# Preventing Burnout: Moving Beyond Atheoretical, Self-report Based and Treatment-Focused Approaches

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## Dedication

Thank you to my darling daughter for your support and encouragement throughout my PhD.

Thank you to my parents for giving up so much to give me a good education and for helping me proofread countless essays and assignments leading up to this thesis.

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## Abstract

Burnout is a pervasive occupational health concern with significant impacts on indiviuals, organisations and society. While research into this field has recently expanded, it is grounded in a history of clinical observations and self-report measures. A systematic review was conducted to examine the effectiveness of one of the most researched interventions, mindfulness-based interventions. However, the systematic review ended up highlighting several issues with the current state of burnout research including an over reliance on self-report measures, a focus on treatment, heterogenous multi-component interventions and a lack of theory-based models.

The subsequent studies outlined in this thesis sought to address these limitations and advance burnout research. The randomised experimental studies used combined pre- post- self-report measures with daily self-reports and physiological measures of stress (heart rate variability). By using a single-component, focused meditation intervention during a predicted high-stress period and including a control group, the studies reduced intervention heterogeneity and examined the preventative effects of focused meditation. Results indicated a dose-response relationship of focused meditation when compared to the control group. The final study extended this work by developing and testing a new theoretical model of burnout which identified rumination and a central mechanisms of burnout.

Whilst the findings were modest, these studies demonstrate methodological and conceptual advances. The studies establish the feasibility of daily multimodal assessments outside laboratory environments, reframe meditations as preventive, isolate the effects of focused meditation and introduce a new mechanism-driven theoretical model of burnout. Collectively, these contributions provide new directions for more rigourous, theory-based burnout research.

*Keywords*: Meditation; Mindfulness; Prevention and Control; Stress, Psychological; Emergency Responders

## Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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University of Adelaide

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# Chapter 1: Introduction

## Burnout as a Contemporary Challenge

Burnout has become one of the most pressing occupational and public health issues of the twenty-first century. First defined in the 1970s in observations on healthcare workers, it is now recognised as a pervasive condition across a wide range of occupations (Freudenberger, 1974). Burnout is typically characterised by emotional exhaustion, cynicism and a reduced sense of personal accomplishment (Maslach et al., 2001). Together these dimensions capture the depletion of emotional resources, a defensive detachment from work and a sense of reduced efficacy and achievement.

The global prevalence of burnout has risen to levels that necessitate serious policy and research attention. The prevalence of burnout has increased across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). In mental health workers in the US and UK, burnout prevalence is estimated at around 67%, up to 40% in Western nurses and 13%-18% in general workers (Aiken et al., 2004; Morse et al., 2012; Norlund et al., 2010). These statistics highlight that burnout is not confined to exceptional contexts or rare circumstances; rather, it represents a widespread outcome of contemporary working life.

The recent COVID-19 pandemic has amplified concerns about burnout among healthcare professionals and other high-demand workers. Systematic reviews reveal increased prevalence of burnout and psychological distress among frontline clinicians, linked to high workloads, moral injury, resource scarcity, and sustained uncertainty (Chen et al., 2021; Serrano-Ripoll et al., 2020). Beyond healthcare, similar patterns

emerge in educators, emergency responders, and corporate employees facing chronic organisational stressors (Norlund et al., 2010; Poghosyan et al., 2010).

The impact of burnout extends well beyond the individual. At the individual level it has been linked to sleep disturbance, immune dysregulation, substance abuse, cardiovascular risk and elevated risks of anxiety and depression (Bährer-Kohler, 2013; Melamed et al., 2006). At the organisational level, burnout contributes to absenteeism, diminished productivity, increased errors and higher staff turnover (Aiken et al., 2004; Hassard et al., 2014). These outcomes generate substantial economic costs and it is estimated that it costs over €600 billion annually while in Australia the figure has been estimated at AUD$12 billion (Hassard et al., 2014; National Occupatational Health and Safety Commission, 2003).

Ultimately, burnout is more than a workplace concern and has detrimental impacts on workers, workplaces and society as a whole. As such, burnout research has two important roles, to investigate the mechanisms through which burnout develops and identify interventions that can prevent its onset.

## Rationale behind this Thesis

Given the severity and the prevalence of burnout, the original aim of this thesis was to investigate ways to prevent the onset of burnout. The first step was to understand the current literature around burnout which spawned an initial literature review followed by a systematic review. However, during these reviews, several critical limitations of the current literature were evident. As such, the aim moved toward developing the field of burnout research by addressing these limitations through the development of novel study methodologies and models whilst using meditation as a test-case for assessing the ability to prevent stress and burnout.

## Limitations in the Current Literature to be Addressed

### 1.3.1 An Over-Reliance on Self-Report Measures

The Maslach Burnout Inventory (MBI)(Maslach & Jackson, 1981) remains the dominant measure for burnout alongside other subjective questionnaires such as the Shirom-Melamed Burnout Measure (Melamed et al., 2006). While these instruments have strong psychometric properties, they are vulnerable to well-known limitations of self-report measures such as recall bias and defensive responding (Podgurski et al., 2019). More importantly, self-report measures cannot isolate and identify the underlying mechanistic or physiological properties underlying burnout leaving it as being characterised, defined and measured largely at the surface level of subjective experience.

### 1.3.2 Treatment rather than Prevention Focused

Given this focus on subjective experience and symptoms, early intervention studies were aimed at reducing such symptoms in those already experiencing burnout. Little focus has been placed on preventing the development of burnout in the first place.

Prevention plays a vital role in treating burnout early and includes steps to delay or prevent the onset of burnout or, if not possible, mitigate the consequences (Karl & Fischer, 2012). Primary prevention measures are aimed at people before they develop burnout symptoms such as education to assist in coping with stress and strengthening an individual's existing resources (Karl & Fischer, 2012). The next step, secondary prevention, is for those who are starting to develop burnout and is designed to prevent severe burnout (Karl & Fischer, 2012). Lastly tertiary prevention is designed to stop significant damage from burnout (Karl & Fischer, 2012).

Given that burnout is an interaction between work and the individual, preventive measures can include changes to the work environment or improving an individual's

coping ability (Carod-Artal & Vázquez-Cabrera, 2012). Some argue that this second category can encompass both individual prevention measures and collective ones which include teams, groups and all employees of a company (Pirker-Binder, 2017). It is argued that collective prevention is vital for commercial success and healthy teams and groups have positive interactions internally and externally with other teams above and below (Pirker-Binder, 2017).

While the best way to prevent burnout is to reduce occupational stress, this is not always possible and improving an employee's coping capacity may be preferred through training in stress management, time management and dealing with clients (Carod-Artal & Vázquez-Cabrera, 2012). High-risk occupations such as healthcare, emergency services and the military, arguably are characterised by often unavoidable chronic stressors such as shift work, risk of injury and emotional dissonance (Bährer-Kohler, 2013; Zapf et al., 2001). In these and similar occupational environments, treatment becomes temporary and costly, and prevention becomes increasingly vital.

### 1.3.3 Heterogeneity of Interventions

The existing interventions are characterised by complexity and heterogeneity. The majority of mindfulness-based interventions are multi-component programs that combine meditation with yoga, psycho-education and group discussions (Chaukos et al., 2018; Kabat-Zinn, 1990). While studies have found these to be effective, the combination of different modes of intervention makes it impossible to isolate which component, or particular combination of components, is responsible for the observed effects, which makes comparisons across studies difficult, undermines the credibility of the interventions and makes it impossible to develop theories behind the mechanisms at work.

### 1.3.4 Atheoretical Research

This history of focusing on symptoms and self-report measures in combination with multi-modal interventions makes developing theory of the mechanisms behind burnout extremely difficult. This atheoretical approach makes it difficult to understand how interventions work and how to refine them.

## Thesis Overview

The aim of this thesis shifted to address these gaps in the literature through the use of focused meditation as a test-case for prevention. Chapter II will go through a review of the history and current state of burnout literature including its impact, conceptual development, definitional debates, distinctiveness issues, measures and limited theories. It will also go through common mindfulness-based therapies, the relationship between mindfulness and burnout as well as definitional debates surrounding mindfulness and meditation and possible mechanism involved.

### 1.4.1 Systematic Review

Chapter III encompasses a systematic review which was conducted to examine research into burnout and meditation in high-risk occupations including emergency services workers, military personnel, corporate executives and healthcare workers. An initial literature review revealed that the majority of burnout research had been conducted in health care settings, but that burnout was affecting a broader area of the working population. While originally it was thought that burnout was due to the unique emotional challenges of working in caregiving roles, subsequent research found that other common job-related stressors were more highly correlated with burnout (Maslach et al., 2001). One of the main occupational features impacting burnout was the concept of emotion work/labour, including emotional dissonance and emotional suppression, where employees are required to display appropriate emotions which are incongruent

with their actual feelings and can lead to emotional exhaustion (Iszatt-White, 2013; Zapf et al., 2001). As such this systematic review sought to understand how burnout affected occupations that involve emotional work outside of healthcare.

The second issue to be examined by the systematic review was how burnout is measured. While the majority of research seems to use self-report measures of burnout, more recently, research has examined the physiological measures of burnout. By examining how the body responds to stress, these physiological measures of burnout can provide another way to measure levels of prolonged stress and burnout. This review aimed to examine research into these measures and how they relate to the existing self-report measures.

Lastly, in examining treatments for burnout, this review will examine how mindfulness, and more specifically meditation affects burnout as well as the definitional issues associated with mindfulness and meditation.

The systematic review highlighted the heterogeneity of interventions in the literature. The main intervention identified in the review was MBSR which combines several different types of meditation with yoga whilst the second most common intervention, SMART, also incorporates cognitive reframing strategies. This makes it difficult to determine what makes these programs effective and what mechanisms are responsible.

Another gap that was identified was that of outcome measures. The only outcome measures that had enough available data to conduct meta-analyses were self-report measures. Physiological measures are able to track the body's stress response in order to measure burnout. Additionally, the pre- and post- test measures don't provide the ability to monitor stress levels on a smaller-time scale and in a response to particular stressors.

Lastly, the review found that the majority of studies examined mindfulness practices as treatments for burnout rather than as a preventative measure. In the majority of high-risk occupations examined in the review, it can be identified early on that these employees are at an increased risk of burnout. Hence, a preventative measure that can reduce the likelihood and severity of burnout would be of greater use.

### 1.4.2 Stress During Assignment Period (Randomised Experimental Studies)

Chapters IV and V describe a series of randomised experimental studies that sought to address the gaps in the literature that were identified in the literature. Participants were university students during the assignment due date window who were randomised into a meditation group, who conducted an app based daily focused meditation, and a control group, who conducted a sham meditation. Participants conducted pre- and post- intervention self-reports of perceived stress and burnout as well as daily measures of self-report perceived stress and daily measures of heart rate variability.

The use of a focused meditation as a single form of intervention for the study and used a control group with a sham meditation to examine the effectiveness of a single type of mindfulness intervention. The addition of daily self-reports of perceived stress and HRV sought to address the gaps in the literature by examining stress over time and using a physiological measure of stress in combination with a self-report measure. Lastly, by measuring perceived stress and burnout and commencing meditation training prior to a stressful period, the effect of meditation in reducing increases in perceived stress and burnout could be examined allowing for the consideration of focused meditation as a preventative measure rather than just as a treatment.

### 1.4.3 Attentional Control/Rumination Pathway Study

The last gap in the literature identified in the systematic review was the lack of theory regarding mechanisms behind the effectiveness of mindfulness-based interventions in reducing burnout. Chapter VI describes a cross-sectional study that sought to examine some possible mechanisms behind the effectiveness of focused meditation. One proposed mechanism responsible for the benefits of meditation is via an increase in attentional control resulting in a better ability to shift attention away from negative thoughts and emotions and inhibit being drawn back toward them resulting in a reduction in rumination. This is important as rumination has been implicated in prolonging stress and burnout.

The study was a cross-sectional study which asked participants to conduct a meditation habits survey, the Attentional Network Test, the Rumination Response Scale, the Perceived Stress Scale and the Burnout Assessment Tool. Structural equational modelling was used to ascertain the relationship between meditation habits, attentional control, rumination, perceived stress and burnout.

## Conclusion

Chapter VII seeks to synthesise the findings of these studies in the context of the history of burnout history and how this thesis contributes to advancing the field. It also outlines the limitations of the studies and gives insight into possible future research avenues. This discussion highlights four keen advancements to the burnout field including a novel research design for integrating daily physiological measures in addition to existing self-report ones. This design also provides a way to test the ability to burnout interventions to prevent the build of stress and burnout and changes the mindset of research toward from one of treatment to one of prevention. It also provides a test case for evaluating the benefits of a single modality intervention, in this case

focused meditation. Lastly, it describes a new theoretical model of burnout and a study design to test it.

This thesis started by documenting the conceptual development of burnout and meditation and providing a review of findings in the field thus far. Despite decades of research, the field has been hamstrung by conceptual and definitional ambiguities, a reliance on self-report measures, treatment-oriented designs, heterogenous intervention programs and atheoretical approaches. Against this backdrop, the studies in this thesis seek to advance the field by moving beyond self-report measures toward multimodal assessments, reframing interventions as preventive rather than purely treatment-focused, demonstrating the testing of a single-modality, homogeneous intervention, and developing and testing a theory-based model of burnout. By doing so, this thesis advances the field of burnout research design and, also, provides practical insights into how burnout can be more effectively prevented and managed in real-world contexts in high-risk occupational settings.

# Chapter 2: Concepts and Definitions

## Introduction

This chapter will outline the conceptual definitions of burnout, mindfulness and the proposed theories and mechanisms involved. Burnout has become a pervasive occupational and public health issue, attracting substantial empirical, clinical, and policy attention over the past five decades. First described in 1974 to describe exhaustion and disillusionment amongst free-clinic volunteers, it has since developed into a major focus of empirical research and policy concern (Freudenberger, 1974). It is now most commonly characterised by emotional exhaustion, depersonalisation or cynicism, and a reduced sense of personal accomplishment (Maslach et al., 2001). Originally identified among human service professionals, burnout is now recognised across diverse occupational contexts (Maslach et al., 2001). Its consequences extend beyond individual suffering to encompass reduced productivity, compromised quality of care, elevated turnover, and significant economic costs to organisations and healthcare systems (Hassard et al., 2014).

Increasingly, burnout is understood not as an acute response but as the endpoint of chronic exposure to psychosocial stressors that overwhelm coping resources over time (Hobfoll & Freedy, 1993). This cumulative conceptualisation aligns with the broader stress literature, where sustained activation of the hypothalamic–pituitary–adrenal (HPA) axis and sympathetic nervous system (SNS) is linked to dysregulation of physiological, cognitive, and emotional systems (Harvard Medical School, 2020; McLeod, 2010). Consequently, burnout is associated with a range of adverse physical outcomes, including cardiovascular disease, immune dysregulation, metabolic disturbances, and sleep disorders, as well as elevated risk of depression, anxiety, and substance use (Bährer-Kohler, 2013; Maslach et al., 2001).

