Synergistic Effects of Mindfulness Meditation and Relaxation Response Meditation on Perceived Stress Levels

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Training and Milestones in Summer I and Summer II

The Laidlaw Scholars program has been such a valuable and unique experience that has allowed me the opportunity to gain research and leadership training that is rare and difficult to attain as an undergraduate student. Through my experience as a Laidlaw Scholar, I have grown familiar with the research process, including writing a research proposal, conducting a literature review, submitting an ethics proposal and preregistration application, collecting and analyzing data, and reporting on results. I have also developed my skills in communication, collaboration, and critical thinking and analysis through regularly meeting with my advisor, and tasks such as the literature review and troubleshooting. Developing these skills and experiences would not have been possible without the support of the Laidlaw Foundation.

We would also like to thank the Laidlaw Foundation for making it possible for us to achieve our Summer I and Summer II milestones and work towards our goal of publishing, all shown in Table 1.

Table 1. Progress Report

	Task	Progress
Summer I	Comprehensive Literature Review and Establishing a Stronger Theoretical Background	Completed
	Ethics Board Proposal	Completed
	Preregistration of Hypothesis and Analysis Plan	Completed
	Experimental Setup and Design that can be used to Practically Apply this Research	Completed
Summer II	Data Collection	Completed
	Data Analysis	Completed
	Reporting on the Final Experimental Results	Completed
Future Directions	Publishing Research	In Progress

Abstract

Stress is highly prevalent, especially among undergraduate students, and can lead to serious negative effects. There is limited research to demonstrate the benefits of scalable, affordable, and accessible mental health interventions. The present study aims to identify whether students benefit from self-directed mental health interventions. More specifically, the study explores the unique effects of Mindfulness Meditation (MM), Relaxation Response Meditation (RRM), and a combined intervention, Applied Relaxation & Applied Mindfulness (ARAM), on perceived stress levels and related mental health outcomes. The study consisted of a three-arm randomized control trial in which participants were randomly assigned to MM, RRM, or ARAM. Meditation interventions were administered three times a week over a four-week intervention period. The results showed overall greater mental health in the RRM condition, as well as greater improvements to relaxation and mindfulness outcomes in the RRM and ARAM groups. Furthermore, greater contributions to mental health improvement were seen from RRM. Future studies may benefit from expanding the generalizability of our results and considering a longer intervention period as well as an element of choice of intervention.

Keywords: synergistic, applied relaxation & applied mindfulness, mindfulness, relaxation, perceived stress, self-directed interventions

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Background

Stress is highly prevalent in today's society. Undergraduate students, specifically, are faced with periods of transition and uncertainty which make stress common among this population. Previous studies have reported a fair percentage of students experiencing at least moderate stress on a regular basis. In addition, the COVID-19 pandemic has introduced new challenges that have further contributed to students' stress levels. Wang et al. (2020) observed increased stress and anxiety in university students during the pandemic.

Chronic, and possibly severe, stress arises from prolonged short-term stress that is not controlled. High levels of chronic stress are especially concerning due to the associated negative psychological and physiological implications, such as cognitive failure, decreased efficiency in work performance, increased levels of anxiety and depression, increased physical fatigue, and suppressed immune functioning (Allan et al., 2013). Severe chronic stress has even been found to contribute to the development of certain diseases and disorders (Yaribeygi et al., 2017). The negative implications of stress demonstrate the importance of efforts towards reducing stress and improving mental health. These efforts not only help to improve wellbeing, but can also contribute greater student success and more productive members of society.

One concern, in considering action targeted towards improving stress levels and mental health, is the lack of resources available to treat, improve, or maintain individuals' mental health in a timely manner. There are a variety of therapies available to help improve mental health, including meditation, yoga, psychotherapy, and pharmacotherapy, among others; however, many available mental health resources are costly or require on-site

intervention that may not be feasible for all individuals. In order to resolve this issue, mental health practices must be made more scalable, affordable, and accessible. This becomes especially important when discussing individuals whose mental health concerns are not associated with serious distress or dysfunction. Motivation to pursue costly or time-consuming interventions is often low when one's mental health concerns are at least somewhat manageable. In order to increase the popularity and availability of accessible and affordable mental health interventions, research is needed to demonstrate the effectiveness and benefits of out-of-lab interventions (Dimidjian & Segal, 2015). Research on out-of-lab interventions can also be useful as it eliminates confounding variables such as mental health instructors, the proximity of the site administering mental health practices, the reputation of different programs, etc.

