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

Laidlaw Scholars Program Summer I Research Summary Paper

Background

Short term stress may negatively influence performance and cognitive functioning. A study by Allan (2013) found stress in nurses to lead to cognitive failure and decreased efficiency in work performance. If short-term stress is not controlled, chronic stress may develop and lead to even greater implications, such as its potential to increase breast cancer likelihood. A study by Cui (2019) showed greater tumour growth in mouse models, in the presence of prolonged stressors. Long-term stress may be prevented through meditation. Relaxation Response Meditation (RRM) and Mindfulness Meditation (MM) are particularly associated with stress reduction (Sevinc, 2018).

Mindfulness meditation (MM) is the practice of training attention and present moment awareness with the intention of developing a state of emotional calm, mental clarity, self-awareness, and concentration (Feldman et al., 2010). MM training involves an object of awareness, which is typically the flow of the inbreath and outbreath (Kabat-Zinn, 1982). MM is associated with stress reduction and trains participants to increase their acceptance and tolerance to stress (Luberto, 2020).

Relaxation response meditation (RRM) is a practice which involves greater activation of the parasympathetic nervous system over the sympathetic nervous system, with the goal of reducing physical tension and training participants to manage emotional and physiological reactivity (Luberto, 2020; Mccann, 2013). Specifically, progressive muscle relaxation (PMR), an RRM technique, involves a process of tensing and relaxing muscles (Gao, 2017). RRM is associated with stress reduction due to its role in reducing the fight or flight state of stress (Sevinc, 2018).

Due to the distinct influences of MM and RRM on stress reduction, it is worthwhile to consider whether a combined practice of MM and RRM, Applied Relaxation and Applied Mindfulness (ARAM), produces a stronger reduction to perceived stress levels, as compared to the individual MM and RRM practices.

Purpose

To determine the most effective meditation practice, as related to the reduction of perceived stress levels.

Study Objectives and Summer I Goals

The objective of this research project is to determine whether an ARAM practice will produce a stronger reduction in perceived stress levels, as compared to the individual practice of MM or RRM. Additionally, a literature review by Sedlmeier (2012) explained how several past meditation studies have lacked precise theoretical background. Thus, this project aims to create an impact in meditation research by contributing more dependable methodology through a comprehensive literature review preceding the study. This project also aims to use technology in order to improve stress coping, through the use of online meditation modules, used to administer regular meditation sessions throughout the week.

Due to timely ethics approval and experimental setup, this project was designed to occur over two summers. The specific Summer I goals of the study included: establishing a strong theoretical background through a comprehensive literature review, completing an ethics board proposal, the preregistration of the hypothesis and analysis plan, the experimental setup and design for the second part of the project, and outlining the Summer II goals. Important details of the successful completion of the Summer I goals outlined above are explained below, in this summary paper.

Introduction – Literature Review Findings

The literature review of this study carried a focus on gaining a deeper understanding of the following concepts: the gap in meditation research, the distinct effects of MM and RRM specifically as related to stress, the appropriate scales used to measure the most significant effects of MM and RRM respectively, and the minimal components required to design MM and RRM trainings respectively.

Concerning the research gap, the following was identified to be lacking in meditation research:

- ❖ The effects of a combined MM and RRM approach, specifically on perceived stress levels and the associated symptoms
- ❖ The correlation of physiological effects of RRM on the psychological effects of MM
- ❖ A comparison of the feasibility, acceptability, and efficacy of a combined MM and RRM approach, as compared to the individual approaches (Luberto, 2020)
- ❖ The amount of meditation needed to develop the target effects of MM and RRM (Mccann, 2013)
- ❖ The implementation of ARAM randomized controlled studies (Mccann, 2013)

Regarding the remainder of the literature review findings, the tables that follow were produced in order to summarize these literature review findings. Table 1 below compares MM and RRM, with regards to the description and effects of each practice:

Table 1. Similarities and Differences Between the Description and Effects of MM and RRM

	MM	Both (Similarities)	RRM
Brief Description of Practice	- Intentional non-judgemental, accepting, and non-reactive present moment awareness free of forgetfulness and distraction	N/A	- Greater activation of the parasympathetic nervous system over the sympathetic nervous system
Psychological Effects (including effects that improve, effects that are reduced, effects on which the specific practice has a greater effect, and effects with mixed results)	- <u>Improve</u> : observation, non-judgement, decentering, curiosity, cognition, emotion regulation, acceptance, self-compassion, equanimity, cognitive reappraisal, attentional control - <u>Reduce</u> : description, rumination, distraction, worry - <u>Greater effect on</u> : reducing repetitive thoughts, non-reactivity, mindfulness, mood - <u>Mixed Results</u> : awareness (mostly increases)	- <u>Improve</u> : wellbeing, stress, anxiety, depression, mindful awareness, cognitive decentering, non-reactivity, mood - <u>Reduce</u> : perceived stress, emotional exhaustion - <u>Mixed Results</u> : affect (mostly, positive affect increases but it may decrease with novice meditators)	- <u>Improve</u> : Spirituality, mental relaxation - <u>Reduce</u> : arousal, negative thoughts - <u>Greater Effect on</u> : reducing anxiety (although, potential acute anxiety may arise in novice meditators)
Physiological Effects (including effects that improve, and effects that are reduced)	(Please refer to the “both” column – the literature review did not reveal any physiological effects that were unique to MM)	- <u>Improve</u> : pain relief, tolerance, threshold - <u>Reduce</u> : fight or flight state, blood pressure	- <u>Improve</u> : immune system - <u>Reduce</u> : physiological effects of anxiety, heart rate, salivary cortisol, arousal, muscle tension
Evidence of Unique Effects	- Unique effects were more evident in high threat situations.	N/A	- Unique effects were more evident in low threat situations.
Enhancement Effect When Combined	- MM was found to increase awareness of what is relaxing when combined with RRM.	- When both practices were combined even greater improvements were seen in self-regulation, mindfulness, non-judgement, and stress reduction.	- The literature review did not reveal any unique RRM enhancing effects.