Against this backdrop, mindfulness and meditation-based interventions have gained prominence as potential solutions. Mindfulness practices are some of the most reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019).Nevertheless, critical gaps persist. The first is the historically narrow perspective of burnout research. The second is the definitions of mindfulness and meditation. Thirdly, the measurement of burnout. Lastly, there is an absence of theoretical models describing how meditation affects stress and burnout.

Despite decades of research, however, burnout research contains several conceptual and definitional debates. This chapter will describe the historical arc of burnout research and how this has contributed to these debates. It will also examine the proposed theoretical frameworks and risk factors involved with burnout. Additionally, it will explore the conceptual and definitional debates surround mindfulness and meditation and how these tie in with research examining mindfulness as a possible intervention for burnout.

## Impact of Burnout

The impact of burnout is not limited to the individual but extends to the organisations who provide employment and society, in general. The following section covers the individual (physical and behavioural) and organisational impacts of burnout.

### 2.2.1 Individual Impacts

#### 2.2.1.1 Physical Impact

While no unique physiological markers of burnout have been made available, burnout has been linked to increased cortisol levels, elevated blood pressure and inflammation markers in the blood, as well as increased cardiovascular risk factors such

as total cholesterol, low-density lipoprotein cholesterol, fasting glucose and triglyceride levels (Bhatia & Tandon, 2005; Gerber et al., 2016; Grossi et al., 2005; Kivimäki et al., 2013; Landsbergis et al., 2013; Melamed et al., 2006; Melamed et al., 1999; Stansfeld & Candy, 2006). Physical symptoms can include anxiety-like symptoms such as nervous tics, sexual problems, nausea, headache and light-headedness (Melamed et al., 2006). They can also include depressive-like symptoms such as physical exhaustion, loss of appetite and chronic fatigue (Glass et al., 1993; Nyklíček & Pop, 2005). Psychosomatic symptoms can also be present such as ulcers, frequent and prolonged colds, menstrual cycle issues, neck and low back pain and sleep disturbance (Nuallaong, 2013; Peterson et al., 2008).

#### 2.2.1.2 Behavioural Impact

Burnout can present itself through behavioural changes including impulsivity, procrastination, hyperactivity, neglect of recreational activities and compulsive complaining (Nuallaong, 2013). Poorer impulse control can lead to violence and aggression (Nuallaong, 2013). A decrease in work performance is also seen with poor patient interactions in health professionals, reduced job commitment and readiness to support their organisation as well as an increase in counterproductive workplace behaviours (Turek, 2021; Van Bogaert et al., 2014).

### 2.2.2 Financial and Organisational Impact

Burnout can result in direct and indirect financial costs for the individual and the organisation that they work for. Direct costs incorporate loss of productivity, vacancy costs and training replacement employees while indirect costs incorporate reduced productivity, decreased commitment to work and an unstable workforce (Carod-Artal & Vázquez-Cabrera, 2012). These can lead to a reduced quality of service provided

including avoiding contact with clients due to apathy and lack of empathy toward them (Pines & Maslach, 1978).

In terms of absenteeism, it is estimated that 272 billion Euro was lost due to absenteeism from depression and an estimated 5 million lost days due to stress while in Canada, it is estimated that stress related absenteeism costs $3.5 billion each year (Matrix, 2013; Milczarek et al., 2009; Williams & Normand, 2003). A survey found that half of those with burnout were expecting to leave their job within the next decade, with 24% naming burnout as the primary cause (Kamal et al., 2020). High turnover rates also are detrimental to the quality and continuity of care provided by an organisation. On a societal level, the European Agency for Safety and Health at Work estimated the cost of burnout at over 600 billion Euros while in Australia, excessive job stress is estimated to cost $12 billion (Hassard et al., 2014; National Occupatational Health and Safety Commission, 2003).

Burnout has extensive and broad impact on those who suffer from it. It affects individuals on a physical level but also affects broader behaviours and aspects of life. It also has wider impacts than the individual with effects being felt across the workplace and wider society.

## Historical and Conceptual Development of Burnout

Burnout is a term used by many workers across many industries in everyday language to describe a feeling of being overworked, exhausted and flat but has also become a pervasive public health issue attracting substantial empirical, clinical and policy attention over the past decade. It spawned from practical observations in the workforce rather than psychological or academic roots and, as such, the initial research into burnout focused on clinical descriptions of the symptoms displayed but not on people suffering from burnout (Maslach & Schaufeli, 2017). In the 1980s, it moved

toward an empirical phase of research including steps to operationalise and measure the concept (Maslach & Schaufeli, 2017). In the modern era, these empirical measures have started to move from purely self-report and observational measures toward biophysiological measures and toward other non-health care occupations (Bährer-Kohler, 2013).

The concept of burnout emerged in the 1970s against a backdrop of rising concern about occupational stress in human service professions. These first articles appeared gave burnout a name, described the key features of the condition and determined that it was more common that initially thought (Maslach & Schaufeli, 2017). In 1974, burnout was first described as a verb describing a process of failure, wearing out or become exhausted due to excessive demands on resources, strength or energy (Freudenberger, 1974). The signs involved feelings of exhaustion and difficulties in emotional regulation, including quickness to anger or cry with preventative measures including reducing workload and physical exercise (Freudenberger, 1974). However, as research into burnout increased, three issues arose which continue to present as issues in modern day burnout research. The first was that although different researchers were looking at ‘burnout’ they were often examining different concepts (Maslach & Schaufeli, 2017). The second, related issue, was that burnout expanded to encompass more than the original concept which today leads to overlap and issues distinguishing it from other mental health issues (Maslach & Schaufeli, 2017). The last issue was that the initial research into burnout was largely non-empirical and focused largely on symptoms of individuals suffering from burnout. A review of articles on burnout between 1974 and 1981 found that only 10% of them used empirical data with most using observations of individual case studies (Perlman &

Hartman, 1982). This pioneer stage of burnout research hence gave rise to several of the issues in the field today including issues with definition, measurement and distinction.

In the 1980s, the research shifted toward more systematic empirical research, resulting in more academic papers on burnout and the development of standardised measures (Maslach & Schaufeli, 2017). The development of the Maslach Burnout Inventory (MBI) operationalised burnout as a syndrome consisting of emotional exhaustion, depersonalisation and reduced personal accomplishment and this tripartite model shaped decades of research and intervention (Maslach & Jackson, 1981). The research area also drew attention in countries other than the United States and more recently, burnout research started to extend beyond education and human services into areas such as law enforcement, business and sport (Maslach & Schaufeli, 2017).

Whilst burnout research has moved from observational to empirical research, several issues are still present in modern burnout research. The first is the vast majority of empirical work on burnout is correlational and relies on self-report data which can lead to issues with subjective assessments (Maslach & Schaufeli, 2017). The second issue is that most of the research has not been grounded in a theoretical framework which can make prevention and treatment pathways difficult to predict and test (Maslach & Schaufeli, 2017). With the move toward biophysiological measures and some movement towards theoretical approaches, modern burnout research should lead toward more objective and theory driven prevention and treatment measures.

This thesis will attempt to build on the current burnout research in three major ways. Firstly, this research will use biophysiological as well as self-report measures of stress and burnout in an aim to provide a better fidelity and objectivity to the measurement of burnout. Secondly, it will add longitudinal studies examining the trajectory of stress across a predicted stressful period in time and measure the ability to

prevent these increases of stress. Lastly, the research will develop and test a theoretical model of burnout involving attentional control, rumination and worry as factors influencing the development of burnout.

## Measures of Burnout

These conceptional fuzziness of burnout make creating an instrument to measure burnout is difficult. Some argue that self-reporting scales may be the most valid measure of burnout. There are several inventories established looking at burnout. The most used is the Maslach Burnout Inventory (MBI) which is a 22-item inventory using a five-point rating scale on three dimensions including emotional exhaustion, depersonalisation and personal accomplishment (Bährer-Kohler, 2013). Studies have found the inventory has a high internal consistency for each factor and results of confirmatory factor analyses have supported the three-factor model (Kitaoka-Higashiguchi et al., 2004). Additionally external validity has been examined through comparison with work characteristics such as job demands and decision authority (Kitaoka-Higashiguchi et al., 2004; Taris et al., 1999). The Shirom-Melamed Burnout Measure (SMBM) is similar but is based on the Conservation of Resources theory and instead uses the dimensions of physical fatigue, emotional exhaustion and cognitive weariness and has demonstrated validity and reliability in several studies (Shirom & Melamed, 2006). Another inventory that has been used is the Bergen Burnout Inventory (BBI) which uses a three-factor structure including an emotional, cognitive and behavioural aspect shown to have validity in longitudinal studies including group and time invariance (Feldt et al., 2014; Salmela-Aro et al., 2011). More recently, the Burnout Assessment Tool (BAT) has been used and consists of four core dimensions that include exhaustion, mental distance, emotional impairment and cognitive

impairment. It also includes two secondary dimensions consisting of psychological complaints and psychosomatic complaints (Schaufeli et al., 2020). Additionally, as many propose that burnout is the result of prolonged work stress, self-report measures of stress may also be useful in examining burnout such as the Stress Reactivity Scale (SRS) and Perceived Stress Scale (PSS). Thus, the majority of research has focused on using self-report inventories to measure burnout.

However, more recently, research has looked at physiological measures of burnout which largely focus on the body's neurophysiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS activation due to stress (Bährer-Kohler, 2013). These include increased heart rate, decreased heart rate variability and increased blood pressure (Melamed et al., 2006). Following this initial release, the hypothalamus also activates the HPA system which triggers the release of cortisol (Harvard Medical School, 2020; Melamed et al., 2006). Studies have found work-related stress is associated with increased cortisol response to waking and throughout the day (Lundberg & Hellström, 2002; Melamed et al., 1999). Those suffering burnout have been found to have reduced hippocampal neurogenesis leading to disturbed hippocampal regulation of the HPA axis and chronic stress can lead to persistent epinephrine surges and elevated cortisol levels due to the body's cortisol receptors which remove circulating cortisol being 'turned down' through cellular

changes in the hippocampus. Thus, studies have found that those affected by burnout have reduced serotonergic or dopaminergic function (Eriksson & Wallin, 2004; Harvard Medical School, 2020). Stress, including chronic stress, has also been found to affect several neurochemicals including serotonin, and the catecholamines noradrenaline, and dopamine that the HPA system releases to activate the amygdala to trigger an emotional response to the stressful event. The neuropeptide S is also released, a protein that modulates stress by increasing alertness, decreasing sleep and generating a sense of urgency and anxiety in the individual, raising glucocorticoid levels (mainly cortisol) and reinforcing the feedback loop (Joëls & Baram, 2009; Selye, 1956; Yao et al., 2018). In addition to the existing self-report measures, research has started to examine physiological responses to stress to measure burnout.

## Conceptualisation of Burnout

As the concept of burnout emerged from an observed practical social problem and not in the academic world, confusion occurs between the colloquial vernacular of the term burnout and a psychological definition (Maslach & Schaufeli, 2017). One of the initial reviews into burnout found more than 48 definitions (Perlman & Hartman, 1982). The definitional and conceptual fuzziness of burnout born from its observational research history can also lead to issues with measurement and distinctiveness.

### 2.5.1 State or Process

Much of the research defines burnout as a state of physical, mental and emotional exhaustion occurring after chronic workplace stress (Bährer-Kohler, 2013). It is also characterised as a state of emotional exhaustion, depersonlisation and reduce personal accomplishment and this is reflected in the self-report measures used in the majority of burnout research (Maslach & Jackson, 1981; Schaufeli & Buunk, 1996).

However, others argue that burnout is more than this extreme state and treat burnout as a process (Leiter, 2018). In the 1980s, views started to emerge of burnout as a process whereby workers disengage from work due to job stress (Cherniss, 1980). One model involves three phases, absorbing commitment, frustrated striving and depression (burnout) (Hallsten, 1993). The absorbing commitment process is one where the employee has their identity and self-image contingent on their work outcomes, their job is important to them and perceived to be important to others, they envisage that they can succeed, are entitled to rewards from their job and feel that should be able to lead a good life (Hallsten, 1993). If these expectations are not met, then they move onto the frustrated strivings (burning out) phase where they feel obstructed from their goals due to lack of personal resources or external obstacles resulting in feelings of powerlessness, withdrawal, hopelessness and emotional exhaustion (Hallsten, 1993). If the goals are reached but the rewards are less than expected, an employee can move onto success depression (burnout) and can result in a loss in meaning in life and self-esteem (Hallsten, 1993). Several models have been put forward to describe the burnout process. What these process models of burnout have in common is the genesis in stress resulting from the discrepancy between an individual's expectations with the reality of work life which gradually causes strain and leads to changes in worker's attitudes at work and an eventual state of exhaustion (Schaufeli & Buunk, 1996). This final state of exhaustion is the 'state' of burnout proposed by those advocating a state definition of burnout.

This thesis will examine and measure burnout as a state whilst acknowledging that the development of this state involves a process over time.

### 2.5.2 Distinctiveness of Burnout

The diversity of burnout definitions and symptoms have contributed to a confusion regarding the specificity and distinctiveness of burnout (Maslach & Schaufeli, 2017). Due to this, it is important to examine how burnout relates to and differs from job stress, depression and anxiety.

#### 2.5.2.1 Burnout and Job Stress

In comparing burnout to job stress, burnout is considered to be the result of prolonged job stress where the workplace demands are in excess of an individual's perceived resources (Maslach & Schaufeli, 2017). So while stress is the temporary adaptation process, burnout describes when this adaption process breaks down resulting in chronic malfunction (Brill, 1984). Thus, job stress and burnout cannot be distinguished from each other based on their symptoms but instead are distinguished by their time course (Maslach & Schaufeli, 2017).

It is proposed that the experience of stress contributes to burnout (Bährer-Kohler, 2013). In the context of occupational burnout, work stress is a psychological state resulting from an imbalance between work perceptions of workplace demands and coping abilities(Bährer-Kohler, 2013; Kolbell, 1995). When this is continuing and unmediated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress (Bährer-Kohler, 2013). Given that stress is dependent on both stressors and coping mechanisms, it is proposed that the context of burnout in the workplace, that it is impossible to totally preclude stress factors and thus burnout is less dependent on chronic work stress factors and more to do with an inability to cope (Bährer-Kohler, 2013).

In short, stress, and in particular, prolonged workplace stress, coupled with an inability to cope is proposed to lead to burnout.

#### 2.5.2.2 Burnout and Depression

In comparing burnout to depression, there are overlapping symptoms such as low energy, inability to concentrate, fatigue and sadness. However, burnout is conceptually separate from depression (Schaufeli & Buunk, 2003). Burnout tends to be more work specific whereas depression tends to be more widespread (Corrigan et al., 1994). However, given the questionable discriminant validity of measures of burnout with depression, some argue that burnout is actually a type of depression that comes from the process of burning out or put another way, the process of burning out is one road to depression (Hallsten, 1993). This aligns with findings that as burnout severity increase, so too does the probability of depression (Ahola et al., 2005). The distinction between burnout and depression has been subject to debate in the literature. Some propose that burnout and depression contain a considerable overlap in symptoms and are part of the same pathological realm (Bianchi et al., 2013). Both burnout and depression can result in the symptom of physical fatigue. Emotional exhaustion is similar to the fatigue and sadness of depression and overlapping symptoms include low energy, helplessness, lowered motivation and lack of control (Glass et al., 1993; Nyklíček & Pop, 2005).