Designing self-directed meditation programs, targeted towards reducing perceived stress levels, can be an effective way to introduce these out-of-lab mental health interventions. Previous studies have reliably shown Mindfulness Meditation (MM) and Relaxation Response Meditation (RRM) to be effective at reducing stress levels, with each practice carrying unique positive effects.

MM carries a greater focus on improving the psychological emotion regulation capacities associated with stress, while RRM has been shown to improve physiological concerns associated with stress such as increased physical tension and pulse. In discussing MM, there is an emphasis on training attention and present moment awareness in order to develop a state of emotional calm, mental clarity, self-awareness, and concentration (Feldman et al., 2010). Achieving this positive mental state requires an object of awareness, which is typically the flow of the inbreath and outbreath (Kabat-Zinn, 1982). This MM training allows for an increased acceptance and tolerance of stress (Luberto et al., 2020). As opposed to increasing stress tolerance, RRM is more commonly known to help manage emotional and

physiological reactivity which arise from stress (Luberto et al., 2020). Reactivity and physical tension decrease in RRM participants, as a result of the increased activation of the parasympathetic nervous system over the sympathetic nervous system (Mccann et al., 2013). RRM typically employs the technique of progressive muscle relaxation (PMR), involving the tensing and relaxing of muscles (Gao, 2017). This RRM training has been found to carry a role in reducing the fight or flight state of stress (Sevinc, 2018).

A meditation practice that incorporates aspects of both MM and RRM training may more effectively address both the psychological and physiological concerns that arise with stress, possibly through combining the benefits of both meditation practices. One study, by Mccann et al. (2013), employed a combined practice, termed Applied Relaxation & Applied Mindfulness (ARAM), and showed the practice to be well-received by participants. The limited amount of research exploring the effectiveness of ARAM makes it worthwhile to further study the outcomes of the practice. Furthermore, the present study contributes to the Mccann et al. (2013) study by uniquely implementing a three-arm randomized control trial, comparing the effects of MM, RRM, and ARAM. The present study also examines a broader range of mental health measures, as compared to simply measuring mindfulness levels in the Mccann et al. (2013) study. The generalizability of the results showing the benefits of ARAM are also broadened by this study, as the undergraduate population is examined, as compared to observing medical students in the Mccann et al. (2013) study.

In supporting undergraduate students' mental health through this study, we consider the emerging popularity of self-directed contemplative training which may be an indicator of the benefits of these practices. Despite this popularity, we still lack knowledge in the aspects of training that are most effective for stress relief. Comparing the three practices of MM, RRM, and ARAM allows us to explore whether the driving benefits of stress reduction arise from the ability to relax, the ability to gain deeper introspection and insights, or a

combination of both relaxation and introspection outcomes. Developing a greater understanding of the vital components of these contemplative practices allows us to deliver more efficient mental health support to students and more strongly pitch for participation in these programs.

In administering contemplative training to participants, this study aims to identify the meditation practices to which undergraduate students positively respond, specifically in a self-directed intervention context. We compare the effects of MM, RRM, and ARAM on perceived stress levels and related mental health outcomes, while also examining whether ARAM combines the effects of both MM and RRM. All hypotheses were pre-registered prior to the start of our data collection and analysis. We hypothesize that ARAM will result in greater improvements to across-study mental health (H1) and evaluation-related stress (H2) than MM and RRM, with higher levels of within-session relaxation in RRM and ARAM (H3) and higher levels of within-session decentering and acceptance in MM and ARAM (H4). We also hypothesize that within-session changes to relaxation, decentering, and acceptance will predict across-study changes to mental health (H5).

Method

Design

A three-arm randomized control trial was employed where participants were randomly assigned to one of three meditation intervention groups: the MM group, RRM group, or ARAM group. In addition to group, time was also factor, with three datasets which were present with respect to time: baseline versus post-intervention, within-intervention check-ins, and within-session effects observed at pre-session versus post-session.