Table 2 below summarizes the literature review findings concerning the most significant effects to measure relevant to MM, RRM, and both practices, specifically as related to stress. Table 2 also outlines the appropriate scales, tasks, or questions to use in order to measure each effect.

Table 2. The Most Significant Effects to Measure and the Appropriate Scales, Tasks, or Questions for MM, RRM, and Both

Meditation Practice	The Most Significant Effects to Measure	Appropriate Scales, Tasks, or Questions*
MM	Awareness, Acceptance, and Nonreactivity	PHLMS Scale
	Decentering and Ruminative Thinking**	EQ Scale
RRM	Physical Tension	Physical Tension Questionnaire
	Heart Rate (beats/minute)	Self-Reported Pulse Rate Task
Both	Locus of Control***	Locus of Control Scale
	Perceived Stress	PSS-10 Scale
	Mood and Affect	PANAS
	Burnout Strength and Frequency	MBI
	Anxiety and Depression	PHQ-4 Scale

* Please refer to Appendix A for details regarding the assessment schedule and each of the appropriate scales, tasks, or questions.

** Decentering can be defined as viewing thoughts and feelings as temporary and objective, as opposed to viewing them as true depictions of one’s self (Fresco, 2007).

*** Locus of control can be defined as the source of stress (Kurosawa, 2018).

Table 3 below summarizes the literature review findings regarding the minimal components required to design MM and RRM trainings, respectively. Please refer to Appendix D for sample MM and RRM instructions from the literature.

Table 3. Important Training Elements of MM, RRM, and Both and Different Types of MM and RRM Practices

Meditation Practice	Important Training Elements	Different Types of the Meditation Practice
MM	<ul style="list-style-type: none"> - Present Moment Awareness and redirecting attention whenever it is lost. - The practice of decentering - Object of Awareness: The object of awareness in MM is typically the breath. Over several sessions and in stages, the object of awareness can expand to include other mental and physical events such as: body sensations, thoughts, memories, emotions, perceptions, intuitions, fantasies, and sound. It is also encouraged to acknowledge the details of one’s experiences such as the volume and tone of sound. - Accepting Attitude: Physical and mental experiences should not be suppressed and instead should be approached with a sense of openness, curiosity, non-judgement, and acceptance. 	<ul style="list-style-type: none"> - <u>Sweeping</u>: This practice involves developing one’s awareness of different areas of the body with the goal of developing breath awareness and relaxation. In the supine position, one engages in a gradual process of directing their attention to one area of the body at a time, beginning at the feet and progressing up to the head. - <u>Mindfulness of the breath and other perceptions</u>: This practice involves directing one’s attention and awareness to different objects of awareness such as the breath and other perceptions.
RRM	<ul style="list-style-type: none"> - An emphasis is placed on relaxing the body and mind. - There are 4 crucial elements that make up an RRM practice: <ul style="list-style-type: none"> o Mental Device – this is a single point of focus which is typically a word or phrase that is repeated. o Passive Attitude – this involves ignoring and letting go of any disruptive thoughts while carrying no concern towards one’s success in achieving a relaxed state. o Decreased Muscle Tonus – one should meditate in a comfortable position and exert minimal muscular work. o Quiet Environment 	<ul style="list-style-type: none"> - <u>Breath-Focused</u>: This practice involves a process of deep breathing in order to increase relaxation. - <u>Tension-Release</u>: This practice is commonly more specifically referred to as progressive muscle relaxation (PMR). PMR incorporates a process of tension release in which one tenses and relaxes different muscles in the body while deep breathing, in order to further increase the relaxation effect.
Both	<ul style="list-style-type: none"> - In both practices it is important to focus on the process of meditation as opposed to focusing on the desired outcome (i.e. developing a strong sense of present moment awareness or relaxation for MM and RRM respectively). 	N/A

During the literature review, an annotated bibliography of over 50 publications was produced. Please refer to Appendix F for a list of all of the literature that was reviewed in order to produce the findings outlined above.

Methodology

As this study was designed to extend over two summers, the methodology outlined below will be applied in the second half of the project.

Experimental Setup and Design

Participants will be randomized to 1 of 3 meditation intervention groups: MM group, RRM group, and ARAM group. Participants will be required to complete a baseline assessment and their first intervention, requiring 45 to 60 minutes, at the start of the study as well as a post-assessment, requiring 30 to 45 minutes, at the end of the 28-day intervention period. During the intervention period, participants will receive email links to online guided meditation sessions and brief assessment items, three times a week.

Prior to signing up for the study, participants will view a description of the inclusion/exclusion criteria. Potential participants will complete a 5-minute online pre-consent screener where they will be told about study design, confirm that they can commit to the 4-week period, and are told if they are a good candidate for the study. If they are a good candidate, they will automatically be redirected to the study consent form and baseline assessment questionnaire, followed by their first intervention session and check-in.

An outline of the different components of the study are provided below:

A. Baseline Assessment and First Intervention [~45-60 min]

Screener [~2-5 min]

The screener is an online set of automatically scored yes/no questions to determine if participants meet the inclusion and exclusion criteria of the study.