Others maintain that the two conditions are different but related. Research has found that after controlling for work-related and demographic factors, current symptoms of depression were the strongest predict of all three characteristics of burnout (Glass et al., 1993). Factor analysis has shown that while there is an overlap, depression only accounts for 19% of the variance in emotional exhaustion (Glass et al., 1993). Depression has been found to be correlated with emotional exhaustion. However, due to the cross-sectional nature of previous studies, the exact nature of the relationship has not been determined (Nyklíček & Pop, 2005). Some suggest burnout may generalise to

other parts of life and may herald the onset of depression (Iacovides et al., 2003). However, others suggest that depression is associated with an increased risk of burnout (Iacovides et al., 2003; Nyklíček & Pop, 2005).

In summary, it is likely that there is considerable symptomatic overlap between the symptoms of depression and burnout, however, there is a lack of research regarding overlap in the mechanisms that may be common to both conditions.

#### 2.5.2.3 Burnout and Anxiety

In comparing burnout to anxiety, like depression, anxiety and burnout share common symptoms. The anxiety like symptoms include high blood pressure, increased heart rate, sexual problems, nervous tics, restlessness, light-headedness, nausea and headache (Melamed et al., 2006). Also, in common, are the links between emotional exhaustion. Diagnosis with an anxiety disorder correlated with reports of emotional exhaustion (Bährer-Kohler, 2013). This is suggested, intuitively, as being due to anxious states becoming emotionally draining (Turnipseed, 1998).

While many studies have found correlation between anxiety and burnout, and especially emotional exhaustion, and the more severe the anxiety symptoms the higher the level of burnout, there is some debate about the causal relationship between these two disorders (Seyed Valiollah et al., 2017). It is thought that those who are at risk of burnout have idealistic beliefs and overextend themselves in their efforts to achieve occupational standards and goals, and that when these are not realised, they suffer cognitive fatigue and emotional exhaustion leading to pessimism, lack of control, reduced coping mechanisms and, eventually, high levels of anxiety (Seyed Valiollah et al., 2017). On the other hand, it is argued that it is those with high anxiety that often set unrealistic goals and are often harsh on themselves after failure and because of this interaction between high level of trait anxiety and intense work situations produce a

state of anxiety which contributes to emotional exhaustion and burnout (Richardsen et al., 1992; Turnipseed, 1998). To support this perspective, trait anxiety has been found, more than anxiety state, to predict burnout and predicts 28% of the emotional exhaustion dimension of burnout (Queiros et al., 2016). In other words, trait anxiety increases susceptibility to burnout (Richardsen et al., 1992). It is also possible that both views are true and part of an anxiety burnout cycle.

Like with depression, burnout and anxiety have an overlap in symptoms and in their links with emotional exhaustion. This combined with the comorbidity of anxiety and depression can make distinguishing burnout from these two conditions difficult.

In summary, the history of observational research followed by self-report measures has led to issues of distinctiveness issues between burnout, stress, depression and anxiety. This thesis will treat burnout as a state of chronic occupational stress and will use both self-report and physiological measures of stress as well as burnout as outcome measures.

## Theories and Causes of Burnout

Although, burnout research has been going on for decades, the construct remains largely under-theorised (Maslach & Schaufeli, 2017). A history originating in primarily clinical and descriptive observational work followed by an empirical phase that largely relied on self-report measures as largely resulted in a lack of theoretically driven hypotheses. Unlike depression and anxiety, which are largely grounded in well-researched biopsychosocial models, burnout research has struggled to produce an integrative, theory-driven, model. Despite this, this section seeks to examine some of the major theoretical approaches to burnout that have been important for understanding the role and mechanisms associative with the cognitive components of burnout.

### 2.6.1 Conservation of Resources and Burnout

Conservation of Resources (COR) theory proposes that individuals will endeavour to attain and sustain resources; things they value such as objects, conditions such as employment, personal characteristics and energies such as knowledge and money (Hobfoll & Freedy, 1993). Following from this, stress occurs when resources are threatened, lost or where anticipated rewards are not obtained when investing resources (Hobfoll & Freedy, 1993).

COR theory proposes that employees are sensitive to workplace events that result in resource losses (Hobfoll & Freedy, 1993). Interpersonal conflicts resulting in interpersonal level losses are particularly relevant to burnout (Leiter & Maslach, 1988). Loss of resources does not have to involve singular and large losses but can also be caused by multiple smaller events which result in multiple and ongoing loss of resources (Leiter & Maslach, 1988). Individuals will invest resources in order to gain other resources such as investing time at work to gain status, job security, a reasonable lifestyle or a sense of accomplishment. However, when these goals are not achieved, the invested resources and the expected reward resources are both felt as losses. This is thought to be a significant factor in burnout as most people expect a return for their work, but these expectations are often not met (Hobfoll & Freedy, 1993). Promotions are not always awarded to those who expect them, special efforts are not always acknowledged and inflation can mean that the expected lifestyle is no longer achievable on a given wage (Hobfoll & Freedy, 1993).

This application of COR to burnout argues that ongoing depletion of resources in the workplace slowly results in exhaustion and feeling of a lack of personal accomplishment. It accounts for both acute workplace stressors and chronic strains. However, it does not provide specific practical guidance on how to protect or prevent

these resource losses. This is especially true for high-risk occupations where loss of resources is almost unavoidable. This thesis will examine some factors that contribute to this perceived lack of resources such as rumination and worry as well as interventions that may seek to restore or prevent the loss of these resources.

### 2.6.2 Demand-Control-Social Support Model

This model uses the concept of 'job strain' which is a combination of low control over workload and high job demands (Karasek, 1990). According to this model of job strain, the most stressful jobs are those with high demands where workers have a low level of control (Karasek, 1990; Pugliesi, 1999). Several job demands that are thought to contribute to high levels of work stress include the amount of travel, potential or lack thereof for growth, physical demands, working condition, hazards, public interaction, human-computer interaction, daylight exposure, shift work, ambient noise, competitive environment , risk of injury (self or other), severity of deadlines and public scrutiny (Bährer-Kohler, 2013; Wilkie, 2018). One job demand that is thought to have a particular impact on burnout is emotion work/labour which occurs when employees are required to display the appropriate emotion and accounts for additional variance in burnout above job stressors (Zapf et al., 2001). One aspect of emotion work called emotional dissonance, expressing emotions which are not genuinely felt in the situation, has been found to consistently correlate with emotional exhaustion (Zapf et al., 2001). Healthcare workers are often required to be caring and nurturing at all times, emergency responders are routinely placed in emotionally triggering situations with an inability to express their natural responses and emotion suppression is a common coping mechanism used by military members in combat to increase the likelihood of survival (Abraham, 2000; Arsenault, 2015; Bonanno, 2004; Zapf et al., 2001). Thus,

high risk occupations are often characterised by high job demands outside the control of employees.

However, like the COR model, it does not provide a clear mechanism that links high demands to burnout, nor does it provide a mechanism to reduce unavoidable demands or increase control.

While this model adds an often-overlooked dimension to burnout theory that possibly explains why burnout is found in idealistic professions such as healthcare and emergency services, it lacks empirical measurements that allow for causal testing. It also has not been integrated with the other stress research, nor does it explain burnout in 'non-idealistic' professions.

## Mindfulness-based Therapies and Burnout

### 2.7.1 Mindfulness-based Therapies

In recent years, there has been a dramatic increase in the interest in mindfulness in mental health (Siegel et al., 2009). One theory is that those who were spiritual seekers and meditated in the 1960s and 1970s are now senior researchers and practitioners and are sharing these techniques with their patients. Another is that the science is finally catching up with the practice, with meditation becoming one of the most widely researched psychotherapeutic methods (Walsh & Shapiro, 2006).

There are different levels of the incorporation of mindfulness into treatment. The first is when a therapist practices mindfulness which allows them to be more attentive, empathetic and compassionate with their patients (Siegel et al., 2009). The next level, termed mindfulness-informed psychotherapy, is when a therapist uses their knowledge of mindfulness to change how they approach their patients' issues (Germer, 2004; Siegel et al., 2009). Lastly, there are mindfulness-based therapies where

therapists teach mindfulness practices to patients (Brady et al., 2012; Germer, 2004; Siegel et al., 2009).

Mindfulness practices are the most reported intervention for burnout and has been found to offer improvements in levels of stress and burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). The next section reviews some of the most popular mindfulness-based interventions.

#### 2.7.1.1 Mindfulness Based Stress Reduction (MBSR)

MBSR is one of the most researched mindfulness-based therapies and started being used to treat people with distress and pain in those with chronic health problems from 1979 (Kabat-Zinn, 1990). It usually encompasses a 8-10 week program with 2.5 hour weekly sessions each covering different topics and exercises (Kabat-Zinn, 1990).These topics include different types of meditation practices, yoga poses and mindfulness techniques. As such, MBSR works through the use of several components and techniques (Kabat-Zinn, 1990).

#### 2.7.1.2 Mindfulness-Based Cognitive Therapy (MBCT)

MBCT was originally developed to treat depression and integrates MBSR with Cognitive Based Therapy (CBT) and cognitive science (Segal et al., 2002). MBCT is made up of eight 2-2.5 hour group sessions with each focusing of a different theme (Ferguson et al., 2021). Sessions contain several types of meditative practices including mindful eating, body scan, mindful stretching (yoga), walking meditation, sitting meditation with focused attention, sitting meditation with open monitoring, daily mindfulness, breathing space, brief mindfulness of seeing and/or hearing and 3-minute coping space (Ferguson et al., 2021). These sessions are deemed as essential to relapse prevention and helps to develop focused attention and a nonjudgemental attitude (Ferguson et al., 2021). Focused attention training helps to foster the ability to focus

attention on thoughts and feelings to create space between events and automatic responses, and nonjudgement helps people to observe thoughts and feelings without reacting (Ferguson et al., 2021). In summary, it is thought that MBCT improves attentional control and helps to replace habitual and automatic responses such as worry and rumination (Ferguson et al., 2021).

#### 2.7.1.3 Stress Management and Resilience Training (SMART)

The SMART program consists of two 90-minute group sessions (Loprinzi et al., 2011). The first involves a brief paced breathing meditation where participants are taught to practice deep diaphragmatic breathing once or twice a day while the second reinforced the first session and answered any questions (Loprinzi et al., 2011). It also provides education into the role of positive thoughts and beliefs, the importance of healthy eating, restorative sleep and physical activity (Benson Henry Institute).

### 2.7.2 Mindfulness and Burnout

Meditation has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). Neuroimaging research has found those who underwent a MBSR course had increased activation of the anterior cingulate cortex which detects distractions and activation of the insula which is commonly activated during interoceptive awareness tasks (Craig, 2003; Hölzel et al., 2011; van Veen & Carter, 2002). This increase in body awareness has been proposed to lead to greater emotional awareness and contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness (Garland et al., 2011; Hölzel et al., 2011). This is supported by studies finding that that mindfulness is associated with increased activation in the left and right pre-frontal cortex which are associated with reappraisal (Modinos et al., 2010). Additionally,

meditation, a specific form of mindfulness practice, has been associated with decreased heart rate, blood pressure, cortisol levels, breathing rate, skin conduction response and muscle tension (Carlson et al., 2007; Lazar et al., 2005; Pascoe et al., 2017; Zeidan et al., 2010).

While research into meditation has increased recently, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research. Specifically, methodological heterogeneity in meditation traditions and implementations surrounding the definition of meditation pose issues with the interpretation and integration of the research outcomes. To allow for a validated approach to the examination of meditation, a clear definition is required. To ensure the ability to generalise, interpret and integrate results specific attention will be paid to the definition of the meditation intervention used, the delivery of the intervention and the measures used in assessing the intervention.

### 2.7.3 Definitional Issues in Mindfulness and Meditation Research

#### 2.7.3.1 Mindfulness versus Meditation

This first definitional issue surrounds the use of the terms ‘mindfulness’ and ‘meditation’ which are often used interchangeably, conflating results. While mindfulness is the overarching concept covering the practice of meditation and meditation is often included in mindfulness training, they are not interchangeable (Aiken et al., 2004; Lutz et al., 2015; Verhaeghen, 2017). Mindfulness is an umbrella term which encompasses being psychologically present in any situation and includes many different practices in many different contexts (Joëls & Baram, 2009; Kabat-Zinn, 1990; Van Dam et al., 2018). On the other hand, meditation denotes a specific set of practice where one is mindful in that practice.

Another way to think about this distinction is that there are many ways to foster mindfulness, and meditation is one of them. As is the case with other skills, such as physical activity, improving mindfulness can happen at various levels of intensity. If one wanted to improve their physical fitness, they could start by doing 'non exercise related physical activity' such as parking further away or using the stairs (Siegel et al., 2009). Likewise, mindfulness can be fostered by being more aware and non-judgemental during everyday activities such as eating, drinking and walking (Siegel et al., 2009). Formal meditation is similar to going to the gym and doing formal exercise (Siegel et al., 2009).

#### 2.7.3.2 State, Trait or Process

The second definition issue impinges upon whether meditation is taken as a state, a trait or a procedure/process. Several studies have examined meditation as a state of mind that is produced by practicing meditation and these studies often focus on what happens to the mind once a 'state of meditation' has been achieved (Davidson & Kaszniak, 2015). In addition to these, other studies examine the long-term effects of meditation, examining meditation as a 'trait' (Davidson & Kaszniak, 2015). Lastly, meditation has been examined as a process where a participant 'does' meditation and the effects of this process are measured (Davidson & Kaszniak, 2015).

#### 2.7.3.3 Focused or Open

Looking at meditation specifically, there are broadly two very different types of meditation, focused and open. Focused meditation, also known as concentration meditation, involves practicing the deliberate directing and focusing of attention on a particular element which could be a sensation, sound, word, phrase, object or mental image or breathe (Davidson & Kaszniak, 2015; Lutz et al., 2008). It involves noticing distractions such as thoughts and shifting the attention back to the object of focus

(Davidson & Kaszniak, 2015). Open meditation, conversely, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015).

#### 2.7.3.4 Focused Meditation as a Test-Case Intervention

Give the importance of using a homogenous and measurable intervention to examine the prevention of burnout, this thesis will use the process of focused meditation as a test-case intervention. This is an objectively measurable and homogenous intervention that can be used and replicated in the study designs. In addition, it can be used to examine the theoretically predicted mechanism involved in burnout.

### 2.7.4 Mechanisms

To address the largely atheoretical nature of burnout research, this thesis will examine some of the mechanisms involved in burnout and use focused meditation as a test-case intervention to target these mechanisms.