Participants

Participants were undergraduate students at the University of Toronto Mississauga, enrolled in an Introductory Psychology course. Two hundred thirty-three participants were assessed for eligibility, of which, only 127 participants were included in analysis. The 127 participants were comprised of 43 participants from the MM group, 46 participants from the RRM group, and 38 participants from the ARAM group. Participant ages ranged from 16 to 33, with a mean age of approximately 18.7 years. One hundred fifty-three participants identified as female, 25 identified as male, and 1 identified as transgender male. Students received course credit for their participation in the study.

Inclusion criteria required that participants report moderate or higher levels of daily stress, have daily access to internet, be willing and able to learn meditation techniques, be able to communicate and follow instructions in English, have normal or corrected-to-normal vision and hearing, be 16 years old or older, and self-identify as healthy enough to complete daily internet-based training. Exclusion criteria deemed participants ineligible for the study if they had an ongoing neurological illness, such as head trauma, or an ongoing or recent major psychological disorder (e.g. major depressive disorder, anxiety disorder, bipolar disorder, schizophrenia, etc.). Participants were also deemed ineligible for the study if they took medication that affects the autonomic nervous system (e.g. opiates, stimulants, tricyclic antidepressants, benzodiazepines, cardiac drugs such as beta-blockers, or renin-angiotensin aldosterone system blockers such as angiotensin- converting enzyme inhibitors and angiotensin receptor blockers, etc.) within one week before enrollment in the meditation sessions. Other medications (including antidepressants) were allowed but participants had to be stable on the medication for at least four weeks prior to the study and inform the study team of any medication changes during the study period.

A power analysis, involving G*Power and glimmpse simulation, revealed that a sample size of N = 126 of completed data was required for α at < .05 and power at ≥ .80. Assuming up to 30% of the data is incomplete due to non-adherence or dropout, we would therefore need to recruit 180 participants to power the study.

Materials

Please refer to the appendix for the assessment schedule outlining the items of measure at each stage of the study.

Baseline and Post-Intervention Measures

Mental Health. This was assessed by measuring anxiety and depression using the Patient Health Questionnaire (PHQ-4), positive and negative affect using a modified version of the Positive Affect Negative Affect Schedule (PANAS), and burnout strength and frequency using the Maslach Burnout Inventory (MBI)

Stress. This was measured using the Perceived Stress Scale (PSS-10). Additionally, evaluation-related stress was scored using a regression parameter which was determined for the prediction of evaluation schedule on well-being. Evaluation dates were obtained in order to determine evaluation-related stress.

Mechanistic Markers. Mindfulness was measured using the Philadelphia Mindfulness Scale (PHLMS) and decentering was measured using the Experiences Questionnaire (EQ).

Locus of Control. This was assessed using the Locus of Control Scale.

Demographic Survey. A brief demographic survey measured participants' age and gender. Participants' experience level in meditation was also assessed.

Pre-session and Post-Session Measures

Mental Health. This was assessed using the first principal component of: a positive mood board and negative mood board created using the PANAS items, items three and six from the PSS-10, and burnout strength for items five and six from the MBI scale, such that higher scores indicated greater positive mood as well as lower levels of stress, negative mood, and burnout. Whenever appropriate, reverse scoring was done on the first principal component by multiplying by negative one to fit the interpretive frame.

Stress. This was measured using items three and six from the PSS-10.

Mindfulness Skills. This was scored using the weighted average scores from the decentering and acceptance scores. To obtain this weighted average, all decentering and acceptance scores were entered into a principal components analysis (PCA) and the first component was used as this weighted average score.

Relaxation. This was scored using the average of the scores from the physical tension questionnaire and the self-reported pulse rate task.

Mechanistic Markers. To reduce the number of formal comparisons, the three mechanistic markers of decentering, relaxation, and acceptance were summarized using a single factor score that represented change in these capacities. The first principal component of these three scores was used to generate a mechanistic marker. Acceptance and decentering were measured using acceptance item two from the PHLMS and decentering item 15 from the EQ, respectively. Physical tension was measured using a physical tension questionnaire and self-reported pulse rate was assessed using a self-reported pulse rate task.