Screener data will not be retained, but instead, will be programmed to 'pass'

or ‘fail’ participants as eligible candidates for the study. The screener will also involve a set of 4 ‘catch trials,’ employed to set a minimum standard for participant comprehension and adherence to instructions. Participants must get at least 3 of 4 of these questions correct to be retained in the study.

Participants not meeting eligibility criteria, or who fail the catch trials will be thanked for their interest but will not proceed to the consent form and baseline assessment.

Consent form [~2-5 min]

Eligible candidates for the study must complete the consent form in order to participate and continue with the study.

Baseline Questionnaire [~25-30 min]

Please refer to Table 6 Appendix A, for the list of scales, tasks, and questions included in the baseline questionnaire.

Randomization and Preparation - First Intervention Session and Check-in [~15 min]

At the end of the successful baseline assessment completion, participants will be randomized into 1 of 3 meditation intervention groups: Mindfulness Meditation (MM), Relaxation Response Meditation (RRM), or Applied Relaxation and Applied Mindfulness (ARAM), and provided with a brief description of their intervention condition, schedule, and expectations (e.g. complete at least 50%, or 6 of 12, of the practice sessions).

Participants will then be redirected to their first online meditation session, which will also include brief pre-lesson and post-lesson assessment items.

B. Intervention and Regular Check-Ins [~15 min each]

Pre-Lesson Check-In [~2.5 min]

Please refer to Table 6 in Appendix A, for the list of scales, tasks, and questions included in the pre-lesson check-in.

Guided Meditation Recording [~10min]

- 3x / week [relative to sign up date]
- 1 day after signup [Day 1 of 7]
- 2 days later [Day 3 of 7]
- 2 days later [Day 5 of 7]
- Meditation technique practice will last for 28 days. This will occur via email links to a survey within which the guided meditation audio recording will be embedded. Two days immediately following the first intervention session, participants will begin to receive email links for their intervention condition, three times a week. The three days of the week in which the email link will be sent will be relative to the participant's sign-up date, and will remain the same for the duration of the study.

Post-Lesson Check-In [~2.5 min]

Please refer to Table 6 in Appendix A, for the list of scales, tasks, and questions included in the post-lesson check-in.

C. Post Assessment [~30-45 min]

Post Assessment Questionnaire [~25-30 min]

After the 28-day period, participants will complete a 25 to 30-minute post-assessment questionnaire. Please refer to Table 6 in Appendix A, for the list of scales, tasks, and questions included in the post-assessment questionnaire.

Retrospective Questions [~2-5 min]

Participants will respond to a list of retrospective questions, which will prompt participants to report on their experience in participating in the study. Please refer to Appendix B for the list of retrospective questions.

Open-Ended Comments [~2-5 min]

Participants will be prompted to provide any open-ended comments they may have regarding the study which may contribute to data analysis. For example, participants may report a major life event that occurred in their life during the study, which may have impacted their perceived stress levels. Please refer to Appendix B for an outline of the open-ended comments section.

Debriefing Page [~2-5 min]

Participants will be given information about the project following participation.

Participants

Participants will be undergraduate students at the University of Toronto Mississauga. When signing up for the study, participants will be presented with an overview of the inclusion and exclusion criteria of the study and a link to an online brief screener where participants can assess their eligibility and register for the study. Screening data will not be retained, and instead, the screener will be a web form that is automated only to allow people who fit the inclusion and exclusion criteria to progress to the study consent form, baseline questionnaire, and first intervention.

The inclusion and exclusion criteria for this study can be found below:

Inclusion Criteria:

- ❖ Stress: Participants must report moderate or higher levels of daily stress
- ❖ Internet: Participants must have daily access to internet

- ❖ Willingness: Participants must be willing and able to learn meditation techniques
- ❖ English: Participants must be able to communicate and follow instructions in English
- ❖ Vision and Hearing: Participants must have normal or corrected-to-normal vision and hearing
- ❖ Age: Participants must be 18 years old or older
- ❖ Health: Participants must self-identify as healthy enough to complete daily internet-based training

Exclusion Criteria:

- ❖ Mental Health: Not eligible to individuals who have ongoing neurological illness (eg, head trauma) or ongoing or recent major psychological disorder (eg, major depressive disorder, anxiety disorder, bipolar disorder, or schizophrenia) (Cheong, 2018).
- ❖ Medication: Not eligible to individuals who take medication that affects the autonomic nervous system within 1 week before enrollment in the meditation sessions (opiates, stimulants, tricyclic antidepressants, benzodiazepines, cardiac drugs such as beta- blockers, or renin-angiotensinaldosterone system blockers such as angiotensin- converting enzyme inhibitors and angiotensin receptor blockers). Other medications are allowable (including antidepressants) but participants must be stable on the medication for at least 4 weeks prior to the study and inform the study team of any medication change during the study period (Cheong, 2018).

Survey Programming and Piloting

Full survey programming and piloting was also accomplished in this summer of research. Please refer to Appendix A for details regarding the items of measure included in the survey. Regarding the meditation sessions which were recorded and included in the survey, Table 4 below displays the meditation sessions schedule for the 28-day intervention period; further details regarding the meditation sessions schedule, as well as the link to a sample meditation session audio recording can be found in Appendix C.

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

Analysis

As this study was designed to extend over two summers, the hypothesis and analysis plan outlined below will be applied in the second half of the project.

Hypothesis Plan

The following hypothesis plan was developed for this study:

H1 (Hypothesis 1) – Mental Health

Across study (from baseline to post-intervention) ARAM will result in better mental health than MM and RRM.