#### 2.7.4.1 Perseverative Cognition (PC) – Rumination and Worry

One mechanism behind burnout is thought to be through the reduction of perseverative cognition which includes rumination and worry. Rumination involves repeatedly thinking about information from the past that is negative and is comprised of two components; reflective pondering and brooding (Nolen-Hoeksema et al., 2008; Treynor et al., 2003). Response Style theory proposes that rumination, in particular brooding, promotes and prolongs distress by preventing instrumental behaviour and interfering with problem solving so individuals become fixated on their feelings and problems without acting to improve their mood (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Rumination also prevents the use of distracting activities which would otherwise reduce their distress (Nolen-Hoeksema, 1991). Lastly rumination can result in a depressed mood which further focuses an individual on negative thoughts

and emotions resulting in greater distress (Nolen-Hoeksema, 1991). Thus, ruminating can prolong the stress response resulting in chronic stress and burnout.

Worry also involves repetitive negative thoughts which are instead focused on the future and used to anticipate and avoid danger (Capobianco et al., 2018). It has been found those who have less tolerance for uncertainty, tend to worry more and, additionally, people often use worry as a way regain a sense of control (Freeston et al., 1994). Given that burnout is often associated with a perceived lack of control, it is possible that worry is associated with burnout, too (Bährer-Kohler, 2013). The Reflexive Adaptation Process (RAP) proposes that worry prolongs stress by focusing attention toward threat-related stimuli, depleting the cognitive resources required for the flexible control needed to return cognition to its original threat-free state (Roussis & Wells, 2008). Thus, worry and lack of control in the workplace can lead to increased worry resulting in prolonged stress and burnout.

When taken together, worry and rumination are thought to contribute to a prolonged stress response. The preservative cognition hypothesis proposes that preservative cognition results in a state of moderate, chronic levels of stress including chronic activation of the immune, hypothalamic pituitary adrenal and cardiovascular systems (Brosschot et al., 2006). Additionally, as resources are taken up by worry and rumination, COR predicts that this will deplete resources leading to increased stress and burnout in addition to poor work performance (Hobfoll & Freedy, 1993).

Some studies have found the meditation can help alleviate stress and burnout through the reduction of rumination. One systematic review found that rumination mediated the relationship between mindful-based interventions and stress, anxiety, depression and global psychopathological symptoms (Gu et al., 2016). Specifically, when compared to relaxation therapy, mindfulness meditation's ability to reduce

distress was found to be mediated by reductions in rumination (Hsu et al., 2015; Jain et al., 2007; Willis & Burnett, 2016). Hence, reducing rumination may free resources required for problem solving and instrumental behaviour whilst also allowing for distracting activities which reduce distress and burnout symptoms.

#### 2.7.4.2 Attentional Control

It has been proposed percerative cognition also reduces attentional control. Attentional control refers both the ability to maintain attention on particular entity well as the ability to return attention to that object after a distraction (Hölzel et al., 2011). One model of attention comprises three networks, alerting, orienting and executive control (Posner & Petersen, 1990). The initial capture and sustainment of attention is conducted by the alerting system while the orienting system anticipates the direction of a specific stimulus (Posner & Petersen, 1990). The attentional control theory of anxiety (ACT), proposes that worry disrupts the balance between the "bottom-up" (stimulus-driven) attentional system and the "top-down" (goal-directed) attentional system resulting in the exhaustion of cognitive capacity leading to reduced cognitive efficiency and performance (Eysenck et al., 2007; Fox et al., 2015). Others believe that it is a deficit in attentional control that causes worry and rumination as reduced attentional control leads to a decreased ability to block or disengage from negative, non-task-oriented thoughts (Joormann et al., 2007). The impaired disengagement hypothesis proposes that those who have an impaired ability to exert attentional control are unable to disengage from negative thoughts and feelings are more likely to endure ongoing rumination (Daches et al., 2010; DeJong et al., 2019). It is likely that both pathways are present and that rumination and worry deplete the resources necessary for good attentional control whilst reduced attentional control leads to longer periods of worry and rumination (Koster et al., 2011).

On the other hand, focused meditation is thought to improve attentional control and that improved attentional control is the result of training of meditation skills (Lutz et al., 2008). This relationship has been supported by various studies showing improvements in cognitive tests measuring executive attention in those who meditate (Hölzel et al., 2011; Lutz et al., 2015). In a randomised controlled trial, those who did meditation showed improvements in cognitive tests of attention switching, orienting and executive attention (Vieth & Von Stockhausen, 2022). Neurological findings also suggest that meditation produces enduring brain function changes with neuroimaging studies finding that experienced meditators demonstrate greater activation in the anterior cingulate cortex (ACC) (Hölzel et al., 2011; Slagter et al., 2007). Thus, as focused meditation encourages the practice of sustaining attention and returning from distractions, it is thought to strengthen the attentional control networks responsible for these tasks.

#### 2.7.4.3 Emotion Regulation

Another way in which meditation is proposed to help reduce or prevent burnout is through emotional regulation. In this context, emotion regulation involves using regulatory processes to create new or alter ongoing emotional responses and includes breaking negative viscous cycles and coping with depression, anxiety and stress (Esch et al., 2013; Ochsner & Gross, 2005). Researchers have examined possible beneficial effects on emotion regulation from meditation using self-report, physiological and neuroimaging studies (Hölzel et al., 2011). Another study found novices who did a 7-week mindfulness training program had a reduction in emotional interference and showed a reduced reaction to unpleasant stimuli measured by self-report and skin conductance tests (Ortner et al., 2007). From a neurological perceptive, it has been found that after a mindfulness-based stress reduction course, there was increased

activity in parts of the brain associated with inhibitory control, the ventrolateral pre-frontal cortex (PFC) and a decrease in the amygdala response (Goldin & Gross, 2010; Ortner et al., 2007).

While these studies have shown improvements in emotion regulation, there have been several proposed mechanisms on how this occurs. The first mechanism, cognitive control, includes attention control and cognitive change (Yaroslavsky et al., 2019). As described, meditation has been found to increase regulation and, in the context of emotion regulation, research is examining how decreasing attention on negative stimuli affects emotional appraisal (Ochsner & Gross, 2005). This type of emotion suppression has been associated with late frontal engagement and increased amygdala and insula responses (Ochsner & Gross, 2005). While attention control research seems to focus on averting attention from a negative emotion, cognitive change or reappraisal involves changing an emotional response by reinterpreting the stimulus (Hölzel et al., 2011). Garland et al., (2011) found positive reappraisal, the process of reconstruing stressful events as benign, meaningful or beneficial, mediates the improvement of stress from meditation (Garland et al., 2011). This type of reappraisal has been associated with early frontal engagement, dorsomedial prefrontal cortex and dorsolateral prefrontal cortex, and reduced amygdala/insula responses (Modinos et al., 2010; Ochsner & Gross, 2005).

## Conclusion

In summary, burnout is a condition that affects individuals, organisations and society at large. These impacts spawned research starting with practical observations in the workplace before moving onto empirical research that is heavily reliant on self-report measures. Despite several decades of research, this reliance on observation and self-report symptom-based measures has meant burnout research is still plagued by

conceptual and definitional fuzziness including the state/process debate and an issue of distinctiveness. It has also meant that theories surrounding the mechanisms are incomplete and segmented.

In parallel, the field of research into mindfulness and meditation has gained traction as a possible treatment for burnout. However, this has also been plagued with definitional and measurement issues. Additionally, the most common mindfulness-based interventions are heterogeneous in nature and bundle several different types of mindfulness training into single programs.

To better understand the extent of these issues, a systematic review was conducted in the next chapter in attempt to better understand the field and the limitations in the current literature. This review provides the necessary understanding and foundation for the studies that follow.

Chapter 3: The effectiveness of meditation in preventing burnout in high-risk occupations: A systematic review (Study 1)

**Statement of Authorship**

# Statement of Authorship

| | |
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| Title of Paper | The effectiveness of meditation in preventing burnout in high-risk occupations: A systematic review |
| Publication Status | ☐ Published ☐ Accepted for Publication<br>☒ Submitted for Publication ☐ Unpublished and Unsubmitted w ork w ritten in manuscript style |
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| Name of Principal Author (Candidate) | Peter Chu |
| Contribution to the Paper | Conceptual development<br>Title and Abstract Screening<br>Full Text Screening<br>Data Extraction / Analysis<br>Critical Appraisal<br>Writing Report |
| Overall percentage (%) | 85% |
| Certification: | This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper. |
| Signature | Date: 24 Sep 25 |

## Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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| Signature | Date: 25/09/2025 |

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## Rationale for Study

With an initial literature review conducted, a systematic review was done to examine the research into burnout and meditation and analyse the effectiveness of mindfulness interventions. The study was focused on high-risk occupations including emergency services workers, military personnel, corporate executives and healthcare workers and examined both self-report and biophysiological measures of stress and burnout. The aim was to gain an understanding of the current literature to inform future research.

## Introduction

The prevalence of burnout has increased across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). With the events of the SARS-CoV-2 pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health. One systematic review found the pandemic had degraded the mental health of healthcare workers with levels of occupational burnout ranging from 3.1% - 44.7%, while another found this ranged between 26% and 31% (Sanghera et al., 2020; Serrano-Ripoll et al., 2020). A study on nurses, suggests that, working with COVID-19 patients seemed to correlate with higher scores in depersonalisation and emotional exhaustion (Chen et al., 2021). It is thought that negative emotions in colleagues, family members and patients can trigger similar emotions in nurses affecting their perceived stress levels and increasing vulnerability to emotional exhaustion (Joshi & Sharma, 2020). The prevalence of burnout has been increasing, and the recent pandemic has made this worse.

Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions (Naczenski et al., 2017; Shirom & Melamed, 2006). While the International Classification of Diseases (ICD) has not categorised burnout as an independent disease, it is framed as a state of physical and mental exhaustion (Kronner). In the updated ICD-11, it is characterised as an occupational phenonmenon and not a medical condition (World Health Organization, 2019). Burnout has been linked to reduced quality of sleep and life satisfaction, depressive symptoms, hypertension, and anxiety (Gerber et al., 2016; Maslach et al., 2001; Schonfeld & Bianchi, 2016; Schulz et al., 2011). It has been linked to increased cortisol levels, elevated blood pressure and inflammation markers as well as increased cardiovascular risk factors such as total cholesterol, low-density lipoprotein cholesterol, fasting glucose, and triglyceride levels (Bhatia & Tandon, 2005; Gerber et al., 2016; Grossi et al., 2005; Kivimäki et al., 2013; Landsbergis et al., 2013; Melamed et al., 2006; Melamed et al., 1999). Burnout has psychological and physical impacts which can significantly affect individual health.

Additionally, burnout decreases work performance and affects employers through increased absenteeism and employee turnover (Formanoy et al., 2016; Kuruüzüm et al., 2008). The cognitive weariness that characterises burnout, has been found to reduce executive function performance, while emotional exhaustion results in reduced empathy and an inability to invest in workplace relationships (Beck et al., 2013; Melamed et al., 2006). Burnout in medical professionals has also been associated with an increase in errors, low patient satisfaction and reduced empathy (Aiken et al., 2004; Argentero et al., 2008; Poghosyan et al., 2010; Shanafelt et al., 2002; Tei et al., 2014; West et al., 2010; Williams et al., 2007). In terms of absenteeism, it is estimated that 272 billion Euro was lost due to absenteeism due to depression and an estimated 5

million lost days due to stress (Matrix, 2013; Milczarek et al., 2009). A survey found that half of the respondents were considering leaving their job, with 24% leaving within the next decade (Kamal et al., 2020). On a societal level, the European Agency for Safety and Health at Work estimated the cost of burnout at over 600 billion Euros (Hassard et al., 2014). The impact to individual health of burnout coupled with the workplace and societal impacts has led to an increase of research into the condition.

### 3.3.1 Job Features That Cause Burnout

Initial research into burnout has been primarily focused on human services, including healthcare and this continues to be the primary focus (Maslach et al., 2001). While initially, it was thought that the key issues were the emotional challenges of working with people in a caregiving role, subsequent research found that common job-related stressors were more highly correlated with burnout than human interaction stressors (Maslach et al., 2001). As such, burnout is now thought to be the result of continued exposure to work stress (Kumar & Mellsop, 2013). Many suggest the experience of stress contributes to burnout. In line with the Conservation of Resources theory (COR), psychological stress occurs when resources are threatened, lost, or invested without an anticipated return on investment (Hobfoll & Freedy, 1993). In the context of occupational burnout, work stress is a psychological state resulting from an imbalance between work perceptions of workplace demands and coping abilities (Hobfoll & Freedy, 1993). When this is continuing and un-mitigated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress.

Early examinations of work stress tended to focus on the cognitive and physical demands of work (Sauter & Murphy, 1995). According to the Demand-Control model of job strain, the most stressful jobs are those with high demands where workers have a

low level of control (Karasek, 1990; Pugliesi, 1999). Recent surveys have found several job demands that are thought to contribute to high levels of work stress including the amount of travel, potential or lack thereof for growth, physical demands, working condition, hazards, public interaction, human-computer interaction, daylight exposure, shift work, ambient noise, competitive environment , risk of injury (self or other), severity of deadlines and public scrutiny (Bährer-Kohler, 2013; Wilkie, 2018). When viewed using the COR theoretical framework, many of these factors can be viewed as threatening or depleting resources (Hobfoll & Freedy, 1993). Healthcare workers, military personnel, emergency services workers and corporate executives are exposed to many of these demands with little control over them. Healthcare workers are often subject to physical demands, public interaction and scrutiny and risk of injury to themselves and others. Military personnel, firefighters and police officers have been rated in the top 5 most stressful occupations and expose workers to risk of injury (self and others), public interaction and public scrutiny, physical demands, shift work, high ambient noise and include competition for promotion which can cause competition and issues with potential growth (Satter, 2017). Corporate executives are also placed in the top 10 most stressful occupations and are subject to substantial amounts of travel, growth issues, and public interaction and scrutiny (Satter, 2017). While research into burnout initially focused on healthcare workers, there are other high-stress occupations that have similar characteristics and demands that may lead to burnout.

One job demand that is thought to have a particular impact on burnout is emotion work/labour. Emotion work/labour occurs when employees are required to display the appropriate emotion and accounts for additional variance in burnout above job stressors (Zapf et al., 2001). While emotion work originated in service-oriented industries, the concept has been expanded to include other roles (Iszatt-White, 2013). In

healthcare, workers are required to display care and empathy toward patients and clients (Abraham, 2000). Whilst, the military encourages emotion management in preparation for the realities of war (Godfrey & Brewis, 2018). One aspect of emotion work called emotional dissonance, expressing emotions which are not genuinely felt in the situation, has been found to consistently correlate with emotional exhaustion (Zapf et al., 2001). Healthcare workers are often required to be caring and nurturing even when they do not feel so inclined (Abraham, 2000). Emergency responders are routinely placed in emotionally triggering situations with an inability to express their natural responses which can create emotional dissonance (Arsenault, 2015). Emotion suppression is also a common coping mechanism used by military members in combat to increase team effectiveness and the likelihood of survival (Bonanno, 2004; Zapf et al., 2001). Due to the job requirements to present a calm and professional manner in high stress situations, healthcare workers, emergency responders and military personnel often experience emotion work/labour. Despite this, most of the research has been aimed solely at healthcare workers and this systematic review seeks to expand this to other high-risk occupations.

