do not Use Stress Coping Methods.



Baseline Measures

A correlational analysis was conducted to examine relationships between baseline and demographic variables (see Table 2). This analysis revealed that age was negatively correlated with PSS scores ($r(180) = -0.152$, $p = .041$), indicating younger participants reported more perceived stress. In addition, the higher participants scored on the PSS, the lower they scored on the SMM ($r(180) = -0.430$, $p < .001$), indicating that participants with higher perceived stress have a lower belief that their stress response is beneficial. Further, PSS scores were positively correlated with participant ratings of the strength of their physical stress reaction ($r(180) = 0.408$, $p < 0.001$), indicating participants reporting higher perceived stress also reported stronger physical stress reactions.

Table 2

Descriptive Statistics and Correlations for Baseline Measures

Variable	*n*	*M*	*SD*	1	2	3	4	5	6	7	8
1. Age	181	21.63	5.09	—							
2. Year of Study	182	1.77	1.12	.145	—						
3. GPA	168	3.29	0.46	-.034	−.125	—					
4. PSS Score	182	22.12	6.55	-.152*	−.119	-.006	—				
5. SMM Score	182	1.711	0.68	-.004	.029	.057	-.433**	—			
6. Strength of physical stress	181	2.23	0.93	.018	-.070	-.019	.408**	-.0128	—		
7. Control over mental stress	182	1.60	0.81	.170*	.099	.005	-.568**	.340**	-.342**	—	
8. Control over physical stress	182	1.79	0.78	.060	.025	-.149	-.431**	.270**	-.440**	.479**	—

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed)

PSS Scores were also negatively correlated with the perceived control of the mental stress reaction ($r(180) = -0.598$, $p < .01$) and the physical stress reaction ($r(180) = -0.431$, $p < .01$), suggesting participants with higher perceived stress feel less in control of their stress reactions. Lastly, SMM scores were positively correlated with perceived control over both mental ($r(180) = 0.340$, $p < .01$) and physical ($r(180) = 0.270$, $p < .01$) stress reactions, indicating that participants that viewed their stress response as more helpful also felt more perceived control over their stress response.

Anxiety Medication and Counselling

Independent t-tests were used to examine whether taking anti-anxiety medication or attending counselling for anxiety impacted baseline measures related to stress. The scores of three participants who preferred not to disclose their use of medication or counselling visits were excluded from these analyses. The difference in baseline heart rate between participants that were or were not taking anti-anxiety medication/attending counselling trended toward significance ($t(69) = -1.817$, $p = .074$), with participants taking medication/attending counselling having higher baseline heart rates (n = 18, $M = 39.67$, $SD = 11.96$) compared to participants that were not (n = 53, $M = 35.81$, $SD = 5.78$). In addition, participants taking anxiety medication/attending counselling reported significantly higher perceived stress (n = 34, $M = 25.26$, $SD = 6.71$) compared to participants not taking medication/attending counselling (n =145, $M = 21.59$, $SD = 6.47$; $t(177) = -2.96$, $p = .03$). Lastly, participants taking anxiety medication/attending counselling scored significantly lower on the SMM (n = 33, $M = 1.44$, $SD = .71$) compared to participants not taking medication/attending counselling (n = 146, $M = 1.76$, SD

= .71; $t(177) = 2.45$, $p = .014$), suggesting participants taking medication/attending counselling view their stress response as more negative.

Effect of Stress Coping Technique on Heart Rate

Two independent-sample t-tests were used to determine whether there was a difference in effectiveness of the two stress coping techniques on reducing heart rate. A t-test on heart rate after stress task #2 indicated no significant difference between the deep breathing and cognitive reappraisal techniques (deep breathing with biofeedback: $M = 38.46$, $SD = 8.72$; cognitive reappraisal with biofeedback: $M = 37.40$, $SD = 6.41$; $t(69) = 0.581$, p=.563). Similarly, a t-test on change in heart rate between baseline and stress task #2 indicated no significant difference between coping techniques (deep breathing with biofeedback: $M = 0.286$, $SD = 6.82$; cognitive reappraisal with biofeedback: $M = 1.57$, $SD = 4.98$; $t(69) = -0.908$, p=.367). These results suggest that deep breathing and cognitive reappraisal lead to similar changes in the stress-related biofeedback measure of heart rate.

Effect of Baseline Heart Rate on Heart Rate Change

A regression analysis was used to examine whether baseline heart rate predicted changes in heart rate after stress task #2. This analysis revealed that baseline heart rate significantly predicted change in heart rate after stress task #2 ($\beta = –0.423$, $t(69) = -3.882$, $p < .01$), indicating that participants with a higher baseline heart rate experienced more of a decrease in heart rate after stress task #2 when using the coping strategy they were exposed to in the study (see Fig. 4).