Meditation Training Materials

Twelve 10-minute meditation trainings were created, using the literature, and recorded for each meditation group. Please refer to the Appendix for the meditation training schedule and a sample meditation audio recording.

Procedure

Prior to signing up for the study, participants viewed a description of the inclusion and exclusion criteria, followed by completing a five-minute online pre-consent screener [~2-5 min] and, afterwards, being automatically redirected to the study consent form and baseline assessment questionnaire [~28-35 min]. Prior to the baseline questionnaire, participants were randomly assigned to one of the three meditation groups: MM, RRM, and ARAM. Beginning 24 hours after the baseline survey, participants received email links to group-specific online guided meditation sessions and brief assessment items [~15 min each], three times a week for a duration of four weeks. The link to the post-intervention survey [~30-45 min] was emailed to participants immediately upon completion of the final meditation session.

Deviations from Pre-registration

PANAS. The exact PANAS was not used at baseline and post-intervention due to missed changes that were made to the scale prior to being sent to participants. More specifically, a few of the positive PANAS outcomes were replaced with negative PANAS outcomes. Recent evidence suggests that this deviation in the PANAS may not be a considerable concern as the presence of more negative outcomes seems to be more important, with only a few positive outcomes necessary.

Inclusion Criteria. Participants 16 years or older were allowed to participate in the study after considerations made for Introductory Psychology students under the age of 18.

Evaluation-Related Stress. Evaluation-related stress could not be scored as the evaluation schedule did not predict declining mental health as it has in the past.

Data Analysis

Data analysis was performed using the R statistical programming environment, with the lme4 library used for multilevel models and graphs produced using the ggplot2 library. Data analysis was conducted through multilevel models, in which data was nested within participant IDs, and then comparing the interaction of training Group (MM, RRM, ARAM) and Time. Time was operationalized in two ways: (i) a more conventional baseline to post-intervention analysis, and (ii) a more powerful analysis of scores obtained at each of the 12 intervention sessions. For hypotheses H1 (mental health) and H2 (stress resilience), both operationalizations of time were used, however for the mechanistic hypotheses (H3-H5) analysis focused on the daily session data exclusively to power mechanistic aims.

H1 tested whether intervention group led to better mental health outcomes over time:

$$Mental\ Health \sim Group * Time + (1 \mid Participant\ ID)$$

H2 tested whether intervention group led to improved evaluation-related stress over time:

$$Mental\ Health \sim Group * Evaluation\ Schedule\ Intensity + (1 \mid Participant\ ID)$$

H3 tested whether relaxation (self-reported tension + heart rate) improved better in the RRM and ARAM groups than MM:

$$Relaxation\ Variable \sim Group * Time + (1 \mid Participant\ ID)$$

H4 tested whether mindfulness (decentering + acceptance) improved better in the MM and ARAM groups than RRM:

$$Mindfulness\ Variable \sim Group * Time + (1 \mid Participant\ ID)$$

H5 tested whether change in mechanistic markers was associated with Mental Health change:

$$Mental\ Health \sim Mechanistic\ Marker + (1 \mid Participant\ ID)$$

All tests were initially conducted with an alpha criterion of $p < .05$, and are currently being evaluated for whether they survive correction for multiple comparisons (12 tests total to be corrected for, using the Benjamini-Hochberg procedure).

Results

For brevity, the present report will summarize the major findings of the study. We hope to share more details on our results in our published report in the future.

Participants were placed in either the MM, RRM, or ARAM group and engaged in meditation interventions administered three times a week, for a four-week period. We hypothesized that ARAM will result in the greatest improvements to mental health (H1) and evaluation-related stress (H2), with higher relaxation in RRM and ARAM (H3) and higher mindfulness in MM and ARAM (H4). Within-session changes were hypothesized to improve across-study mental health (H5).