### 3.3.2 The Measurement of Burnout

Another issue with the current research concerns the measurement of burnout. Some argue that self-report scales may be the most valid measure of burnout (Alarcon et al., 2009). There are several inventories established looking at burnout and the most used is the Maslach Burnout Inventory (MBI) which is a 22-item inventory using a five-point rating scale on three dimensions including emotional exhaustion, depersonalisation, and personal accomplishment (Bährer-Kohler, 2013). Studies have found the inventory has a high internal consistency for each factor and results of confirmatory factor analyses have supported the three-factor model (Kitaoka-

Higashiguchi et al., 2004). Additionally, external validity has been examined through comparison with work characteristics such as job demands and decision authority (Kitaoka-Higashiguchi et al., 2004; Taris et al., 1999). The Shirom-Melamed Burnout Measure (SMBM) is similar but is based on the COR framework and instead uses the dimensions of physical fatigue, emotional exhaustion and cognitive weariness and has demonstrated validity and reliability in several studies (Shirom & Melamed, 2006). Another inventory that has been used is the Bergen Burnout Inventory (BBI) which uses a three-factor structure including an emotional, cognitive, and behavioural aspect shown to have validity in longitudinal studies including group and time invariance (Feldt et al., 2014; Salmela-Aro et al., 2011). Lastly, the Copenhagen Burnout Inventory consists of three scales measuring client-related burnout, work-related burnout and personal burnout (Kristensen et al., 2005). Additionally, as many propose that burnout is the result of prolonged work stress, self-report measures of stress may also be useful in examining burnout such as the Stress Reactivity Scale (SRS) and Perceived Stress Scale (PSS). Thus, most of the research has focused on using self-report inventories to measure burnout.

However, more recently, research has looked at physiological measures of burnout which focus on the body's neurophysiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS

activation due to stress (Bährer-Kohler, 2013). These include increased heart rate, decreased heart rate variability and increased blood pressure (Melamed et al., 2006). Following this initial release, the hypothalamus also activates the HPA system which triggers the release of cortisol (Harvard Medical School, 2020; Melamed et al., 2006). Studies have found work-related stress is associated with increased cortisol response to waking and throughout the day (Lundberg & Hellström, 2002; Melamed et al., 1999). Those suffering burnout have been found to have reduced hippocampal neurogenesis leading to disturbed hippocampal regulation of the HPA axis and chronic stress can lead to persistent epinephrine surges and elevated cortisol levels due to the body's cortisol receptors which remove circulating cortisol being 'turned down' through cellular changes in the hippocampus. Thus, studies have found that those affected by burnout have reduced serotonergic or dopaminergic function (Eriksson & Wallin, 2004; Harvard Medical School, 2020). Stress, including chronic stress, has also been found to affect several neurochemicals including serotonin, and the catecholamines noradrenaline, and dopamine that the HPA system releases to activate the amygdala to trigger an emotional response to the stressful event. The neuropeptide S is also released, a protein that modulates stress by increasing alertness, decreasing sleep, and generating a sense of urgency and anxiety in the individual, raising glucocorticoid levels (cortisol) and reinforcing the feedback loop (Joëls & Baram, 2009; Selye, 1956; Yao et al., 2018). In addition to the existing self-report measures, research has started to examine such neurophysiological responses to stress to measure burnout.

### 3.3.3 Prevention and Treatment of Burnout

While a lack of recognition and awareness of burnout can limit the uptake of interventions, with the increasing prevalence of burnout, research has begun to look at treatment.(Adnan et al., 2022) Mindfulness practices are the most reported intervention

for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). Mindfulness practice has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). Neuroimaging research has found those who underwent a mindfulness-based stress reduction course had increased activation of the anterior cingulate cortex which detects distractions and activation of insula which is commonly activated during interoceptive awareness tasks (Craig, 2003; Hölzel et al., 2011; van Veen & Carter, 2002). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events(Garland et al., 2011; Hölzel et al., 2011). This is supported by findings that mindfulness is linked with increased activation in the left and right pre-frontal cortex which are associated with reappraisal (Modinos et al., 2010). Additionally, meditation, a specific form of mindfulness practice, has been associated with decreased heart rate, blood pressure, cortisol levels, breathing rate, skin conduction response and muscle tension (Carlson et al., 2007; Lazar et al., 2005; Pascoe et al., 2017; Zeidan et al., 2010).

While research into meditation has increased, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research. Specifically, methodological heterogeneity in meditation traditions and implementations

pose issues with the interpretation and integration of the research outcomes (Davidson & Kaszniak, 2015). To allow for a validated approach to the examination of meditation, a clear definition is required (Przyrembel & Singer, 2018). To ensure the ability to generalise, interpret and integrate results in this systematic review, specific attention will be paid to the definition of the meditation intervention used, the delivery of the intervention and the measures used in assessing the intervention.

### 3.3.4 Defining Mindfulness Meditation Interventions

This first definitional issue surrounds the use of the terms ‘mindfulness’ and ‘meditation.’ While many articles use these terms interchangeably this can conflate the results and affect the generalisability of these studies. While mindfulness subsumes the practice of meditation and meditation is often included in mindfulness training, they are not the same thing (Aiken et al., 2004; Lutz et al., 2015; Verhaeghen, 2017). Mindfulness is an umbrella term which encompasses being psychologically present in any situation (Van Dam et al., 2018). It is not a unitary construct and includes many different practices in many different contexts (Joëls & Baram, 2009; Kabat-Zinn, 1990). On the other hand, meditation denotes a specific set of practices where one is mindful in that practice. For this systematic review, interventions that include meditation practices will be included, with the preference for those focusing solely of meditation.

The second definitional issue impinges upon whether meditation is taken as a state, a trait, or a procedure/process. Several studies have examined meditation as a state of mind that is produced by practicing meditation. In doing so, these studies often focus on what happens to the mind once a ‘state of meditation’ has been achieved (Davidson & Kaszniak, 2015). In addition to these, other studies have gone a step further to examine the long-term effects of meditation, examining meditation as a ‘trait’. These studies often involve comparing an experienced meditator with a novice to

examine long-term changes (Davidson & Kaszniak, 2015). Lastly, meditation has been examined as a procedure where a participant ‘does’ meditation and the effects of this procedure are measured (Davidson & Kaszniak, 2015). As the use of meditation as a 'state' or 'trait' requires the use of an arbitrary standard for when someone is in a meditation ‘state’ or ‘trait’, this systematic review will focus on research using meditation as a procedure/process undertaken by participants.

Broadly, there are two quite distinct types of meditation, focused and open. Focused meditation involves practicing the deliberate directing and focusing of attention on a particular element (Lutz et al., 2015). This element can be the breath, sensation, sound, mental image, word, phrase, or object (Davidson & Kaszniak, 2015). Focused meditation also involves noticing distractions such as thoughts and shifting the attention back to the object of focus (Davidson & Kaszniak, 2015). Open meditation, on the other hand, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015). As the substantial proportion of the literature examines focused meditation and the impact of this on attentional regulation and emotion regulation, this systematic review will focus on studies examining focused meditation as an intervention.

### 3.3.5 Previous Reviews

A preliminary search of PubMed, PEDro, PsycINFO, the Cochrane Database of Systematic Reviews and the JBI (Johanna Briggs Institute) Database of Systematic Reviews and Implementation Reports was conducted (May 2020). These have focused primarily on burnout in healthcare workers. In contrast, this study will include workers in other high stress occupations including military personnel, emergency services workers and corporate executives. While there is no single definition of meditation agreed upon in the research, to assess the effectiveness of meditation in preventing

burnout, this systematic review will only include research examining focused meditation practices examined as a procedure and exclude wider studies on mindfulness, open meditation and meditation as a state or trait. It will assess effectiveness by examining both self-report measures of burnout and stress including the Maslach Burnout Inventory, Shirom-Melamed Burnout Inventory, Bergen Burnout Inventory, Perceived Stress Scale and Stress Reactivity Scale. Additionally physiological measures including neuroimaging and the effect on the SAM and HPA axes including heart rate, blood pressure, levels of cortisol, noradrenaline, serotonin, and dopamine will be included.

Given the extensive negative effects of burnout on the physiological and psychological health of individuals, workplace performance and society, employers are increasingly starting to invest in employee wellness programs, including the use of meditation (King et al., 2019). Thus, a review of the effectiveness of mindfulness in the prevention of burnout in those who are exposed to high-stress environments will aid in ensuring these programs are evidenced and implemented in line with the best outcomes.

### 3.3.6 Review question(s)

What is the effectiveness of meditation procedures in preventing burnout in high-risk populations?

### 3.3.7 Keywords

Meditation; Mindfulness; Prevention and Control; Stress, Psychological; Emergency Responders

### 3.3.8 Inclusion criteria

#### 3.3.8.1 Participants

The review considered studies that included emergency services workers / first responders, military personnel, health care workers and those working in corporate management.

#### 3.3.8.2 Intervention(s)

While there is no single definition of meditation agreed upon in the research, this systematic review sought to only include research examining focused meditation practices examined as a procedure and exclude wider studies on mindfulness, open meditation and meditation as a state or trait. It also sought to include interventions where meditation was used in conjunction with other aspects of mindfulness such as mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR).

#### 3.3.8.3 Comparator(s)

This review considered all studies that compared meditation to groups who did not participate in a meditation program as well as pre-post, single arm study designs.

#### 3.3.8.4 Outcomes

This review considered studies that included psychological and physiological measures of burnout. Psychological outcomes were the Maslach Burnout Inventory (MBI), Shirom-Melamed Burnout Measure (SMBM), Health and Safety Executive (HSE), Bergen Burnout Indicator (BBI), Stress Reactivity Scale (SRS) and Perceived Stress Scale (PSS). Physiological outcomes were heart rate, cortisol levels, heart rate variability, blood pressure, stress reactivity, activation of the hypothalamic-pituitary adrenal axis (HPA) and levels of neurotransmitters (dopamine, serotonin, oxytocin, and vasopressin).

#### 3.3.8.5 Types of studies

The review considered both experimental and quasi-experimental study designs including randomised controlled trials, non-randomised controlled trials, pre-post intervention studies and interrupted time-series studies. In addition, analytical observational studies including prospective and retrospective cohort studies, case-control studies and analytical cross-sectional studies included, as well as descriptive observational study designs including case series, individual case reports and descriptive cross-sectional studies. Studies published in English from 2010 onward were included due to the recent developments in physiological measurement techniques.

## Method

The systematic review was conducted in accordance with the Joanna Briggs Institute methodology for systematic reviews of effectiveness evidence (Tufanaru et al., 2017).

### 3.4.1 Search strategy

The search strategy aimed to locate both published and unpublished studies. An initial limited search of PsycINFO, PubMed and CINAHL was undertaken in May 2020 to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy for PsycINFO, PubMed and CINAHL (see Appendix 1). The search strategy, including all identified keywords and index terms, was adapted for each included information source. The reference list of all studies selected for critical appraisal were screened for additional studies.

### 3.4.2 Study selection

Following the search, all identified citations were collated and uploaded into Covidence systematic review software ($N = 529$) and duplicates removed ($N = 94$) (Innovation). Titles and abstracts were then screened by two reviewers. Potentially relevant studies were retrieved in full, and their citation details imported into the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI) (Munn et al., 2019). The full text of selected citations were assessed in detail against the inclusion criteria by two independent reviewers. The reasons for exclusion of full text studies that did not meet the inclusion criteria were recorded and are reported in the Appendix II below . Any disagreements that arose between the reviewers at each stage of the study selection process were resolved through discussion, or with a third reviewer. The results of the search are reported and presented in a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram below (Figure 1) (Moher et al., 2009).

### 3.4.3 Assessment of methodological quality

Eligible studies were critically appraised by two independent reviewers at the outcome level for methodological quality in the review using standardised critical appraisal instruments from the Joanna Briggs Institute for experimental and quasi-experimental studies (Tufanaru et al., 2020). Authors of papers were contacted to request missing or additional data for clarification, where required. Any disagreements in the rating of methodological quality were resolved by a third reviewer. All studies, regardless of the results of their methodological quality, underwent data extraction and synthesis (where possible). Methodological quality was assessed using the appropriate JBI Critical Appraisal Checklist for the type of study (Tufanaru et al., 2017).

### 3.4.4 Data extraction

Data were extracted from studies included in the review by two independent reviewers using the standardised data extraction tool.

This included specific details about the populations, study methods, interventions, and outcomes of significance to the review objective. Any disagreements between the reviewers were resolved through discussion, or with a third reviewer. Authors of papers were contacted to request missing or additional data, where required.

### 3.4.5 Data synthesis

Studies were pooled in a statistical meta-analysis in RStudio version 2024.4.1.748 (Posit, 2024), using multi-level modelling to account for grouping and population differences. Effect sizes are expressed as either odds ratios (for dichotomous data) or weighted (or standardised) final post-intervention mean differences (for continuous data) and their 95% confidence intervals calculated for analysis. Heterogeneity was assessed statistically using the standard chi squared and I squared tests. Statistical analyses were performed using random effects models (Tufanaru et al., 2015). Where statistical pooling was not possible, the findings are presented in narrative form including tables and figures to aid in data presentation where appropriate. A funnel plot was generated to assess publication bias if there are 10 or more studies included in a meta-analysis. Statistical tests for funnel plot asymmetry (Egger test, Begg test, Harbord test) were performed where appropriate.

## Results

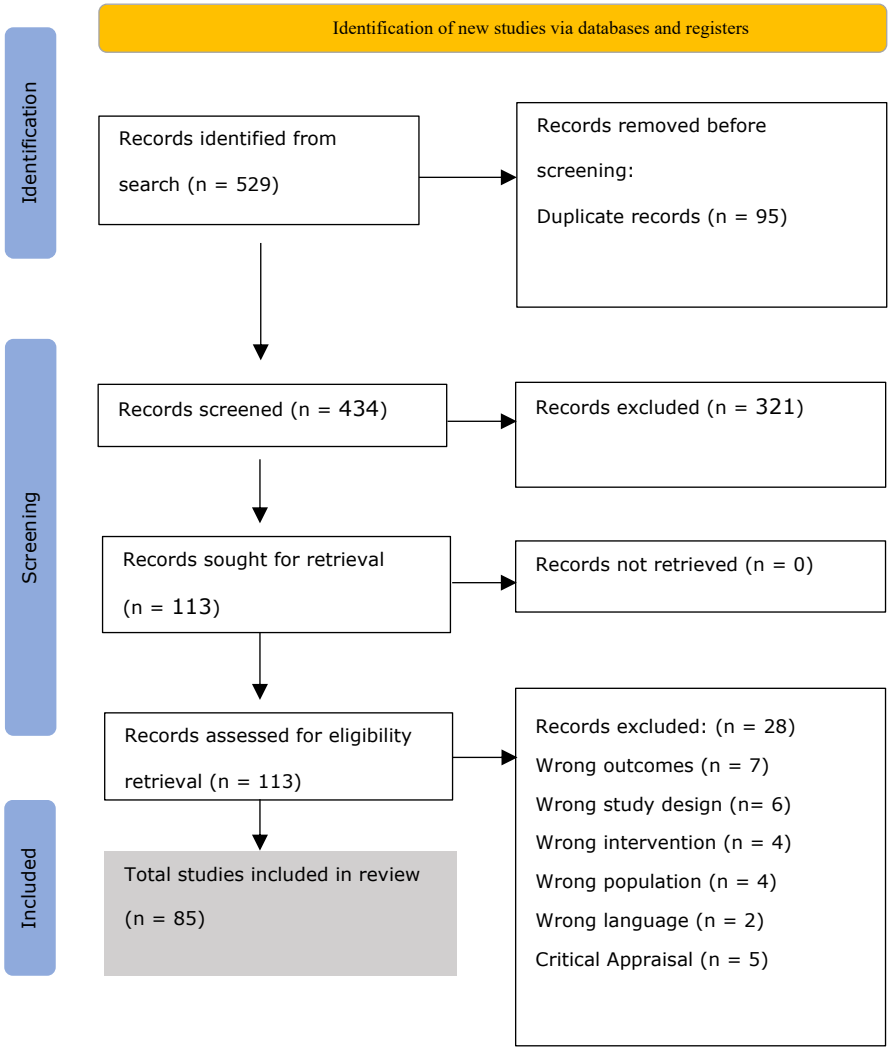
### 3.5.1 Study inclusion

A total of 529 articles were identified in the search of which 95 were deemed duplicate articles and removed. The remaining 434 articles were screened using title and abstract and 321 were excluded leaving 113 articles for full text review. After the

full text review, 23 articles were excluded (4 for wrong population, 4 for wrong intervention, 6 for wrong study design, 7 for wrong outcome measures and 2 for wrong language). Five were removed during the critical appraisal. The remaining 85 articles were selected for systematic review (Figure 1).