Part Two Analyses

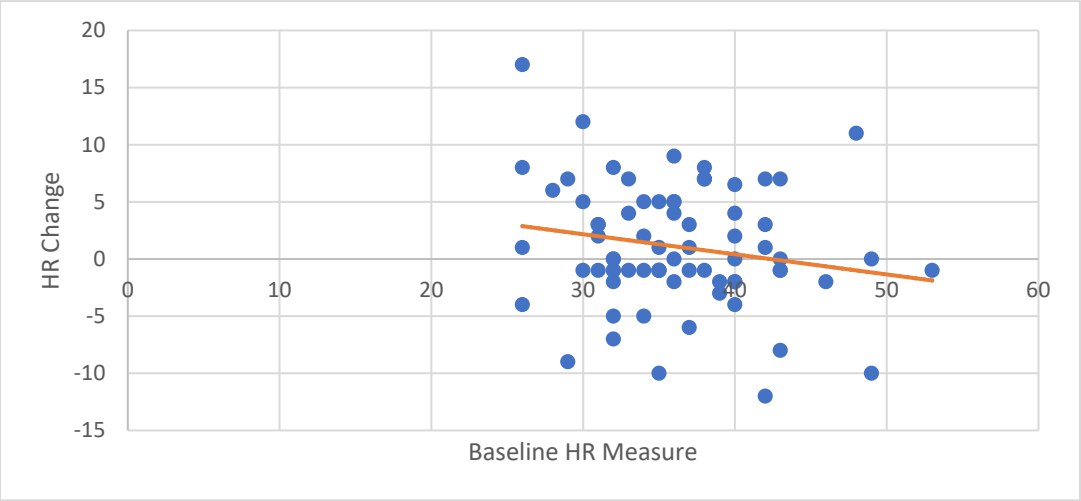
Changes in Stress Coping Technique Use

A Pearson correlation revealed an overall significant positive correlation between change in the use of deep breathing and change in the use of cognitive reappraisal between parts 1 and 2 of the

study (r(75) = .262, p = 0.023), indicating that as participants reported increased use of one coping technique, they also reported increased use of the other coping technique.

Figure 4

Higher HR at Baseline Lead to Greater Decrease of HR After Stress Task 2.



A 2x3 MAVOVA was used to examine changes in the use of coping techniques (deep breathing and cognitive reappraisal) between parts 1 and 2 of the study. The MANOVA revealed no significant main effect of coping technique exposed to in the study ($F(4,138) = 0.253$, $p = .907$, $\eta_p^2 = .007$), no significant main effect of biofeedback ($F(2,69) = 0.040$, $p = .961$, $\eta_p^2 = .001$), and no significant interaction ($F(2,69) = 0.050$, $p = .951$, $\eta_p^2 = .001$). These results indicate that the coping technique participants were exposed to in the study or seeing how their heart rate changed after using a coping technique, did not impact how often participants reported using those specific coping techniques throughout the semester.

Changes in Perceived Control of Stress Reaction

Correlational analysis revealed a significant positive correlation between change in perception of control over both the physical and mental stress response between parts 1 and 2 of the study

($r(76) = .295$, $p = .009$), indicating that participants that reported more control over their physical stress response in part 2 of the study also reported more control over their mental stress response in part 2. In addition, the correlation analysis revealed significant negative correlations between perception of the strength of the stress response and both control over the physical and mental stress response (physical: $r(77) = -.291$, $p = 0.010$; mental: $r(77) = -.422$, $p < .001$; see Table 3). These results indicate that as perception of control over both the physical and mental stress responses increased, perceptions of the strength of the stress response decreased.

Table 3

Correlations of Control Over Physical and Mental Stress and Strength of Physical Stress.

Variable	*n*	*M*	*SD*	1	2	3
1. Difference in physical stress control	78	-0.18	0.75	—		
2. Difference in mental stress control	78	0.09	0.78	.295**	—	
3. Difference in physical stress reaction	79	-0.01	1.21	-.291**	-.423**	—

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Another 2x3 MANOVA was used to examine changes in perceptions of control over the physical stress response, control over the mental stress response, and perceived strength of the physical stress response between parts 1 and 2 of the study (see Table 4 for descriptive data of all groups, and Table 5 for MANOVA). The MANOVA revealed a significant main effect of coping technique exposed to in the study ($F(6,144) = 3.231$, $p = .005$, $\eta p2 = .119$). Coping strategy exposed to during the study had a significant effect on changes in perceived control of the mental

stress response ($F(2,74) = 4.078$, $p = .021$, $\eta p2 = .099$). Specifically, simple contrasts revealed that participants expose to the deep breathing technique, with or without biofeedback, reported significantly increased control over their mental stress response ($M = 0.25$, $SD = 0.928$) compared to participants in the control group ($M = -0.18$, $SD = .733$; $p = .021$) (see Fig. 5). Participants exposed to cognitive reappraisal, with or without biofeedback, also reported more control over their mental stress response ($M = 0.14$, $SD = .581$; $p = .037$) compared to the control group, and this effect was trending towards significance ($p = .065$). The MANOVA revealed no significant main effect of biofeedback ($F(3,72) = 1.692$, $p = .176$, $\eta p2 = .066$), and no significant interaction ($F(3,72) = 1.458$, $p = .233$, $\eta p2 = .057$) indicating that the groups that used biofeedback did not report similar changes in their perceived control over their mental of physical stress reaction from part 1 of the study to part 2.