Across the study, a significant increase in mental health was observed in the RRM and ARAM conditions, with a decrease in mental health being observed in the MM condition (H1; Figure 1(A)). Regarding measures of evaluation-related stress, the evaluation schedule did not predict declining mental health as it has in the past; there were no evaluation intensity by group interactions observed (H2). Concerning measures of relaxation, across the study, physical tension increased the most in MM, increased moderately in ARAM, and decreased in RRM (H3; Figure 1(B)). Pulse decreased over time in all groups; however, time by group interactions were not observed (H3). To discuss measures of mindfulness, across the study, acceptance significantly increased in the RRM and ARAM conditions, and decreased in MM (H4; Figure 1(C)). Decentering increased over time in all groups; however, time by group interactions were not observed (H4).

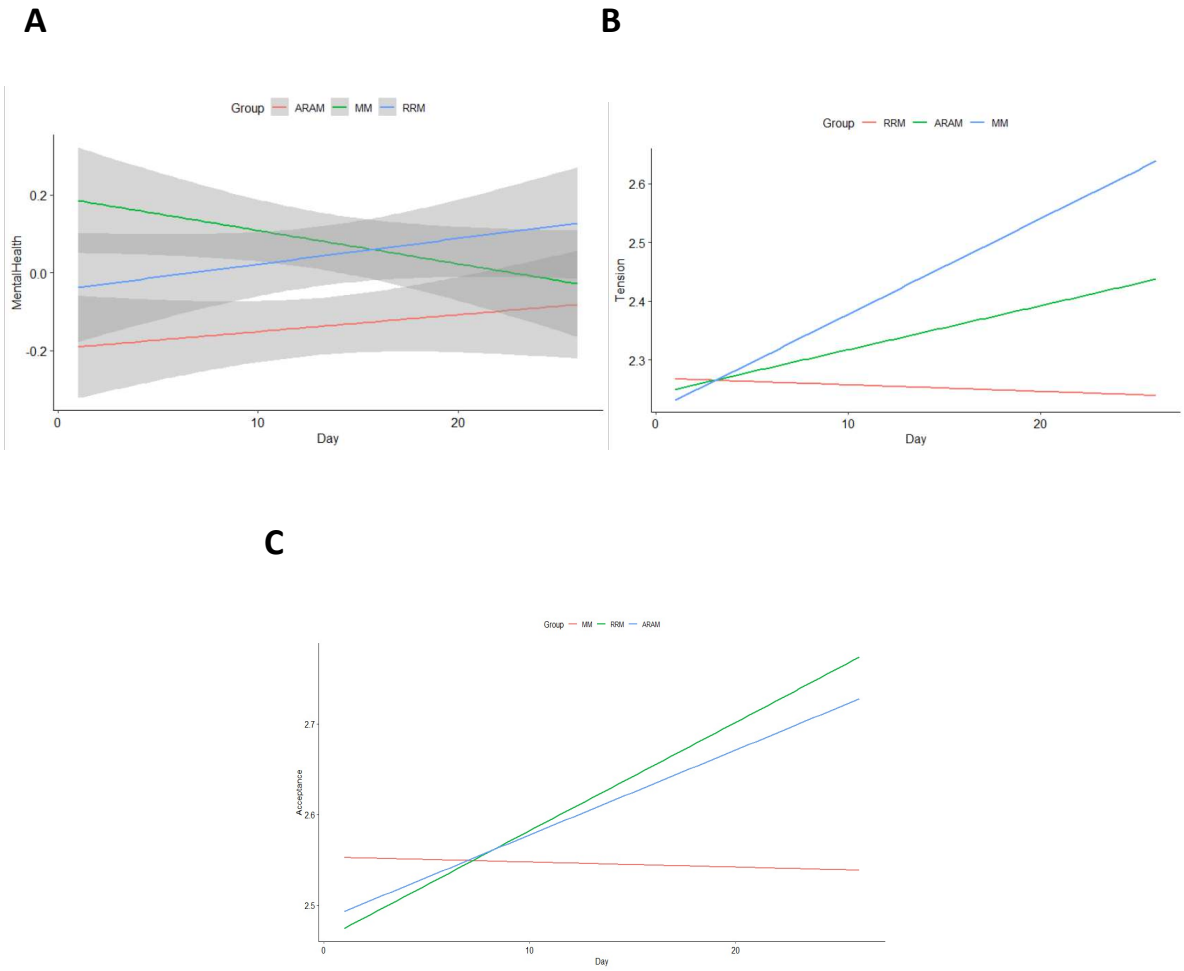

Figure 1. Intervention-specific effects on primary outcome variables.