**Figure 1**

*PRISMA Flow Diagram*




### 3.5.2 Methodological quality

A critical appraisal was conducted on the 90 studies using the JBI Critical Appraisal Checklist appropriate to their study design and the overarching methodological quality was moderate to high. In total, five studies were excluded due to either inappropriate statistical analyses or inappropriate study design.

Thirty-three of the studies were RCTs of generally moderate to high methodological quality with the majority meeting the criteria for valid and reliable

outcome measurement and appropriate statistical analyses. However, allocation concealment was unclear in many of the studies and it was only made clear in 21 studies (64%) if the groups were similar at baseline. Additionally, only six RCTs (18%) reported blinding participants and just one (3%) reported blinding those delivering the intervention. However, with meditation-based interventions, it is not always feasible to blind participants or providers due to the active nature of the intervention. Lastly, one study was excluded as the trial design used was not appropriate.

There was only one cohort study but it was of high methodological quality (Chaukos et al., 2018). The main limitation was in identifying and controlling for potential confounding factors which is a known limitation for this type of observational design. Despite this, its inclusion was supported by a clearly defined population, valid outcome measures and appropriate statistical analyses.

The majority of the studies were quasi-experimental studies with 54 appraised as having moderate methodological quality. Overall, these studies provided a clear temporal direction between intervention and outcome (100% compliance), had consistent and reliable outcome measurement (96% and 98% compliance) and used appropriate statistical analysis (89% compliance). However, only 10 studies (19%) included a control group. Additionally, four were excluded due to inappropriate statistical analyses.

Lastly, two cross-sectional studies were included with both being of moderate methodological quality with both providing good outcome measures and statistical analyses but being limited in identifying and controlling confounding factors.

### 3.5.3 Review findings

The results of the articles included in this systematic review will be discussed with a focus on the population group of interest they examined, the intervention

implemented and the stress or burnout outcome measures used to assess the efficacy of the intervention.

#### 3.5.3.1 Population Group of Interest

Of the 85 studies included for analysis, one examined corporate executives, five examined emergency services personnel (specifically law enforcement officers), eight examined military personnel while, the vast majority examined healthcare workers.

#### 3.5.3.2 Intervention

Seventy of the studies used interventions that combined a number of different techniques into one, while thirteen used a single intervention form and two did not specify. Several mind-body interventions were used with the majority using Kabat-Zin's Mind-body Based Stress Reduction program (MBSR) (9) or a modified version of it (17). Four used versions of Stress Management and Resilience Training (SMART), four used Mindfulness in Motion (MIM), three used Transcendental Meditation, two used Mind-Body Skills (MBS), three used a Wellbeing Mobile App while two used Modified Mindfulness-Base Cognitive Therapy (MBCT). The rest used intervention unique that study.

Most interventions involved were MBSR or modified MBSR courses. MBSR is made up of multiple interventions combined into an 8-week program and involves several core practices including mindfulness meditation, body scan meditation and gentle yoga. Mindfulness meditation involves participants focusing on body sensations or their breath. Body scan meditation involves participants systematically directing their attention to different parts of the body to recognise physical sensations and release tension. Gentle yoga combines movement and breathing exercise. MBSR also involves sitting and walking meditation which involves observing thoughts and emotions as well as awareness whilst walking (Kabat-Zinn, 1990).

The SMART program also combines multiple techniques aimed at improving cognitive skills, increasing emotional awareness and using mindfulness practices. It incorporates positive psychology exercises, relaxation techniques and cognitive reframing strategies.

#### 3.5.3.3 Comparison Groups

An analysis of the comparison groups used in each study found 41 used no comparison group, 15 used a waitlist group, 10 used care as usual while the rest used a variety of different control groups including dietary supplementary courses, stress management courses and other education courses. No study specifically examined mindfulness as a preventative measure.

#### 3.5.3.4 Outcome Measures

The most frequent stress and burnout related measures used were PSS-10 (44 studies), Maslach Burnout Inventory – Human Services (MBI-HSS; 32 studies), PSS-14 (13 studies), Connor-Davidson Resilience Scale (CD-RISC; 9 studies) and Cortisol levels (8 studies). Of these, 4 had enough available data to conduct a meta-analysis (PSS-10: 29 studies, PSS-14: 7 studies, MBI-HSS: 32 studies). Of note, there were several articles that did not specify what type of MBI was used. Emails were sent to the authors with only one author confirming they used MBI-HSS. The original MBI was designed for healthcare workers, and it was only after the student (MBI-SS) and general (MBI-GS) versions were created was the original measure labelled as MBI-HSS. All the versions use a different number of questions and name the dimensions differently. Therefore, if the article indicated that there were 22-items and emotional exhaustion, depersonalisation and personal accomplishments were the dimensions of burnout, these were assessed as being MBI-HSS.

### *Perceived Stress Scale – 10 item*

The most commonly used outcome measure was the PSS-10 which was used in 44 studies. The vast majority of these studies focused on healthcare workers (37 studies) with four looking at military personnel, two on emergency services and one on corporate workers. Thirty-four used multicomponent interventions, eight used single component, two did not say with nine using a modified MBSR and four using MBSR. Twenty-five did not use a control group. Twenty-nine of these had the mean and SD data for analysis. Seventeen of these found a significant improvement in PSS-10 scores whereas one showed a significant increase in perceived stress and 11 studies showed no significant change in stress levels.

### *Perceived Stress Scale – 14 item*

The PSS-14 is the original version of the perceived stress scale and focuses on perceived stress and includes self-report questions about feelings and thoughts in the last month (Cohen et al., 1983). Thirteen studies used the PSS-14 as an outcome measure. Twelve were aimed at healtcare workers whilst the last was focused on emergency services workers. Three used SMART while two each use modified MBSR and MBSR. Four did not use a control group. Seven of the studies had mean and SD data and all of them reported an improvement in perceived stress.

### *Maslach Burnout Inventory – Human Services Scale*

The MBI-HSS is used to assess burnout across three dimensions, Emotional Exhaustion (EE), Depersonalisation (DP) and Personal Accomplishment (PA). It was found that 32 articles used the MBI-HSS as an outcome measure and all were aimed at healthcare workers with seven using MBSR. Twenty of the studies had no control group. Twenty-one had the data available for use in a meta-analysis and all of these studies involved healthcare workers and the results were examined for each dimension.

#### 3.5.3.5 Theoretical Explanations

While some studies cited the Transactional Model of Stress (3 studies), Watson's Theory of Caring and Coping (2 studies), the majority (51 studies) of the studies did not propose a theory or mechanism behind the relationship between meditation, stress and burnout.

### 3.5.4 Meta-analytic results

Stress and burnout measures that were included in five or more studies were used in the meta-analysis. These measures were the PSS-10, PSS-14 and MBI-HSS. As there were not five or more included studies for single modality interventions or population groups other than medical personnel, separate meta-analyses looking at these subsets were not able to be conducted.

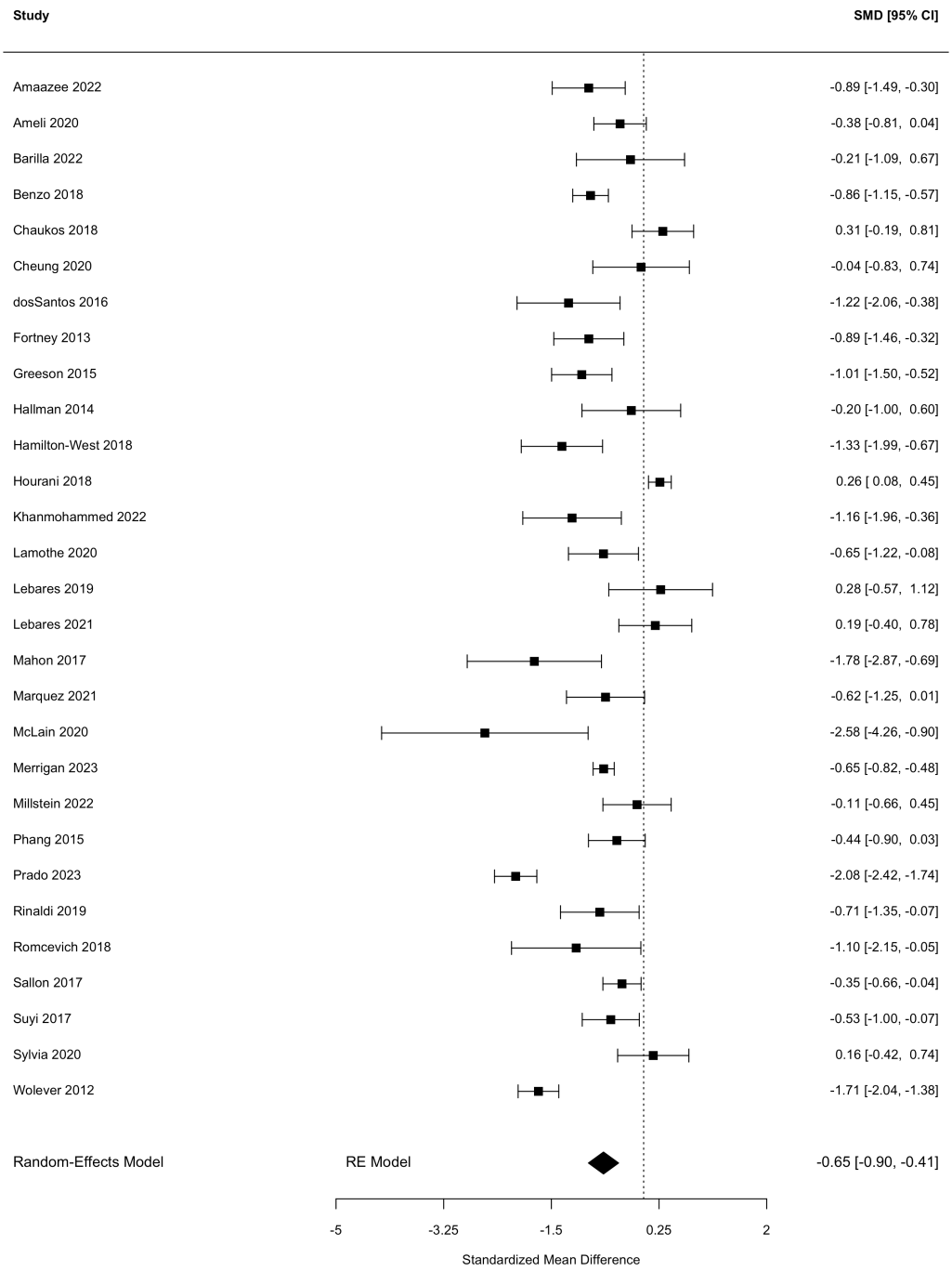
#### 3.5.4.1 Perceived Stress Scale – 10 Item

Of the studies that used the PSS-10 as an outcome measure, mean and standard deviation values were able to be ascertain for 29 of them allowing for in-depth meta-analytic comparisons. The results were synthesised using the 'metafor' package in RStudio and displayed in a forest plot highlighting the standardised mean differences (SMD) for each study and the overall effect size using a random-effects model (Posit, 2024; Viechtbauer, 2010).

The pooled effect size from the random-effects model showed a significant reduction in PSS-10 score suggesting that mindfulness interventions can effectively decrease stress (SMD = -.65, 95% CI[-.90, -.41], $p < .05$) (Figure 2) Of note, the largest effect size was found by Mclain (2020) (SMD = -2.58, 95% CI [-4.26,-.90], $p < .05$) while some studies such had smaller and non-significant changes. Variability among these studies was high ($I^2 = 87.6\%$, $p < .05$).

**Figure 2**

*Forest plot of PSS-10 results*



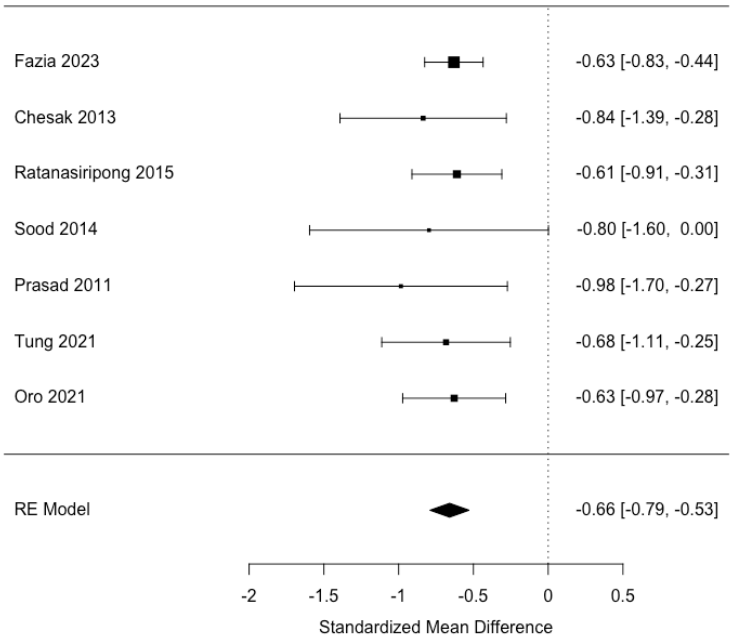

### 3.5.4.2 Perceived Stress Scale – 14 Item

The same analysis was conducted in RStudio with the PSS-14 outcome measure. The overall pooled effect size showed a significant decrease in stress levels

(SMD = -1.20, 95% CI[-1.89,-.51], $p < .05$) (Figure 3). The variability was assessed and indicated that the intervention effects were consistent across the included studies ($Q(6) = 1.53$, $p = .957$, $I^2 = 0\%$).