H2 - Stress Resilience

Group will moderate the effect of evaluation schedule on well-being (evaluation-related stress), such that ARAM will result in a weaker relationship between evaluation schedule and well-being than MM and RRM.

H3 - Relaxation as Mechanism

Within sessions (from start to end of session), RRM and ARAM will result in higher levels of relaxation (self-reported tension + heart rate) than MM.

H4 - Mindfulness as Mechanism

Within sessions (from start to end of session), MM and ARAM will result in higher levels of mindfulness skills (decentering and acceptance) than RRM.

H5 - Mechanisms Lead to Mental Health Outcomes

Within session (from start to end of session) changes to Mechanistic Markers (relaxation, decentering, and acceptance) will predict across study (from baseline to post-intervention) changes to mental health.

Analysis Plan

For details regarding the indices, as well as the exploratory hypotheses of the analysis plan please see Appendix E.

H1 – Mental Health

Well-Being ~ Group [ARAM vs. MM and RRM] x Session [from baseline, through 12 lessons to post] | Participant

To test this, we will use a multilevel model implemented in the ‘nlme’ package in the R statistical programming environment. At the lower level, participant sessions are nested within participants, and at the higher level, participants are nested within one of 3 groups. So, this is a within (variance across participant sessions) x between (comparison between groups) interaction test.

The model above will generate an output that looks like:

	Parameter	Std Error	T Statistic	P Value
Intercept				
Main effect of Group				
Main effect of Session				
Group x Session Interaction				THIS ONE

The critical term in this model is the group x session interaction, if it is significant, we will perform both graphing and follow-up, uncorrected simple effects tests to better understand what is driving the interaction, and in particular the simple effects of session for ARAM compared to MM + RRM.

H2 – Stress Resilience

Well-Being ~ Evaluation Schedule * Group | Participant

In this case it is not a simple linear vector of chronological sessions that will predict well-being, but instead an Evaluation Schedule vector generated for each participant (see Indices in Appendix E for details) will be used to predict well-being. The individual participant beta weights for this prediction are binned and compared between the groups.

The group x evaluation schedule interaction is the critical term. Again, uncorrected follow-up simple effects analyses will follow a significant interaction finding to clarify the nature of the interaction.

H3 - Relaxation as Mechanism

Relaxation ~ Group [RRM + ARAM vs. MM] x Within-Session [pre vs. post session]
| Participant

Here we actually have a third level of nesting, because within session scores are at the lowest level, nested within participant sessions, which are nested within group. However, we are not interested in the three-level interaction, we are interested in modelling the average effect within session, averaging across all participant sessions for a given participant.

So, even though we could run a model that would generate a Group x Session x Within Session interaction, we only are interested in the Group x Within Session interaction and are not including Session as a predictor in the model.

Again, a significant Group x Within-Session interaction will be explored post-hoc.

H4 - Mindfulness as Mechanism

Mindfulness Skills ~ Group [RRM + ARAM vs. MM] x Within-Session [pre vs. post session] | Participant

This is the same setup as H3 above, the Group x Within-Session Interaction is the critical term in the model, and a significant interaction will be explored post-hoc.

H5- Mechanisms Lead to Mental Health Outcomes

Change in Well-Being ~ Combined Mechanism Change Score [from baseline, through 12 lessons to post] | Participant / Session

This is actually a simple bivariate regression made up of multilevel data. So, the dependent variable is slope of well-being change that can be extracted from the analysis in H1. The Combined Mechanism Change Score is the participant-averaged difference score of [post-session - pre-session] combined mechanism factor scores. The average ‘impact’ of sessions for a participant is being used to predict the participant’s change in well-being over the intervention period.

Future Directions – Summer II Objectives

Table 5 below summarizes the tasks that were completed in Summer I, as well as the tasks that are anticipated to be completed in the second half of the project:

Table 5. Progress Report

Task	Progress
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
Data Collection	Anticipated Completion by Summer 2021
Data Analysis	Anticipated Completion by Summer 2021
Reporting on the Final Experimental Results	Anticipated Completion by Summer 2021

Reflections of Summer I Research Experience

Through this summer research project, I was able to develop my research experience and familiarize myself with the research process, improve upon some of my skills, and gain further knowledge surrounding my research topic. Designing and implementing this study, alongside my research advisor, has allowed me to develop my experience in research, which is an accomplishment that is especially important to me as an individual who seeks to work in research in the future. The research experience that I have gained this summer has allowed me to gain a stronger sense of the steps involved in planning and conducting a research project, which has given me an increased sense of confidence in running another student-led research project in the future. I have become more familiar with the steps involved in securing a research advisor and writing a research proposal, effectively conducting a

literature review, writing an ethics proposal as well as a preregistration application, and designing and setting up an experiment. I have also learned more about the importance of an ethics proposal and the preregistration process. This summer, I also developed my skills in communication as well as my interpersonal skills while interacting with my research advisor on a regular basis. I also feel that I have developed my critical thinking and analysis skills through tasks such as the literature review and troubleshooting whenever an obstacle arose. Lastly, this project has deepened my knowledge in meditation and perceived stress. I feel that I have been able to apply this knowledge to my daily life, especially as an individual who regularly faces stress, as a student. We are extremely thankful towards the Laidlaw Scholars Foundation for funding this project and making it possible to achieve our Summer I research results. We look forward to continuing to work on this project and sharing our final results in the future.

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Appendix A: Assessment Schedule and Items of Measure

A. Assessment Schedule:

Table 6. 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	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.