Table 4

Descriptive Data for All Groups of Control Over Mental and Physical Stress and Strength of Stress.

	Part 1		Part 2		N	
	M	*SD*	*M*	*SD*	*Pt1*	*Pt2*
Control					37	22
Control of mental stress response	1.68	0.873	1.59	0.734		
Control of physical stress response	1.63	0.786	1.59	0.590		
Strength of physical stress response	2.59	0.927	2.23	0.752		
Deep Breathing					35	13
Control of mental stress response	1.77	0.910	2.23	0.599		
Control of physical stress response	2.06	0.802	2.15	0.555		
Strength of physical stress response	1.97	0.785	2.23	1.166		
Cognitive reappraisal					38	13
Control of mental stress response	1.39	0.755	1.62	0.768		
Control of physical stress response	1.95	0.655	1.62	0.650		
Strength of physical stress response	2.37	0.751	2.15	0.801		
Deep Breathing and Biofeedback					35	14
Control of mental stress response	1.49	0.781	1.50	0.650		
Control of physical stress response	1.63	0.770	1.64	0.633		
Strength of physical stress response	2.11	0.933	2.29	0.611		
Cognitive Reappraisal and Biofeedback					36	16
Change in control mental stress	1.69	0.710	1.87	0.500		
Change in control physical stress	1.67	0.793	1.38	0.806		
Change in physical stress	2.06	1.068	2.06	0.748		

Note. N=Participants in parts 1 and 2

Table 5

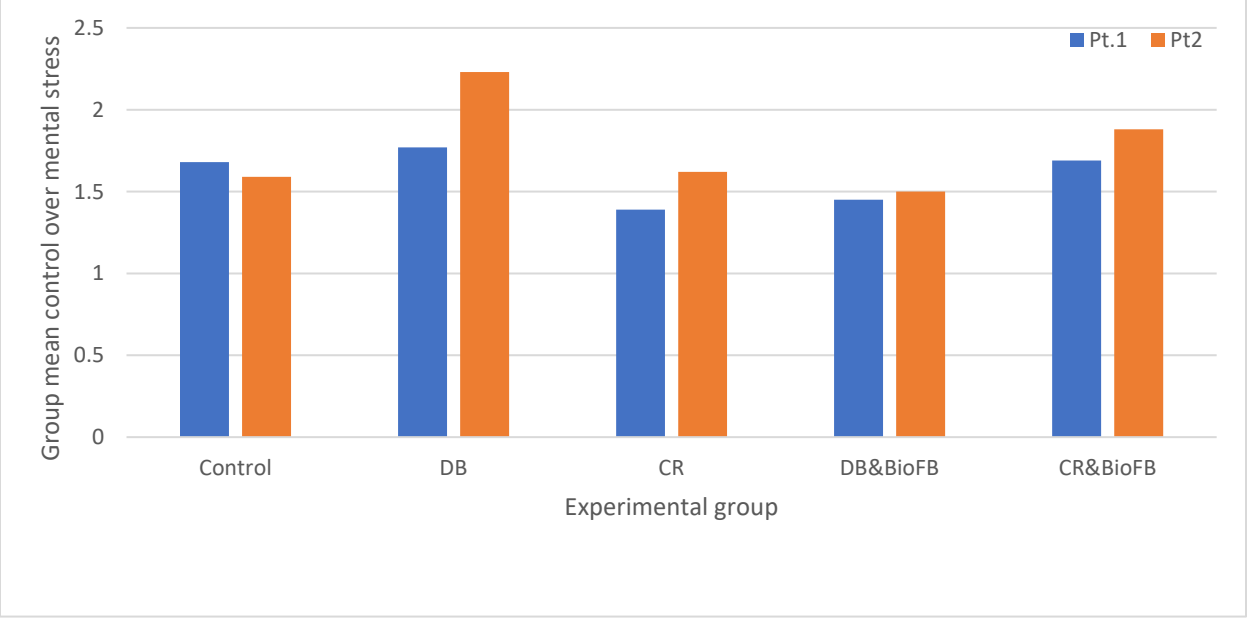
Results MANOVA of Changes in Stress Experience by Coping Method and Biofeedback

	df	*SS*	MS	*F*	*P*	η^2
Coping method						
Change in mental stress control	2	4.548	2.274	4.078	.021*	0.099
Change in physical stress control	2	1.058	0.529	0.937	.396	0.025
Change in physical stress strength	2	2.235	1.118	0.822	.443	0.022
Biofeedback						
Change in mental stress control	1	0.010	0.010	0.018	.895	0.000
Change in physical stress control	1	2.530	2.530	4.536	.037*	0.058
Change in physical stress strength	1	0.354	0.354	0.261	.611	0.004
Coping method * Biofeedback						
Change in mental stress control	1	0.459	0.459	0.814	.370	0.011
Change in physical stress control	1	0.188	0.188	0.337	.563	0.005
Change in physical stress strength	1	2.254	2.254	1.659	.202	0.022

Note. * $p < 0.05$

Figure 5

Participant perception change of control over mental stress reaction between parts 1 and 2.