**Figure 3**

*Forest plot of PSS-14 results*

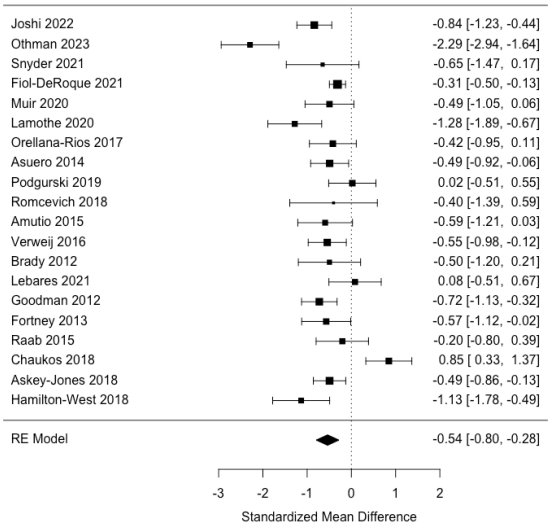



### 3.5.4.3 Maslach Burnout Inventory – Human Services Survey

Meta-analyses were conducted to assess the efficacy of the mindfulness interventions at reducing burnout, as measured by the three dimensions of burnout, Emotional Exhaustion (EE), Depersonalisation (DP) and Personal Accomplishment (PA). Each dimension was analysed separately as shown in Figure 4, Figure 5 and Figure 6.

**Figure 4**

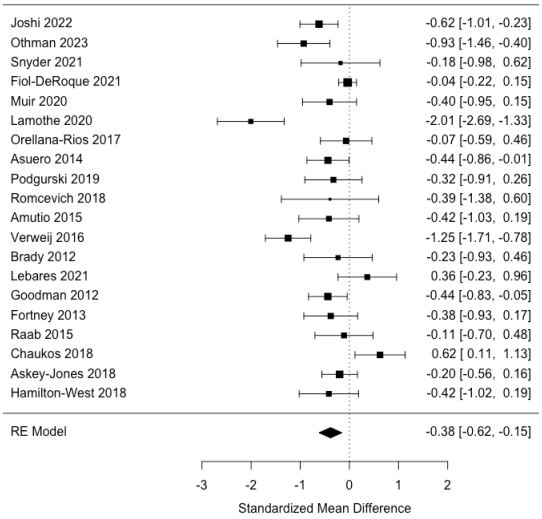
*Forest plot of MBI-HSS EE results*




There was a significant reduction in emotional exhaustion (SMD = -.54, 95% CI [-.80, -.28]. $p < .05$). However, the heterogeneity among these studies was substantial, suggesting that the effect sizes varied considerably across the studies ($I^2 = 65\%$, $p < .05$).

**Figure 5**

*Forest plot of MBI-HSS DP results*

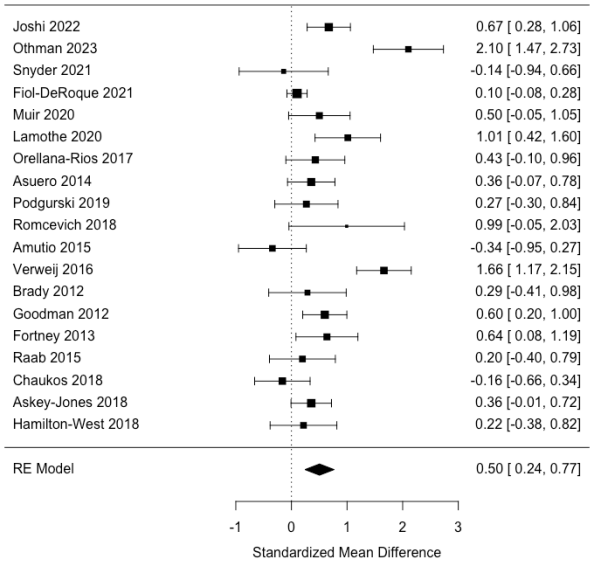



The meta-analyses also showed a significant reduction in depersonalisation (SMD = 0.38, 95% CI [-.62. -.15, $p < .05$). In this case heterogeneity tests showed moderate heterogeneity indicating some variability across studies ($I^2 = 50\%$, $p < .05$).

Lastly, the analysis showed a moderate improvement in personal accomplishment (SMD = .50, 95% CI [.24, .77]. $p < .05$). The low heterogeneity also suggests a consistent effect across the studies ($I^2 = 30\%$, $p < .05$).

**Figure 6**

*Forest plot of MBI-HSS PA results*




## Discussion

This systematic review identified that meditation and, more broadly, mindfulness interventions had significant improvements on stress and burnout across various high-stress occupations such as healthcare workers, emergency services personnel, military personnel and corporate executives. Reductions in stress scores, namely in the PSS-10 and PSS-14, and burnout dimensions, in particular emotional exhaustion and depersonalisation, were observed. These findings support previous studies demonstrating the effectiveness of mindfulness interventions as a tool for stress and burnout reduction (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). However, there were insufficient studies using physiological measures to conduct an analysis into the effect on non-self-report measures. Despite these findings, this review also highlighted several gaps in the literature regarding the effectiveness of meditation in preventing stress and burnout.

The first was the limited research outside the healthcare worker populations. Of the studies identified for analysis in the review, the vast majority examined healthcare workers with very few examining military personnel, emergency service workers and corporate executives. The Conservation of Resource theory (COR) proposes that psychological stress occurs when resources are threatened or lost while the Demand-Control model of job strain proposes that jobs with high demands and low levels of control are more likely to be stressful (Pugliesi, 1999). These characteristics are not solely found in healthcare environments and the overwhelming focus of burnout research on healthcare workers can drastically limit the generalisability of interventions to other high stress occupations (Wilkie, 2018). Future studies should examine if burnout interventions, such as meditation, still provide positive effects in other high-stress populations.

The second was the heterogeneity of the interventions examined. The vast majority of studies analysed in this review used interventions that combined a number of techniques into one treatment. The main intervention identified in the review, MBSR, combines several different types of meditation with yoga and the second most common intervention, SMART, also incorporates cognitive reframing strategies (Kabat-Zinn, 1990; Sood et al., 2014). While it is unknown if mechanisms are synergistic or additive, this multi-modal approach to mindfulness interventions makes identifying which mode is effective difficult, and the mechanisms behind their effectiveness nearly impossible. The finding that the majority of studies did not use a control group, also increases the difficulty in identifying specific benefits and mechanisms, with a strong possibility of placebo effects.

The third gap identified was that the majority of studies focused on self-report measures. The only outcome measures that had enough available data to conduct meta-

analyses were self-report measures. Physiological measures are able to track to body's stress response in order to measure burnout but are rarely reported in the research literature. Additionally, the primarily involved pre- and post- test measures which doesn't provide for the ability to monitor stress levels on a smaller-time scale and in a response to particular stressors.

The fourth gap in the literature identified was the majority of studies examined mindfulness practices as treatments for burnout rather than as a preventative measure. In the majority of high-risk occupations examined in the review, it can be identified early on that these employees are at an increased risk of burnout. Hence, a preventative measure that can reduce the likelihood and severity of burnout would be of greater use.

The last gap identified was the lack of theory regarding mechanisms behind the effectiveness of mindfulness-based interventions in reducing burnout. This study sought to examine some possible mechanisms behind the effectiveness of focused meditation. One proposed mechanism responsible for the benefits of meditation is via an increase in attentional control resulting in a better ability to shift attention away from negative thoughts and emotions and inhibit being drawn back toward them resulting in a reduction in rumination. This is important as rumination has been implicated in prolonging stress and burnout (Bianchi & Schonfeld, 2016; Košir et al., 2015; Liu et al., 2021).

## Conclusions

This study supports previous studies showing an improvement in self-report measures of perceived stress and burnout following mindfulness interventions, particularly in healthcare workers. However, it also highlighted the absence of research into other high-stress occupations, the high level of heterogeneity in interventions and the lack of research using physiological measures of stress and burnout. This makes it

increasingly difficult to identify mechanisms responsible for any positive effects and predict the effectiveness in occupations other than healthcare workers.

### 3.7.1 Recommendations for practice or policy

These findings suggest that broader mindfulness interventions such as MBSR and SMART can be effective in treating high levels of perceived stress and burnout in healthcare workers but does not provide sufficient evidence for the use as a preventative measure or the generalisability to other high-stress occupations.

### 3.7.2 Recommendations for research

Future studies should seek to focus on a single modality, such as focused meditation, use both self-report and physiological measures of stress and burnout in order to identify which mindfulness modalities are most effective and the mechanisms behind them. Future studies should also seek to examine the potential for meditation as a preventative measure rather than just a treatment measure. Lastly, they should use an appropriate control condition – so that placebo effects can be ruled out as the explanation for their benefit.

# Chapter 4: The Preventative Effects of Focused Meditation on Perceived Stress and Burnout: A Randomised Experimental Study Using EMA and Physiological Measures (Study 2)

## Statement of Authorship

### Statement of Authorship

| | |
|---|---|
| Title of Paper | The Preventative Effects of Focused Meditation on Perceived Stress and Burnout: A Randomised Controlled Trial Using EMA and Physiological Measures |
| Publication Status | ☐ Published ☐ Accepted for Publication<br>☒ Submitted for Publication ☐ Unpublished and Unsubmitted w ork w ritten in manuscript style |
| Publication Details | Mindfulness Journal |

### Principal Author

| | |
|---|---|
| Name of Principal Author (Candidate) | Peter Chu |
| Contribution to the Paper | Conceptual development.<br>Study Creation.<br>Participant recruitment<br>Data Analysis<br>Writing Report |
| Overall percentage (%) | 90% |
| Certification: | This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper. |
| Signature | Date: 24 Sep 25 |

### Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);
ii. permission is granted for the candidate in include the publication in the thesis; and
iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

| | |
|---|---|
| Name of Co-Author | Carolyn Semmler |
| Contribution to the Paper | Resources, Conceptual development, Supervision<br>Formal Analysis, Writing - Reviewing & Editing |
| Signature | Date: 25/09/2025 |

| | |
|---|---|
| Name of Co-Author | Fiona Kerr |
| Contribution to the Paper | Conception<br>Knowledge |
| Signature | Date: 25/09/2025 |

Please cut and paste additional co-author panels here as required.

## Rationale for Study

This randomised experimental study sought to address several gaps identified in the systematic review. The use of focused meditation for the intervention sought to address the issue of heterogeneity of interventions identified in the systematic review. Instead of using mindfulness interventions that incorporate several mindfulness strategies such as yoga and cognitive reframing strategies, the intervention in these studies used a single strategy, focused meditation.

This study replicated the pre- and post- self-report methodology found in the majority of randomised controlled trials and quasi-experimental studies analysed in the systematic review but also added the use of ecological momentary analysis with the use of both daily self-report measures of perceived stress and daily physiological measures of stress in the form of heart rate variability.

Thirdly, this study used a sham meditation control group to address the lack of blinded control groups found in the systematic review. This allows for the exploration of any placebo effects associated with doing mindfulness and meditation interventions.

Lastly, the study was conducted prior and during the assignment period for first year university psychology students. This is a period during the semester where several subjects have due dates for their assignments leading to a predicted increase of stress on students. While not ‘workers’, students’ academic work includes structured activities such as lectures and submitting assignments that can be considered as ‘work’ and acadmic burnout shares many similarities with occupational burnout and also includes chronic stress leading to decreased motivation and emotional exhaustion as well as drop out from the education system (Lin & Huang, 2014). Students often juggle multiple assignments with casual work and extracurricular activities which has been found to significantly contribute to academic burnout (Salanova et al., 2010). By conducting the

study in this way, it allows for examination of meditation as a preventative measure rather than as a treatment measure as seen in all of the studies analysed in the systematic review. This is of crucial importance to those in high-risk occupations where the exposure to high stress and the risk of burnout are predictable, making prevention of excess perceived stress and burnout vital.

## Introduction

Current studies have found an increase in the prevalence of burnout across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). With the events of the SARS-CoV-2 pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health. One systematic review found the pandemic had a significant degradation on the mental health of healthcare workers with levels of occupational burnout ranging from 3.1%-44.7% while another found this ranged between 26% and 31% (Sanghera et al., 2020; Serrano-Ripoll et al., 2020). A study on nurses suggests that working with COVID-19 patients seemed to correlate with higher scores in depersonalisation and emotional exhaustion (Chen et al., 2021). It is thought that negative emotions in colleagues, family members and patients can trigger similar emotions in nurses affecting their perceived stress levels and increasing vulnerability to emotional exhaustion (Joshi & Sharma, 2020). The prevalence of burnout has been increasing and the recent pandemic has made this worse.

While initially it was thought that the main issues were the emotional challenges of working with people in a caregiving role, subsequent research found that common job-related stressors were more highly correlated with burnout than human interaction

stressors (Maslach et al., 2001). As such, burnout is now thought to be the result of continued exposure to work stress (Kumar & Mellsop, 2013). Many suggest the experience of stress contributes to burnout. In line with the Conservation of Resources theory (COR), psychological stress occurs when resources are threatened, lost or invested without an anticipated return on investment (Hobfoll & Freedy, 1993). In the context of occupational burnout, work stress is a psychological state resulting from an imbalance between work perceptions of workplace demands and coping abilities. When this is continuing and unmitigated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress.

Although not 'workers', students' academic work includes structured activities such as lectures and submitting assignments that can be considered as 'work' (Lin & Huang, 2014). Burnout in students shares many similarities with occupational burnout and also includes chronic stress leading to decreased motivation and emotional exhaustion as well as drop out from the education system (Lin & Huang, 2014). Students often juggle multiple assignments with casual work and extracurricular activities which has been found to significantly contribute to academic burnout (Salanova et al., 2010). As such, this study will examine burnout by looking at students during a busy assignment period.

Previous studies have often looked at stress and burnout levels before and after an intervention to see if they are effective in reducing burnout. These types of studies tend to be recollective in nature and subject to participant bias with people's summaries of their own experiences and states often being inaccurate portrayals of their actual experiences and states (Beal & Weiss, 2003). Additionally, pre- post- surveys do not accurately examine the variance and covariance of the same variables overtime within the same participant (Beal & Weiss, 2003). Perceived stress levels can be dynamic with

variables such as proximity to assignment due dates and the number of upcoming assignments varying throughout the assignment period and pre-post- measurements may not accurately reflect this. To measure perceived stress levels during the assignment period, this study will use daily PSS-EMA surveys and a weighted assignment score to account for the fact that both the number of assignments and their imminence are likely to affect the level of perceived stress on any particular day.

A second issue with the current research is that it tends to heavily rely on self-report surveys. Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions (Naczenski et al., 2017; Shirom & Melamed, 2006). Research has started to look at physiological measures of burnout which largely focus on the body's physiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS activation due to stress including increased heart rate, decreased heart rate variability (HRV) and increased blood pressure (Bährer-Kohler, 2013; Melamed et al., 2006).