B. Brief Demographic Survey:

Please select your age and gender from the options presented below:

Age

- 18-20
- 21-25
- 26-29
- 30-35
- 36-39
- 40-45
- 46-49
- 50 or over

Gender

- Male
- Female
- Transgender male
- Transgender female
- Genderqueer/Gender non-conforming
- I prefer not to answer
- Other, please specify: _____

C. Meditation Experience Question:

Meditation can be defined as a practice that focuses on training psychological and/or physiological attention and awareness with the goal of reducing tension and producing a state of emotional calm and self-awareness.

	Once a Day or More	At least Once A Week	Once per Month	I do not meditate regularly
1. Considering the definition of meditation provided above, how often do you meditate?	1	2	3	4

D. Evaluation Dates Question:

Counting today as Day 1, please list any major evaluations (papers, midterms, presentations, etc.) that you have coming up in the next 3 weeks (up to Day 28). Please select the number of evaluations you have on each day or leave a blank if you have no evaluations on that day.

Day	Number of Evaluations	Day	Number of Evaluations
1	_____	15	_____
2	_____	16	_____
3	_____	17	_____
4	_____	18	_____
5	_____	19	_____
6	_____	20	_____
7	_____	21	_____
8	_____	22	_____
9	_____	23	_____
10	_____	24	_____
11	_____	25	_____
12	_____	26	_____
13	_____	27	_____
14	_____	28	_____

E. PHQ-4 Scale:

Over the last 2 weeks, how often have you been bothered by the following problems?

	Not at all	Several Days	More than half the days	Nearly Everyday
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Feeling nervous, anxious, or on edge	0	1	2	3
4. Not being able to stop or control worrying	0	1	2	3

F. Perceived Stress Scale (PSS-10):

Scale: 0 = Never; 1 = Almost Never; 2 = Sometimes; 3 = Fairly Often; 4 = Very Often

1. In the past few days, how often have you been upset because of something that happened unexpectedly?	0	1	2	3	4
2. In the past few days, how often have you felt that you were unable to control the important things in your life?	0	1	2	3	4
3. In the past few days, how often have you felt nervous and “stressed”?	0	1	2	3	4
4. In the past few days, how often have you felt confident about your ability to handle your personal problems?	0	1	2	3	4
5. In the past few days, how often have you felt that things were going your way?	0	1	2	3	4
6. In the past few days, how often have you found that you could not cope with all the things that you had to do?	0	1	2	3	4
7. In the past few days, how often have you been able to control irritations in your life?	0	1	2	3	4
8. In the past few days, how often have you felt that you were on top of things?	0	1	2	3	4
9. In the past few days, how often have you been angered because of things that were outside of your control?	0	1	2	3	4
10. In the past few days, how often have you felt difficulties were piling up so high that you could not overcome them?	0	1	2	3	4

G. Positive Affect Negative Affect Schedule (PANAS):

How often have you experienced each of the emotions below within the past few days?

Scale: 1 = Very slightly or not at all; 2 = A little; 3 = Moderately; 4 = Quite a bit; 5 = very much

	Very Slightly or Not At All	A little	Moderately	Quite a bit	Very Much
Attentive	1	2	3	4	5
Interested	1	2	3	4	5
Alert	1	2	3	4	5
Enthusiastic	1	2	3	4	5
Excited	1	2	3	4	5
Inspired	1	2	3	4	5
Proud	1	2	3	4	5
Determined	1	2	3	4	5
Strong	1	2	3	4	5
Active	1	2	3	4	5
Distressed	1	2	3	4	5
Upset	1	2	3	4	5
Hostile	1	2	3	4	5
Irritable	1	2	3	4	5
Scared	1	2	3	4	5
Afraid	1	2	3	4	5
Ashamed	1	2	3	4	5
Guilty	1	2	3	4	5
Nervous	1	2	3	4	5
Jittery	1	2	3	4	5

I. Philadelphia Mindfulness Scale (PHLMS):

Scale: 1 = Never; 2 = Rarely; 3 = Sometimes; 4 = Often; 5 = Very Often

1. I am aware of what thoughts are passing through my mind	1	2	3	4	5
2. I try to distract myself when I feel unpleasant emotions	1	2	3	4	5
3. When talking with other people, I am aware of their facial and body expressions	1	2	3	4	5
4. There are aspects of myself I don't want to think about	1	2	3	4	5
5. When I shower, I am aware of how the water is running over my body	1	2	3	4	5
6. I try to stay busy to keep thoughts or feelings from coming to mind	1	2	3	4	5
7. When I am startled, I notice what is going on inside my body	1	2	3	4	5
8. I wish I could control my emotions more easily	1	2	3	4	5
9. When I walk outside, I am aware of smells or how the air feels against my face	1	2	3	4	5
10. I tell myself that I shouldn't have certain thoughts	1	2	3	4	5
11. When someone asks how I am feeling, I can identify my emotions easily	1	2	3	4	5
12. There are things I try not to think about	1	2	3	4	5
13. I am aware of thoughts I'm having when my mood changes	1	2	3	4	5
14. I tell myself that I shouldn't feel sad	1	2	3	4	5
15. I notice changes inside my body, like my heart beating faster or my muscles getting tense	1	2	3	4	5
16. If there is something I don't want to think about, I'll try many things to get it out of my mind	1	2	3	4	5
17. Whenever my emotions change, I am conscious of them immediately	1	2	3	4	5
18. I try to put my problems out of mind	1	2	3	4	5
19. When talking with other people, I am aware of the emotions I am experiencing	1	2	3	4	5
20. When I have a bad memory, I try to distract myself to make it go away	1	2	3	4	5