Changes in Perceived Stress and Stress Mindset

A Pearson correlation revealed an overall significant negative correlation between change perceived stress and change in stress mindset between parts 1 and 2 of the study ($r(58) = -.436$, $p = 0.001$), indicating that as participants reported less perceived stress, they reported an increase in perceptions that their stress response was helpful.

A final 2x3 MANOVA was used to examine the changes in PSS and SMM Scores between parts 1 and 2 of the study. The MANOVA revealed no significant main effect of coping technique exposed to in the study ($F(4,104) = 0.877$, $p = .481$, $\eta_p^2 = .033$), no significant main effect of biofeedback ($F(2,52) = 2.521$, $p = .090$, $\eta_p^2 = .088$), and no significant interaction ($F(2,52) = 2.248$, $p = .116$, $\eta_p^2 = .080$). These results indicate that the coping technique participants were exposed to in the study or seeing how their heart rate changed after using a coping technique, did not impact how perceived stress or stress mindset scores changed throughout the semester.

Effect of Baseline Stress on Stress Coping Technique Use

Six regression analyses were used to examine whether baseline immediate stress (i.e., baseline heart rate), baseline perceived stress (i.e., PSS score), or baseline stress mindset (i.e., SMM score) influenced how often participants reported using a coping strategy (deep breathing or cognitive reappraisal) during part 2 of the study. Our regression analyses reveal that none of the baseline measures indicated significantly predicted the use of either deep breathing or cognitive reappraisal throughout the semester (see Table 6).

Table 6

Results Linear Regressions of Baseline HR, PSS, and SMM

Variable	*B*	*SE B*	β	*t*	*P*
Use of Deep Breathing					
Baseline Heart Rate	-.025	.028	-.174	-.889	.382
PSS	.020	.026	.163	.761	.454
SMM	.245	.260	.202	.941	.356
Use of Cognitive Reappraisal					
Baseline HR	.047	.033	.277	1.434	.164
PSS	.005	.031	.037	.173	.864
SMM	.091	.312	.062	.291	.773

We next conducted six more regression analyses to determine whether the same predictor variables (i.e., baseline heart rate, PSS score, and SMM score) predicted the change in use of either deep breathing or cognitive reappraisal from part 1 to part 2 of the study (see Table 7). Baseline heart rate significantly predicted change in use of deep breathing between part 1 and part 2 of the study ($\beta = –0.446$, $t(27) = -2.47$, $p = .021$). Specifically, participants with higher heart rates at baseline reported increase in their use of deep breathing (see Figure 6). Other regressions showed no significant results were found.

Table 7

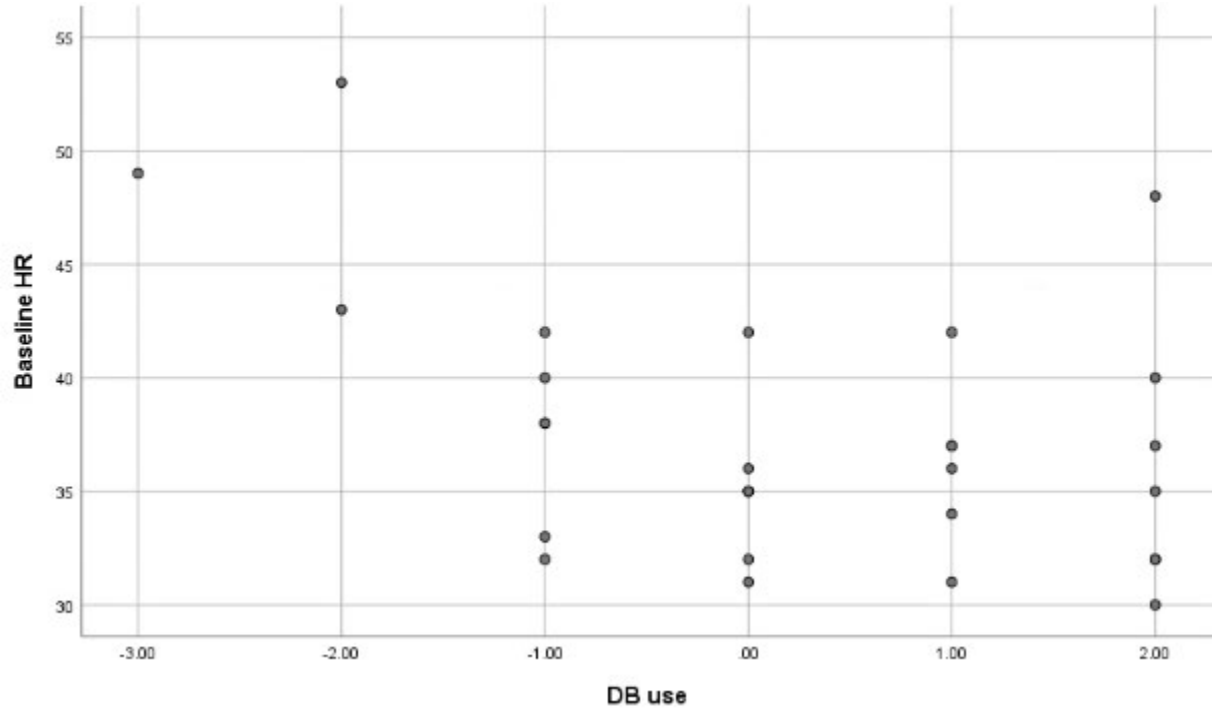
Results Linear Regressions of Baseline HR, PSS, and SMM and use of stress coping methods.