Regarding the effects of the mechanistic markers on mental health, across the study, the strongest correlate of mental health was physical tension, with decentering, acceptance, and pulse contributing less strongly to mental health changes (H5; Table 2).

Table 2. Correlation of Mechanistic Markers with Mental Health

Predictor	**std. Beta**	**95% CI**	**p**
Physical Tension	-0.29	-0.32 – -0.25	**<0.001**
Decentering	0.11	0.07 – 0.14	**<0.001**
Acceptance	0.11	0.07 – 0.15	**<0.001**
Pulse	-0.08	-0.12 – -0.04	**<0.00**

Discussion

The results of this study showed increased mental health in the RRM and ARAM conditions, with greater improvements to physical tension and acceptance in RRM and ARAM, as well as a greater contribution to mental health from RRM and ARAM. The purpose of this study was to examine whether students respond to self-directed mental health interventions, and to explore the varying effects of MM, RRM, and ARAM on perceived stress levels and related mental health outcomes. The hypotheses stated that ARAM will result in the greatest improvements to mental health (H1) and evaluation-related stress (H2), with higher relaxation in RRM and ARAM (H3) and higher mindfulness in MM and ARAM (H4). It was also hypothesized that within-session changes will improve across-study mental health (H5). Overall, the results were not expected based on the hypotheses.

The RRM condition yielded the greatest improvements to mental health, rather than the ARAM condition; however, ARAM resulted in greater improvements to mental health as compared to MM (H1). The intervention effects on evaluation-related stress could not be measured as the evaluation schedule failed to predict declining mental health (H2). Higher relaxation was in fact observed in the RRM and ARAM groups, as predicted by the hypotheses (H3). On the contrary, greater mindfulness was observed in RRM and ARAM, as opposed to being observed in MM and ARAM as the hypotheses predicted (H4). Within-session changes indeed improved across-study mental health, as predicted by the hypotheses; however, it was not predicted that improvements in physical tension would yield the greatest contribution to mental health changes (H5).

It is possible that due to the shorter intervention period of four weeks, as opposed to eight weeks, RRM resulted in better mental health outcomes than MM and ARAM. Based on past studies, mindfulness outcomes may take longer to achieve than relaxation outcomes,

especially in novice or inexperienced meditators. Concerning the evaluation schedule unexpectedly failing to predict declining mental health, it may have been beneficial to request that students provide further details along with their evaluation schedule, such as what types of evaluations students had on each day.

Limitations and Future Directions

Future studies may benefit from implementing research that expands the generalizability of our results, while also considering employing longer intervention periods and an element of choice. Participants in the present study were undergraduate Introductory Psychology students at the University of Toronto Mississauga. Future studies can benefit from testing a broader sample and conducting research that is more generalizable to different populations. It might also be worthwhile to explore having an eight-week, as opposed to a four-week, intervention period, as it would be expected to produce stronger intervention effects. More research may be needed to determine the amount of meditation needed to develop the target effects of MM and RRM (Mccann et al., 2013). Future studies can explore whether shorter intervention periods are more appropriate for RRM as compared to MM. It may also be worth exploring whether participants choosing their meditation intervention leads to stronger mental health effects. A study by van Hooff and Baas (2012) found that meditation participants experienced greater mental health outcomes when they were intrinsically motivated to engage in the interventions.

Conclusion

The results of this study demonstrate the effectiveness of self-directed mental health interventions, with general improvements in mental health outcomes being observed. Overall, RRM resulted in better mental health outcomes, as compared to MM and ARAM, suggesting

that for brief intervention periods, participants may benefit most from a focus on physical relaxation, as opposed to mindfulness.