J. Experiences Questionnaire (EQ):

Scale: 1 = Never; 2 = Rarely; 3 = Occasionally; 4 = Very frequently; 5 = All the time

1. I think about what will happen in the future.	1	2	3	4	5
2. I remind myself that thoughts aren't facts.	1	2	3	4	5
3. I am better able to accept myself as I am.	1	2	3	4	5
4. I notice all sorts of little things and details in the world around me.	1	2	3	4	5
5. I am kinder to myself when things go wrong.	1	2	3	4	5
6. I can slow my thinking at times of stress.	1	2	3	4	5
7. I wonder what kind of person I really am.	1	2	3	4	5
8. I am not so easily carried away by my thoughts and feelings.	1	2	3	4	5
9. I notice that I don't take difficulties personally.	1	2	3	4	5
10. I can separate myself from my thoughts and feelings.	1	2	3	4	5
11. I analyze why things turn out the way they do.	1	2	3	4	5
12. I can take time to respond to difficulties.	1	2	3	4	5
13. I think over and over again about what others have said to me.	1	2	3	4	5
14. I can treat myself kindly.	1	2	3	4	5
15. I can observe unpleasant feelings without being drawn into them.	1	2	3	4	5
16. I have the sense that I am fully aware of what is going on around me and inside me.	1	2	3	4	5
17. I can actually see that I am not my thoughts.	1	2	3	4	5
18. I am consciously aware of a sense of my body as a whole.	1	2	3	4	5
19. I think about the ways in which I am different from other people.	1	2	3	4	5
20. I view things from a wider perspective.	1	2	3	4	5

K. Locus of Control Scale:

Scale: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree

1. When I make plans, I am certain that I can make them work.	1	2	3	4	5
2. Getting people to do the right things depends upon ability; luck has nothing to do with it.	1	2	3	4	5
3. What happens to me is my own doing.	1	2	3	4	5
4. Many of the unhappy things in people's lives are partly due to bad luck.	1	2	3	4	5
5. Getting a good job depends mainly on being in the right place at the right time.	1	2	3	4	5
6. Many times I feel that I have little influence over the things that happen to me.	1	2	3	4	5

L. Maslach Burnout Inventory (MBI):

1. I feel emotionally drained from my work.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

2. I feel used up at the end of the school/workday.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

3. I feel fatigued when I get up in the morning and have to face another day.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

4. Working with people all day is really a strain for me.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

5. I feel burned out from my work.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

6. I feel frustrated by school/my job.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

7. I feel I'm working too hard on school/my job.

		A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
Never	How often:	1	2	3	4	5	6
<input type="checkbox"/>	How strong:	1	2	3	4	5	7
		Very mild, barely noticeable			Moderate		Very strong, major

8. Working with people directly puts too much stress on me.

Never <input type="checkbox"/>	How often: How strong:	A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
		1	2	3	4	5	6
		1	2	3	4	5	6
		1	2	3	4	5	6
		Very mild, barely noticeable			Moderate		Very strong, major

9. I feel like I'm at the end of my rope.

Never <input type="checkbox"/>	How often: How strong:	A few times a year	Monthly	A few times a month	Every week	A few times a week	Every day
		1	2	3	4	5	6
		1	2	3	4	5	6
		1	2	3	4	5	6
		Very mild, barely noticeable			Moderate		Very strong, major

M. Physical Tension Questionnaire:

Please think about the muscle groups in your body labelled on the mannequin below and consider the question:

- Using the tension scale provided below, how severe is your overall muscular tension at this moment?

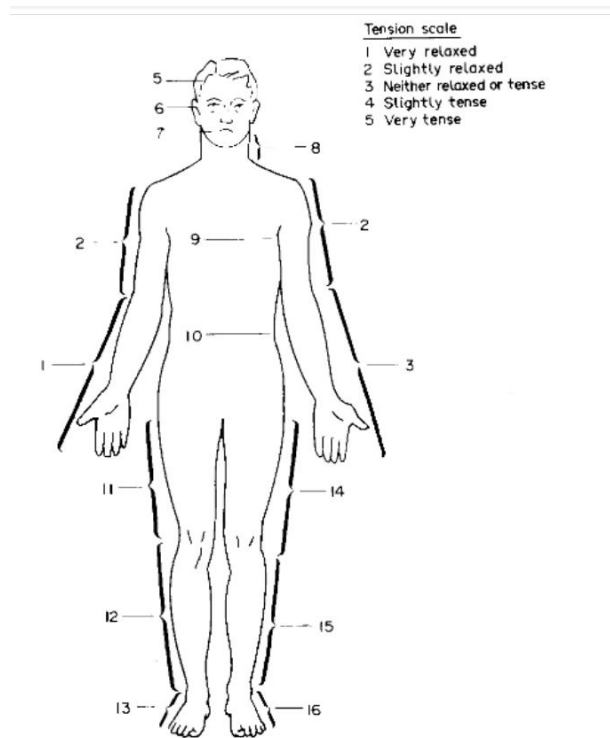


Fig. 1. The Tension Mannequin showing muscle groups 1-16.

N. Self-Reported Pulse Rate Task:

Use the 10-second timer provided.

Lightly place your index finger and middle finger just below the jawbone at the side of your neck and count the number of beats you can feel within 10 seconds.