Variable	*B*	*SE B*	β	*t*	*P*
Difference in Use of Deep Breathing					
Baseline Heart Rate	-.110	.044	-.446	-2.47	.021*
PSS	.002	.042	.010	.051	.960
SMM	.150	.420	.071	.358	.723
Difference in Use of Cognitive Reappraisal					
Baseline HR	.011	.049	.043	.227	.822
PSS	-.078	.046	-.351	-1.69	.103
SMM	-.664	.462	-.298	-1.43	.163

*$p < .05$.

Figure 6

Baseline HR Predicted Greater use of Deep Breathing from Part 1 to Part 2 of the Study.



Note. DB = deep breathing. Negative values indicate less deep breathing use at the time of part 2. Positive values indicate more use of deep breathing at the time of part 2 of the study.

Discussion

The current study explored whether exposure to biofeedback measures would increase the use of stress interventions in University students. We also compared the biofeedback measures of our stress interventions in terms of similarities and differences and whether the stress intervention would increase the participants' perception of control over their stress response both physiologically and mentally.

Our data observed no increases in the use of stress intervention use compared between groups that used biofeedback with the stress intervention, the stress intervention alone, or the control group. The biofeedback results of both stress interventions were not significantly different, suggesting that deep breathing and cognitive feedback lead to similar physiological changes when used as a stress coping strategy. We did observe a significant increase in perceived control over mental stress reaction deep breathing groups. This finding could suggest that deep breathing used in the moment of stress could increase the student's self-efficacy over their mental stress reaction and help them to remain calmer.

Based on our qualitative measures our preliminary hypothesis that students do not engage in stress coping activities due to the lack of time or knowledge were correct aligning with El-Ghoroury et al., 2012 study results, so we wanted to choose methods that did not require significant time investment and could be carried out anywhere. We included deep breathing and cognitive reappraisal as the two coping methods. Deep breathing was included as this coping method is widely known and has been established as an effective stress coping method (Cheng, Croarkin, & Lee, 2019). Cognitive reappraisal of physical stress symptoms was included because it is newer as a stress intervention and generally not as well known but has also shown to be effective at reducing the negative outcomes of stress (Jamieson et al., 2012). Although these easy

to use and quick stress coping methods exist, students are still experiencing high levels of stress. We explored the idea that by providing students proof of the effectiveness of these stress interventions, we could increase the amount of their use. Biofeedback was used to as a tool to show the physiological effects of deep breathing and cognitive reappraisal. Additionally, 61% of 182 students reported school as their main cause of stress. Previous research of student stress (El-Ghoroury et al., 2012) states that student populations experience higher stress levels than non-student populations. The high amount of stress students experience makes the student population particularly vulnerable to the negative outcomes of stress.

Our study has unique properties in that it was conducted during the global COVID-19 pandemic, a period of time in which people are dealing with stressors and challenges they have never faced before. COVID-19 has changed the educational landscape for students. Perceived increases in stress levels reported by Liu et al., (2021) showed that people were experiencing higher stress since the beginning of the pandemic, than before. As many students are learning in an unfamiliar online environment with decreased access to supports such as in person consultations with professors, social support from classmates is which has likely impacted some of our stress measurements. For example, baseline PSS scores might be particularly high in the academic years of 2020 and 2021, as COVID-19 was listed as the fourth major stressor in students' lives during the study.

The baseline correlations of PSS scores with Age, SMM, were all supportive of previous literature reports Cohen et al. (1994) observed a decreasing trend of PSS scores with age, and our data shoed the same pattern. The PSS was used as a convergent measure for SMM (SMM; Crum et al., 2013), at the original validations of the scale’s psychometric qualities and negative correlation was confirmed. We also observed a strong negative correlation of the PSS and SMM

scales. The higher the participants perceived stress (PSS score) the less likely they are to view their stress as life enhancing which is shown in the low SMM scores. We did not observe a correlation between PSS scores and grade point average, which somewhat disagrees with the previous research by Struthers et al. (2000). Struthers et al. (2000) reported negative correlation between high stress levels and academic achievement, but they did not use PSS as their stress scale so it could just be that PSS scores are not relatable to GPA.