Acknowledgements, Reflections, and Future Directions

We are extremely thankful towards the Laidlaw Scholars Foundation for funding this project and making it possible to achieve our research results. My Laidlaw Scholars journey has allowed me to experience an incredible amount of growth in such a short period of time. The Laidlaw Scholars program has been such a valuable experience for my personal and professional development. I would like to thank the Laidlaw Scholars Foundation for allowing me the opportunity to participate in the program, and for continuing to positively impact the lives of incoming Laidlaw Scholars. We look forward to working towards publishing this research and sharing our published paper in the future.

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Appendix

Assessment Schedule

Table 3. Measured Variables and Assessment Schedule – Scales, Tasks, and Questions to Be Used at Baseline, Pre-Lesson, Post-Lesson, and Post-Intervention

Measured Variable	Scales, Tasks, and Questions	Baseline	Pre-Lesson	Post-Lesson	Post-Intervention
- Age - Gender	Brief Demographic Survey	X			
- Meditation Experience	Meditation Experience Question	X			
- Evaluation Dates	Evaluation Dates Question	X			
- Perceived Stress	PSS-10 Scale (only items 3+6 for post-lesson*)	X		X	X
- Anxiety - Depression	PHQ-4 Scale	X			X
- Positive Affect - Negative Affect	Modified PANAS (for post-lesson, participants simply select emotions they feel at the moment*)	X		X	X
- Awareness - Nonreactivity and Acceptance	PHLMS Scale (only acceptance item 2 for pre/post-lesson*)	X	X	X	X
- Decentering - Ruminative Thinking	EQ Scale (only decentering item 15 for pre/post-lesson*)	X	X	X	X
- Locus of Control	Locus of Control Scale	X			X
- Burnout Strength - Burnout Frequency	MBI (only measuring burnout strength and items 5 + 6 for post-lesson*)	X		X	X
- Physical Tension	Physical Tension Questionnaire		X	X	
- Heart Rate (beats/min)	Self-Reported Pulse Rate Task		X	X	

* In cases where the format of a scale differs in the pre-lesson and post-lesson assessments, as compared to the baseline and post-intervention assessments, the same format used at pre-lesson and post-lesson will also be presented at baseline and post-intervention, following the original baseline and post-intervention format.

Meditation Training Schedule

Table 4. Mindfulness Meditation, Relaxation Response Meditation, and Applied Relaxation and Applied Mindfulness Daily Schedule

	Mindfulness Meditation (MM)	Relaxation Response Meditation (RRM)	Applied Relaxation and Applied Mindfulness (ARAM)
Week 1			
Day 1	Breath-focused	Breath and Relaxation Focused	MM Week 1 – Breath-focused
Day 2	Breath-focused	Breath and Relaxation Focused	RRM Week 1 – Breath and Relaxation Focused
Day 3	Breath-focused	Breath and Relaxation Focused	MM Week 1 – Breath-focused
Week 2			
Day 1	Directed Awareness	Guided Relaxation with Tension Release	RRM Week 1 – Breath and Relaxation Focused
Day 2	Directed Awareness	Guided Relaxation with Tension Release	MM Week 2 – Directed Awareness
Day 3	Directed Awareness	Guided Relaxation with Tension Release	RRM Week 2 – Guided Relaxation with Tension Release
Week 3			
Day 1	Advanced Directed Awareness	Advanced Guided Relaxation with Tension Release and Guided Imagery	Combined MM Week 3 + RRM Week 3
Day 2	Advanced Directed Awareness	Advanced Guided Relaxation with Tension Release and Guided Imagery	Combined MM Week 3 + RRM Week 3
Day 3	Advanced Directed Awareness	Advanced Guided Relaxation with Tension Release and Guided Imagery	Combined MM Week 3 + RRM Week 3
Week 4			
Day 1	Open Awareness	Unguided Relaxation	Combined MM Week 4 + RRM Week 4
Day 2	Open Awareness	Unguided Relaxation	Combined MM Week 4 + RRM Week 4
Day 3	Open Awareness	Unguided Relaxation	Combined MM Week 4 + RRM Week 4

Sample Meditation Audio Recording

The following link can be used in order to access a sample meditation audio recording for this study: https://soundcloud.com/asma-behery-761409489/mindfulness-week-1/s-KPjqUUpvUoj