Record the number of beats counted within the ten seconds: _____

Appendix B: Retrospective Questions and Open-ended Comments

A. Retrospective Questions:

On a scale of 0 to 100, where 0 = not at all and 100 = very much, please respond to the following questions concerning your experience in participating in this study:

1. How logical did you find the meditation trainings offered (i.e. consider whether you felt like the trainings could have been better planned and executed to achieve the goal of reducing stress)?
2. How enjoyable did you find the meditation trainings offered?
3. How successful/effective do you think the meditation trainings were in reducing your stress levels (i.e. consider how much you felt the trainings were targeted towards stress reduction)?
4. How much improvement in your stress levels do you **feel** occurred, following the meditation trainings?
5. How confident would you be in recommending this meditation training to a friend?

B. Open-ended Comments:

Optional: Please provide any general comments which you may have regarding your participation in this study, which you feel may be important for the research team to be aware of (e.g. Any changes in medication throughout the study period, a major life event that may have occurred during the study period which may have impacted your stress levels, any technical issues you may have faced in accessing the email links, any difficulties experienced in participating in the study, any recommendations you may have for improving the study, etc.):

Appendix C: Guided Meditation Trainings Details

A. Mindfulness Meditation (MM) Schedule Details:

Breath-focused:

The three meditation trainings of the first week of MM will involve a breath-focused approach. The goal of week 1 is to ensure that participants become comfortable with meditating and to encourage participants to be more aware of the flow of their inbreath and outbreath.

Directed Awareness:

The three meditation trainings of week 2 of MM will involve a directed awareness approach. Participants will be directed towards certain mental and physical experiences and encouraged to be aware of these experiences in an accepting, curious, and non-judgmental manner. Participants will be prompted to be aware of simple mental and physical experiences such as breath, body sensations, thoughts, emotions, and sound.

Advanced Directed Awareness:

The three meditation trainings of week 3 of MM will involve an advanced directed awareness approach. Participants will begin to direct their attention and awareness towards more advanced mental and physical experiences such as memories, perceptions, intuitions, fantasies, etc. Participants will also be prompted to focus more on the details of these mental and physical experiences. For instance, participants may be encouraged to first acknowledge any sounds in their environment, and then be prompted to focus on the tone and volume of these sounds.

Open Awareness:

The three meditation trainings of week 4 of MM will involve an open awareness approach. By week 4, the goal is that participants will have become comfortable with MM trainings and will have developed the ability to practice open awareness. Participants will be encouraged to be curious about any mental or physical events experienced during the meditation session. Minimal guidance will be given concerning to which events participants should be directing their attention and awareness.

B. Relaxation Response Meditation (RRM) Schedule Details:

Breath and Relaxation Focused:

The three meditation trainings of week 1 of RRM will involve a breath and relaxation focused approach. The goal of week 1 is to ensure that participants become comfortable with meditating and to develop greater physiological awareness. Participants will learn how to achieve a greater sense of physiological relaxation through deep breathing and focusing one's attention on reducing physiological tension.

Guided Relaxation with Tension Release:

The three meditation trainings of week 2 of RRM will involve an approach of guided relaxation with tension release. Participants will be guided towards relaxing certain muscles in the body, beginning at the feet and progressing up to the face. Participants will be prompted to tense certain muscles while breathing in, followed by releasing that tension and breathing out.

Advanced Guided Relaxation with Tension Release and Guided Imagery:

The three meditation trainings of week 3 of RRM will involve an approach of advanced guided relaxation with tension release. Week 3 will incorporate more advanced tension release, as compared to week 2, as well as guided imagery. For instance, rather than simply being prompted to tense and relax one's face, one may also be prompted to envision their eyebrow tensing and relaxing.

Unguided Relaxation:

The three meditation trainings of week 4 of RRM will involve an approach of unguided relaxation. By week 4, the goal is the participants will have become comfortable with RRM trainings and will have developed the ability to practice unguided relaxation. Participants will be encouraged to identify areas of tension in the body and to tense and relax those areas, while incorporating deep breathing into their practice. Minimal guidance will be given concerning which areas of the body participants should be tensing and relaxing.

C. Applied Relaxation and Applied Mindfulness (ARAM) Schedule Details:

Week 1 + Week 2:

Week 1 and week 2 of ARAM will involve alternating between the week 1 and week 2 MM and RRM trainings, while maintaining an equal number of MM and RRM trainings. The goal of weeks 1 and 2 is to ensure that participants become familiar and comfortable with MM and RRM trainings, while developing the target skills of each practice (i.e. developing greater present moment awareness, achieving greater physiological relaxation through tension release, etc.).

Week 3 + Week 4:

Week 3 and week 4 of ARAM will involve practices which combine the elements of the MM and RRM trainings for that week. By week 3 and week 4, the goal is that participants will have become more comfortable with both MM and RRM trainings and will have developed the ability to practice a more advanced combined approach. For instance, rather than simply being prompted to direct one's awareness to mental and physical experiences or tense and relax certain muscles, participants would be prompted to first be aware of internal and external experiences, and then focus their attention and awareness on body sensations, and transition into tensing and relaxing certain muscles.