Due to these changed circumstances, we have compared the results of reported perceived stress and stress mindset from our sample to previously reported means of these measures during non-globally stressful events. The average mean PSS score in our sample at baseline was 22.08, which far exceeds the original value of 12.9 reported by Cohen et al. (1994) indicating that our participants were experiencing moderate to high levels of stress while Cohen et al.'s sample mean showed more moderate to low results. Cohen's (1994) original sample, taken almost 30 years ago, used a community-based sample, with mixed ages, ethnicities, and genders while our sample was all undergraduate University students. Warnecke et al. (2011) used a student sample and reported PSS mean of 15.7. Though not significantly different, our sample did obtain higher PSS score suggesting that students' stress is increasing.

Interestingly, participants in the current study reported a somewhat higher mean score for the SMM (M =1.71) than the original study by Crum et al. (2013) (M =1.62). This change suggests that our sample of students may have a more enhancing mindset about their stress reaction than the original sample used by Crum et al. (2013). It Is possible that since Crum et al., conducted their original research more people have become aware of the mindsets impact on stress and are actively attempting to address that. Students might be seeking for other stress coping strategies than the ones they previously relied on due to the gym closures and restricted

social gatherings because of COVID-19. It is also possible that since our sample consisted of mainly psychology students, that the information about stress mindset spreads in that population more than the general population.

Students who reported using anti-anxiety medication or attending counselling for anxiety related disorders scored significantly higher on PSS and significantly lower on SMM than the students who do not. This finding suggests that individuals struggling with anxiety related disorders who are students perceive their stress levels to be even higher and the effects of stress even lower, suggesting that this population is even more at risk of stress related mental and physical illnesses.

Cognitive reappraisal and deep breathing were found to affect the biofeedback measure of heart rate after a stress task in a similar way. This finding suggests that although deep breathing directly influences the physiological stress reaction of raising heart rate and increased breathing frequency, and cognitive reappraisal of stress symptoms acts through a psychological route, they both influence the physiological stress reaction in the same way. These stress coping methods possibly work similarly, because, although cognitive reappraisal is a mental exercise, it involves the reappraisal of psychological stress response, which may be a reason why it affects the physical stress response similarly as deep breathing, which is shown to decrease heart rate (Perciavalle et al., 2017).

An unexpected finding was that all five groups increased the use of either stress intervention from part 1 to part 2 of the study. We expected the intervention groups to use the specific coping strategies they were taught to use (i.e., deep breathing group would have used deep breathing more than cognitive appraisal). We further expected the groups that were exposed to biofeedback to use the coping technique more than the groups that were not. However, these

hypotheses were not supported by our data. It is possible that as the semester got to the final weeks, and with the increasing demands of upcoming finals students opted for using which ever stress coping method they could think of. It is also possible that recording and reporting one's heart rate at one point and time is not enough to convey the benefits of the stress intervention used which might have made the intervention less memorable. Students did report that they had forgotten about stress intervention at the part 2 survey. We expected this to happen, but did not want to send out reminder emails, as that could have introduced a confound of the number of reminders and use of the stress intervention rather than the power of biofeedback and the enhances of the use of stress interventions.

The deep breathing group reported having more control over their mental stress reaction over time. Although the results from the deep breathing group are encouraging, they do counter our initial hypothesis that the cognitive reappraisal group would report the most increased mental control over their stress response, as cognitive reappraisal is a psychological coping technique. We expected the deep breathing group to report more control over the physical stress response because that technique targets physiological functioning, but we found the opposite. The group that learned deep breathing coping method had significant increases in their perceived control over mental stress reaction, where the group that learned about the use of cognitive reappraisal of stress symptoms, had trending results of increases in control of physical stress reaction. Although these findings were unexpected, they may relate to the specific mechanisms of each technique. For example, deep breathing requires the participant to stop ruminating in stressful thoughts and focus on their breathing, which may increase the participant's perceived control over their mental stress reaction, as they learn to disengage from those stressful thoughts through deep breathing (Hoshikawa et al., 2020). In addition, reappraisal (Jamieson et al., 2013) of stress symptoms

involves the notion that the strong physical stress reaction is not harmful, but rather is helpful for providing energy to meet challenges. Thinking of the physical stress response in this way may lead to a perception of more control over the physical stress response. Whatever specific mechanisms may be involved, our results highlight the intimate connection between the mind and body that is the hallmark of the stress response.

We also found that increases in mental control of stress correlated negatively with reported perception of the strength of the physical stress reaction. Similarly, increased perception of control over the physical stress response correlated negative with perception of the strength of the physical stress response. Decreasing perception of the strength of the physical stress response is an important outcome of effective stress coping, as research has shown that it is not necessarily the objective stress response, but rather, the perception that the stress response is detrimental, that can lead to negative health-related outcomes, such as mortality (Keller et al., 2012).