D. Link to 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>

Appendix D: Sample Meditation Instructions from the Literature

Table 7. Sample MM and RRM Instructions from the Literature

Meditation Practice	Sample Instructions from the Literature
MM	<ol style="list-style-type: none"> 1. [<u>Object of Observation</u>] Bring your attention to the primary object of observation. 2. [<u>Present Moment Awareness</u>] Be aware of it from moment to moment. 3. [<u>Redirect Attention</u>] When you notice that the mind has drifted into thought, reverie, and so forth, bring it back to awareness of the present moment, to the observation of what is dominant in that moment. In the sweeping meditation, the primary object is that region of the body through which one is moving at any moment. 4. [<u>Observation</u>] When a strong feeling or emotion arises (i.e., a state of fear, pain, anger, anxiety), direct your attention to the feeling as it occurs and just be with it, observing it. When it subsides, return to the primary object of observation. Distinguish between observation of the experience itself and thoughts and interpretations of the experience. 5. [<u>Decentering</u>] Observe the thinking process itself. Avoid becoming involved in the content of individual thoughts. Observe them as impermanent mind events and not necessarily accurate. Treat all thoughts as equal in value and neither pursue them nor reject them.
RRM	<ol style="list-style-type: none"> 1. [<u>Comfortable Position</u>] Sit quietly in a comfortable position. 2. Close your eyes. 3. [<u>Relax Muscles</u>] Deeply relax all your muscles, beginning at your feet and progressing up to your face. Keep them deeply relaxed. 4. [<u>Breath + Mental Device</u>] Breathe through your nose. Become aware of your breathing. As you breathe out, say the word “ONE” silently to yourself. For example, breathe IN. . .OUT, “ONE”; IN. . .OUT, “ONE”; and so forth. 5. [<u>Sit Quietly</u>] Continue for [ten] minutes. You may open your eyes to check the time, but do not use an alarm. When you finish, sit quietly for several minutes at first with closed eyes and later with opened eyes. 6. [<u>Passive Attitude</u>] Do not worry about whether you are successful in achieving a deep level of relaxation. Maintain a passive attitude and permit relaxation to occur at its own pace. When distracting thoughts occur, ignore them and continue repeating “ONE.” With practice, the response should come with little effort. Practice the technique once or twice daily, and not within two hours after any meal since the digestive processes seem to interfere with the elicitation of anticipated changes.

Note. MM sample instructions were quoted from Kabat-Zinn (1982, p. 36) and RRM sample instructions were quoted from Benson (1975, p. 90)

Appendix E: Exploratory Hypotheses and Indices

A. Exploratory Hypotheses

- EH1 (Exploratory Hypothesis 1) – Gender and Age: Across study (baseline to post-intervention), the effects of gender and age group on symptoms and perceived stress will be explored.
- EH2 – Meditation Experience: Across study (baseline to post-intervention), the effects of meditation experience on symptoms and perceived stress will be explored.
- EH3 – Locus of Control: Across study (baseline to post-intervention), the effects of locus of control on symptoms and perceived stress will be explored.
- EH4 - Study vs. Session Perceived Stress: Across study (baseline to post-intervention), the correlation between changes in perceived stress and symptoms with the slope of change in perceived stress across intervention sessions, will be explored.
- EH5 – Awareness, Acceptance, and Decentering: Across study (baseline to post-intervention), the effects of MM, ARAM, and RRM on awareness, acceptance and decentering will be explored.
- EH6 – Anxiety and Depression: Across study (baseline to postintervention) the effects of MM, RRM, and ARAM on anxiety and depression will be explored.

B. Indices

The following are the indices relevant to the hypotheses of this study:

- Mental Health/Well-Being: We will use the first principal component of: Mood board (Positive), Mood board (Negative), items 3 and 6 from the Perceived Stress Scale (PSS-10), and Burnout strength from the MBI scale, such that higher scores indicate greater positive mood as well as lower levels of stress, negative mood and burnout. If needed, we will reverse score the first principal component by multiplying by -1 to fit this interpretive frame.
- Evaluation Schedule: The coding of the 12 assessment days in terms of the concurrent evaluation related stress. To obtain these scores, first the 28 days in study will be coded as a single vector per participant, where the score on each day is derived from the evaluation schedule provided by each participant at baseline. Days with evaluation are scored as a '3', the day before as a '2', and the day before as a '1', with overlapping evaluations leading to higher scores. For example if a participant has evaluations on days 5, 7 and 8, their vector for the first 8 days will look like: 0 0 1 2 4 3 5 3. Then, because we only assess participants on 12 of those days, we will just inherit the scores from the vector on the appropriate days (i.e., only take scores from days 1, 3 5, 8, 10, 12, 15, 17, 19, 22, 24, 26). So, the final vector will be only 12 scores long, and match up with assessment days.
- Evaluation-related Stress: This will be scored using the regression parameter from prediction of evaluation schedule on well-being- how this will be implemented is described in the analysis plan.
- Decentering: This will be scored using decentering item 15 from the EQ scale.
- Relaxation: This will be scored using the average of the scores from the physical tension questionnaire and the self-reported pulse rate task.
- Acceptance: This will be scored using acceptance item 2 from the PHLMS scale.
- Mindfulness Skills: This will be scored using the weighted average scores from the Decentering and Acceptance scores. To obtain this weighted average, all Decentering and Acceptance scores will be entered into a principal components analysis (PCA) and the first component will be used as this weighted average score.
- Mechanistic Markers: to reduce the number of formal comparisons, the 3 mechanistic markers of Decentering, Relaxation, and Acceptance will be summarized using a single factor score that

represents change in these capacities. The first principal component of these 3 scores will be used to generate a mechanistic marker, using the same methodology as the Mental Health score described above.

- Concerning the exploratory hypotheses, "symptoms" will be scored using scores from the PANAS scale, PHLMS scale, EQ scale, Locus of Control Scale, MBI scale, Physical Tension Questionnaire, and Self-Reported Pulse Rate Task.

Appendix F: List of the Literature That was Reviewed

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