For the most part, the stress the participants experienced on the baseline did not predict how much they used the stress intervention throughout the semester. The only exception was that baseline heart rate did predict an increase in the use of deep breathing intervention from part 1 to part 2 of the study. Deep breathing group had significantly higher mean in the change of use of deep breathing from part 1 to part 2 of the study. This finding does suggest that deep breathing might be used as a stress coping method by individuals with higher heart rates. Since the change was only observed in one group of the two biofeedback groups, further investigation would need to determine the reason for the change. A possible approach to this is that deep breathing might already be used by students who are aware of their higher heart rates.

Limitations

As with any longitudinal or multi-part study, there was participant attrition between part 1 and part 2. In our study, the sample size decreased by 46%. This decrease in sample size led to analyses involving part 2 data to include lower than recommended sample sizes (i.e., $n < 30$). Larger sample sizes would increase the validity of these findings and possibly reveal effects that we cannot detect with our current sample size.

Participants recorded their own heart rates and may have done so inaccurately. The online stress-induction task that was used was perceived as stressful by 54% of the participants. A different stressor task, or one completed in person, may have been perceived as more stressful by participants. Consequently, stronger biofeedback results from using the stress intervention may have been seen with a more stressful task. If the stronger biofeedback results were interpreted as the effectiveness of the stress intervention, it may have been used more, which would have changed the outcome of our research.

One particularly important limitation to note is that an important piece of the data was lost due to a faulty survey model. Participants in the biofeedback condition were asked to record their heart rates at baseline, post-stress task 1 (without using the stress coping technique), and post-stress task 2 (with using the coping technique). The data for heart rate post stress task 1 was over-ridden in the survey responses and thus lost. Without these data, it is difficult to draw definitive conclusions about the effectiveness of the stress coping techniques to reduce heart rate during a stressor because we do not have comparison data for how much the stress task initially increased heart rate in participants.

Future Directions

To address some of the limitations of the current study, an interesting avenue for future research would be to conduct part 1 of the study in person, as initially planned. An in-person research design would offer opportunities for a potentially more stressful stress task and more accurate biofeedback measures. Eliciting stress in participants during the stress tasks would most likely be easier if the researcher could interact with the participant. Telling the participant to go faster or that they made a mistake and must start over are two classic examples of in person techniques used to induce stress, which is a common tool to make Stroop tasks more stressful (Henderson et al., 2012). Additional biofeedback measures (e.g., blood pressure) could be recorded electronically using a sphygmomanometer. The physiological measures of stress, like heart rate and blood pressure presented to the participant at baseline and during stress tasks and intervention phases, might impact the participant's perception of the effectiveness of the coping technique. An in-person experience may also be more impactful in terms of students remembering to use the technique they were exposed to during the experimental session. Furthermore, our study could give direction in investigating whether quick to use stress coping methods addressing acute stress could lead to a decrease in chronic stress, which would mediate the adverse outcomes of stress related illnesses.

Conclusion

Our study investigated the relationship between quick to use stress coping methods of deep breathing and cognitive reappraisal in the context of academic stress. Considering that students have long been a population under enormous stress, they still tend to cope with stress inadequately. We hypothesized that students do not use some coping techniques because they take too much time or that students are not aware of them. Our qualitative data aligns with these

hypotheses. We also hypothesized that we could convince students of the benefits of quick to use coping methods with the help of biofeedback and expected to see higher numbers of recorded use of cognitive reappraisal and deep breathing in the groups shown the effects of the stress intervention via biofeedback. We did observe a slight increase in the use of both stress interventions in all groups, though this increase was not significant, and no significant differences were found between groups.

Despite the limitations of our study, e.g., lower-than-expected participation, we could draw a meaningful effect of the use of the stress coping strategies to the perception of control over physical and mental stress reactions. The perceived control over the stress reactions also negatively correlated with the strength of physical stress reaction, which suggests that the participants with increased control over their stress reactions experienced less strong physical stress reaction.

These findings contribute to the previous research by supporting the idea that the perception of stress reaction, whether it is physiological or mental, can be influenced by adequate stress coping methods, like deep breathing and cognitive reappraisal. And it might not even matter which one is used. The use of either intervention could lead to better confidence that the student controls their stress reaction and the increased control over mental and physical stress reactions can improve students' mental and physical health and help them achieve their fullest potential in academic work and their daily lives.

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Appendix A

PART 1 SURVEY QUESTIONS ASSESSING STRESS EXPERIENCES

General Stress Assessment Questions:

1. How often do you attempt to do something to cope with your stress reaction?
    a. Almost always
    b. Frequently
    c. Sometimes
    d. Rarely
    e. Never
2. How in control do you feel of your physical stress reaction?
    a. I have no control over it
    b. I have little control over it
    c. I have some control over it
    d. I have full control over it.
3. How in control do you feel of your mental stress reaction?
    a. I have no control over it
    b. I have little control over it
    c. I have some control over it
    d. I have full control over it.
4. When you feel stressed, how would you rate your overall stress reaction?
   0= Extremely negative, 1=Somewhat Negative, 2=Neutral, 3=Somewhat Positive, 4=Extremely Positive
5. How would you rate your physical stress reaction?
   0= Extremely uncomfortable, 1=Somewhat uncomfortable, 2=Neutral, 3=Somewhat exhilarating, 4= Extremely exhilarating
6. How strong would you rate your physical stress reaction?
   4=Very Strong 3= Strong 2=Normal 1= Mild 0=Very Mild
7. When you feel stressed before and during an exam, you tend to get a mark:
   0=Much better than expected, 1=better than expected, 2=same as expected, 3=worse than expected, 4=much worse than expected

Appendix B

PART 2 SURVEY QUESTIONS ASSESSING STRESS EXPERIENCES

General Stress Assessment Questions:

1. When you feel stressed, how often do you attempt to control your stress reaction?

    a. Almost always
    b. Frequently
    c. Sometimes
    d. Rarely
    e. Never

2. How in control do you feel of your physical stress reaction?

    a. I have no control over it
    b. I have little control over it
    c. I have some control over it
    d. I have full control over it.

3. How in control do you feel of your mental stress reaction?

    a. I have no control over it
    b. I have little control over it
    c. I have some control over it
    d. I have full control over it.

4. When you feel stressed, how would you rate your overall stress reaction?

    0= Extremely negative, 1=Somewhat Negative, 2=Neutral, 3=Somewhat Positive, 4=Extremely Positive

5. How would you rate your physical stress reaction?

    0= Extremely uncomfortable, 1=Somewhat uncomfortable, 2=Neutral, 3=Somewhat exhilarating, 4= Extremely exhilarating

6. How strong would you rate your physical stress reaction?

    4=Very Strong 3= Strong 2=Normal 1= Mild 0=Very Mild

7. When you feel stressed before and during an exam, you tend to get a mark:

    0=Much better than expected, 1=better than expected, 2=same as expected, 3=worse than expected, 4=much worse than expected

Appendix C

CONVERSION SCALES OF ALL WORD TO VALUE EVALUATIONS

How often do you attempt to do something to cope with your stress reaction?

4=Almost Always 3= Frequently 2=Sometimes 1= Rarely 0= Never

How in control do you feel of your physical stress reaction?

3= I have full control over it.

2= I have some control over it

1= I have little control over it

0= I have no control over it

How in control do you feel of your mental stress reaction?

3= I have full control over it.

2= I have some control over it

1= I have little control over it

0= I have no control over it

When you feel stressed, how would you rate your overall stress reaction?

0= Extremely negative, 1=Somewhat Negative, 2=Neutral, 3=Somewhat Positive, 4=Extremely Positive

How would you rate your physical stress reaction?

0= Extremely uncomfortable, 1=Somewhat uncomfortable, 2=Neutral, 3=Somewhat exhilarating, 4= Extremely exhilarating

How strong would you rate your physical stress reaction?

4=Very Strong 3= Strong 2=Normal 1= Mild 0=Very Mild

When you feel stressed before and during an exam, you tend to get a mark:

0=Much better than expected, 1=better than expected, 2=same as expected, 3=worse than expected, 4=much worse than expected

Appendix D

Stress Intervention Use Assessment

How often do you use the following stress coping methods?

(1. Never; 2. Rarely; 3. Occasionally; 4. Frequently; 5. Often)

Running or exercising	1	2	3	4	5
Meditation or relaxation exercises	1	2	3	4	5
Ignoring or Avoidance	1	2	3	4	5
Talking to a peer or Professor	1	2	3	4	5
Breathing exercises	1	2	3	4	5
Reading	1	2	3	4	5
Psychotherapy	1	2	3	4	5
Spend more time on schoolwork	1	2	3	4	5
Turn to spiritual resources	1	2	3	4	5
Talk to a physician	1	2	3	4	5
Take psychotropic medication	1	2	3	4	5
Reduce your course load	1	2	3	4	5
Self-help books/internet	1	2	3	4	5
Stop working	1	2	3	4	5
Break from school for the semester	1	2	3	4	5
Attend a self-help group	1	2	3	4	5
Rethinking my stress response as helpful	1	2	3	4	5
Consumption of Alcohol	1	2	3	4	5
Smoking Cannabis	1	2	3	4	5
Smoking tobacco	1	2	3	4	5
Watching TV or other streaming services	1	2	3	4	5
Eating	1	2	3	4	5
Sleeping	1	2	3	4	5
Humour	1	2	3	4	5
Other (please describe)	1	2	3	4	5

Select the three most likely reasons why you would not use a particular stress coping method.

a. Unaware it exists

b. Forget to use it

c. Never been taught how to use it

d. It takes too much time

e. The method has not worked in the past

f. Cannot afford the equipment required to use the method (e.g gym membership)

g. Lack of motivation, energy, or interest

h. Shame, guilt, or embarrassment related to using the coping method

i. Discouragement that anything could lower your stress level

j. Minimization or denial of stress

k. Other (please explain)