In healthy individuals, the heart rate represents the overall effect of the neural outputs of the sympathetic nervous system, which accelerates it, and the parasympathetic system, which slows it (Shaffer et al., 2014). The outputs of these two parts of the autonomic nervous system are reflected in beat-to-beat variability in the

heart, HRV (Raymond Trevor et al., 2009). The chronic stress symptoms associated with burnout is thought to be due to the results of sustained activation of the sympathetic nervous system and several studies have shown that HRV can be used to measure this (Castaldo et al., 2015). More specifically in preparations for tests, students exhibited changes in HRV in preparation prior to stressful tests (Raymond Trevor et al., 2009). The gold-standard for measuring HRV uses an electrocardiogram (ECG) to measure R-peaks and requires the use of multiple electrodes placed on the torso to measure the electric potential created by the heart's activity (Wittenberg et al., 2020). The resulting inter-beat intervals can be analysed in the frequency domain or time domain. Spectral analysis (in the frequency domain) provides advantages as it provides frequency and amplitude information to quantify oscillations over a time period allowing the attempted identification of mechanisms affecting HRV (Shaffer et al., 2014). For example, high frequency measures are associated with the parasympathetic nervous system while low frequency measures with the sympathetic nervous system (Shaffer et al., 2014). However, time domain measures are simpler to calculate and have been correlated with power measures in several studies (Shaffer et al., 2014). Two of the main measures using time domain analysis are the standard deviation between normal-to-normal intervals (SDNN) and root mean square of successive differences between normal heart beats (RMSSD) (Shaffer et al., 2014). Both have been found to measure acute stress in short measures (Pereira et al., 2017). However, while RMSSD is thought to measure the parasympathetic nervous system activation, SDNN is thought to measure the joint parasympathetic and sympathetic modulation of heart rate (Carnethon et al., 2006). As this study aims to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using

time domain analysis will be used. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to provide a very strong to almost perfect correlation with the ECG results (Moya-Ramon et al., 2022). As meditation has been found to both increase the parasympathetic nervous system activation and decrease sympathetic nervous system, and SDNN measures the impact of both, it will be used to measure the effectiveness of the intervention (Carnethon et al., 2006; Tang et al., 2009).

Mindfulness practices are the most reported intervention for burnout and has been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). It has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events (Garland et al., 2011; Hölzel et al., 2011). While research into meditation has increased recently, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research. Specifically, methodological heterogeneity in meditation traditions and implementations surrounding the definition of meditation pose issues with the interpretation and integration of the

research outcomes (Chu et al., 2024; Davidson & Kaszniak, 2015). To allow for a validated approach to the examination of meditation, a clear definition is required (Przyrembel & Singer, 2018). A systematic review examining the effectiveness of meditation found that only a small minority used a single form of meditation as an intervention with the overwhelming majority using interventions such as Mindfulness-based Stress Reduction (MBSR) which combines several components including yoga and mindful eating which can confound the results (Chu et al., 2024). This study seeks to remove some of the heterogeneity found in mindfulness and burnout research by using a pure focused meditation program without other mindfulness components.

As such, this study will use the Smiling Minds application, which is a free, non-for-profit, evidence based preventative mental wellbeing smart phone application recommended by the Australian Government Department of Health and Aged care (Department of Health Disability and Aging, 2024; Smilng Mind, 2024). It has been found to reduce stress and burnout in workers in a randomised controlled trial (Lanz et al., 2019). Sham meditations have also been used in these studies as an effective control condition and this study will use one modelled on previous studies (Zeidan et al., 2010). By randomising participants and providing both with a single mindfulness component, focused meditation, it will be able to better understand the effectiveness of meditation in preventing stress and burnout.

Most of the current research focuses on treatment of those displaying signs of burnout but not on the effectiveness of meditation for the prevention of burnout (Chu et al., 2024). With most high-risk occupations, it is expected that employees will be exposed to high-stress environments which may lead to burnout and, hence, prevention is preferable to treatment. By using EMA techniques, this study seeks to examine the

potential of focused meditation as a preventive measure to reduce the increase of stress in response to a stressful environment.

This study aims to fill several gaps in meditation and burnout research. It will use both pre- and post- test measures and EMA techniques to analyse the effects of meditation on stress both within participant in a time series and between groups whilst considering the effect of different assignment dates. It will use both self-report and physiological measures to track stress over time and will use a single intervention of focused meditation rather than a combination of several mindfulness components. Lastly, by using EMA techniques, it will look at meditation as a way to prevent excessive increases in stress brought on by assignments rather than being used as a treatment.

### 4.3.1 Hypotheses

The following hypotheses will be tested in this study and are on the Open Science Framework (https://osf.io/sk72j/):

#### 4.3.1.1 Hypothesis 1

The intervention group will show a decrease in PSS-10, MBI-SS (EE), MBI-SS(CY) and an increase in MBI-SS(PA) from the start to the end of the study.

#### 4.3.1.2 Hypothesis 2

Across the daily measures, an increase in the assignment score, based on the number of assignments due and their proximity in time, will correlate with a decrease in HRV.

#### 4.3.1.3 Hypothesis 3

Across the daily measures, an increase in the assignment score will correlate with an increase in PSS-EMA.

#### 4.3.1.4 Hypothesis 4

Across the daily measures, those in the meditation group would experience less of a decrease in HRV.

#### 4.3.1.5 Hypothesis 5

This effect on HRV will increase with the number of meditations performed for the meditation group.

#### 4.3.1.6 Hypothesis 6

Across the daily measures, those in the meditation group will experience less of an increase in PSS-EMA due to assignment stress

#### 4.3.1.7 Hypothesis 7

This effect on PSS-EMA will increase with the number of meditations performed for the meditation group.

#### 4.3.1.8 Keywords

Meditation; Mindfulness; Prevention and Control; Stress, Psychological;

## Method

### 4.4.1 Participants

Participants were 29 first year psychology students recruited via the University of Adelaide Research Participation System. Once on the study site, they were provided with a participant information sheet and informed page. Participants were required to be over the age of 18 years and be proficient in English. Participants were provided with 3.5 credits toward their semester grade on completion of the study.

### 4.4.2 Measures

#### 4.4.2.1 Perceived Stress Scale – 10 item (PSS-10)

The PSS-10 contains 10 questions regarding thoughts and feelings to measure perceived stress. Using a Likert Scale ranging from “0 - never” to “5 - very often”, it

asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (Cohen, 2012; Cohen et al., 1983). Four of the questions are reversed scored. A review of its validity found that it had internal consistency ($\alpha > .70$) in all 12 studies used and satisfactory test-retest reliability (Lee, 2012). It has been shown to have strong validity in student populations (Smith et al., 2014).

#### 4.4.2.2 Maslach Burnout Inventory – Student Scale (MBI-SS)

The MBI-SS is a modified version of the MBI that measures burnout dimensions of exhaustion, cynicism and professional efficacy (Schaufeli et al., 2002). It has been frequently used with university students and, using the Rasch Measurement Model, has been found to have adequate levels of structural validity, reliability and scalability (Pérez-Mármol & Brown, 2019).

#### 4.4.2.3 Perceived Stress Scale – Ecological Momentary Assessment (PSS-EMA)

This is a brief adapted version of the PSS containing 4-items and shows high internal consistency reliability and significant correlations with several criterion validity measures (Murray et al., 2023).

#### 4.4.2.4 Heart Rate Variability (HRV)

As this study aimed to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis was required. As such, HRV was measured using the Welltory smartphone app and smartphone camera. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to have a provide a very strong to almost perfect correlation the ECG results (Moya-Ramon et al.,

2022). Additionally, research into the validity of 'ultra-short measures' of HRV have found that using ECG, that for SDNN, single measures of at least 30 seconds, are sufficient to obtain reliable readings of SDNN when compared to the gold standard of 240 – 300 seconds (Munoz et al., 2015). The Welltory app uses a 60 second ultra-short SDNN recording.

#### 4.4.2.5 Assignment Stress Score

To account for the different number and due dates for assignments, participants were asked to provide the dates of the due dates of their assignments. The sum of the reciprocal of the days to the due date was calculated for each day they participated to provide a measure of stress expected due to the number of assignments due dates coming up and the proximity to these dates.

$$Assignment\ Stress\ Score = \sum_{i=1}^{n} \left(\frac{1}{D_i + 1}\right)$$

Where:

$D_i$ is the number of days until the $i$-th assignment is due

$n$ is the total number of assignments due

#### 4.4.2.6 Cumulative Meditation Score

Each day, participants were asked to log which meditation they did. This was used to calculate the number of meditations they had done up until the current date and used to examine the effect of cumulative meditation sessions and account for participants doing a different number of meditations due to missing days or different start days.

### 4.4.3 Study Design

This study was an online randomised experimental study using both a pre-, post- and ecological momentary assessment (EMA) designs. It was a repeated measures

design using an intervention and control group. The independent variable was the doing a focused meditation program versus a sham meditation. The dependent varibles were the Perceived Stress Scale (10- item and EMA), Maslach Burnout Inventory – Student Scale and SDNN Heart Rate Variability. The study flow is shown in Figure 7 and the study planner/schedule in Figure 8.

Participants were randomised based on their date of birth with those born between the 1st and 16th inclusive of the month being assigned to the intervention group and those born on the 17th to 31st being assigned to the control group. The intervention group was provided with instructions for the use of the Smiling Minds smart phone application study program consisting of 5 meditation sessions ranging from 4 minutes and 20 seconds to 7 minutes (Figure 9).

Participants were asked to complete one meditation daily and cycle through these for the period of their participation.

The control group were provided with pre-recorded audio files containing a ‘sham meditation’ to do daily. These were the same length as the corresponding Smiling Minds meditation but instead participants were told to, approximately every 4 minutes, to ‘take deep breaths as we sit in meditation’. In a similar use of a sham meditation, participants unanimously answered that they felt they were truly meditating (Zeidan et al., 2010).

To maximise participation, participants were able to start the program on any day during the assignment period with the final day being the same for all participants.

Prior to commencing the meditation program and on the last day of the program, participants were asked to complete self-report measures of stress and burnout. Additionally, each morning prior to their meditation session, participants were asked to

measure stress using heart rate variability (HRV) using the Welltory smart phone app and smart phone camera and complete a short self-report measure of perceived stress.

**Figure 7**

*Study Flow*

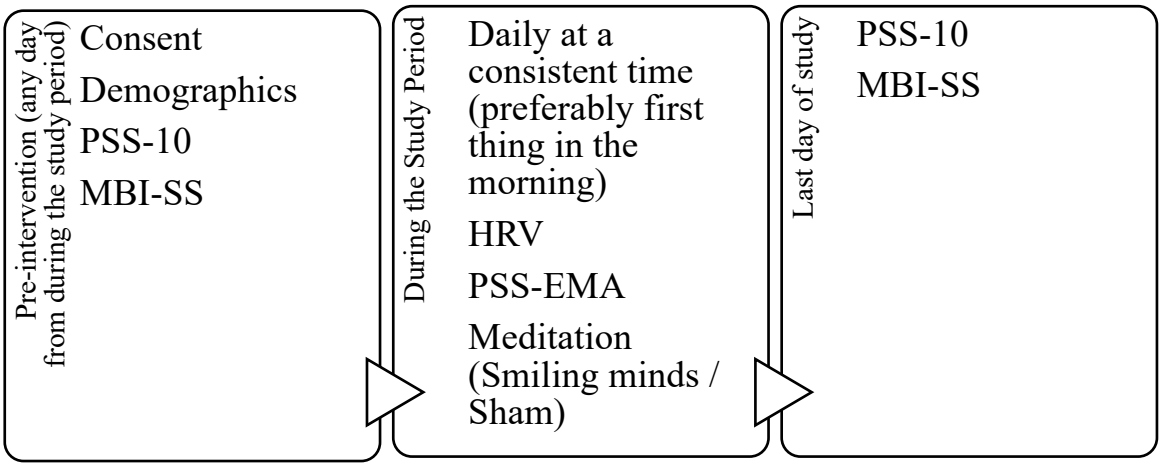



**Figure 8**

*Study Planning Calendar for Paritcipants Scheme of Events.*

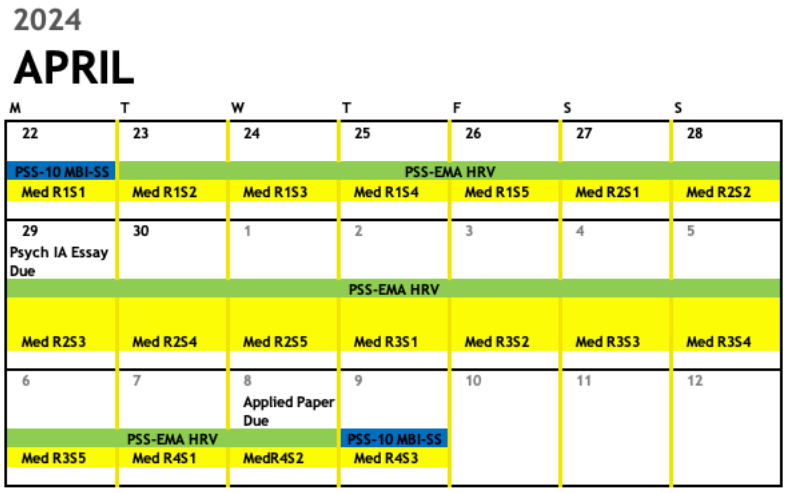
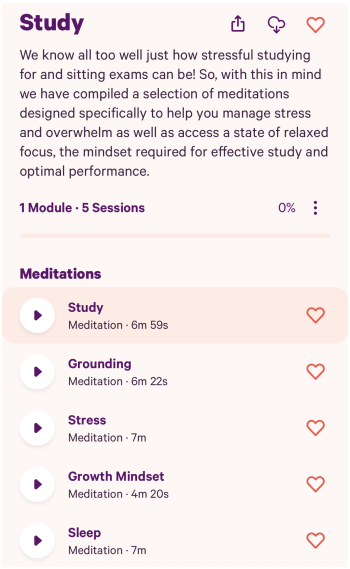


**Figure 9**

*Smiling Minds Study Program*




### 4.4.4 Data analysis

The data was extracted from QualtricsTM, and the tester participant IDs were removed. For anonymity, participants created their own participant ID and self-reported this each session. Participants that did multiple and different initial surveys were excluded. Entries that had conflicting participant IDs were examined and were consolidated if possible. Total scores for PSS-10, MBI-SS and PSS-EMA were calculated. For instances where multiple entries were logged on the same day, all entries were excluded due to being unreliable. It appeared that participants entered self-reported dates that did not align with the date logged by QualtricsTM suggesting that participants were logging entries for past days. A linear mixed-effects model was used to analyse the data in RStudio (RStudio, 2020). The fixed effects included group (intervention and control), assignment stress and cumulative meditation. The interaction effects of group with assignment stress and cumulative meditation were included.

## Results

Two hundred and fifty-two responses were provided during the study. After removing duplicate entries for the same data and participant IDs that did not provide demographic data, 25 unique participant IDs were identified (Figure 10). There were no significant differences between the intervention group and the control group in demographics at baseline testing (Table 1).

**Figure 10**

*PRISMA Flow Diagram*

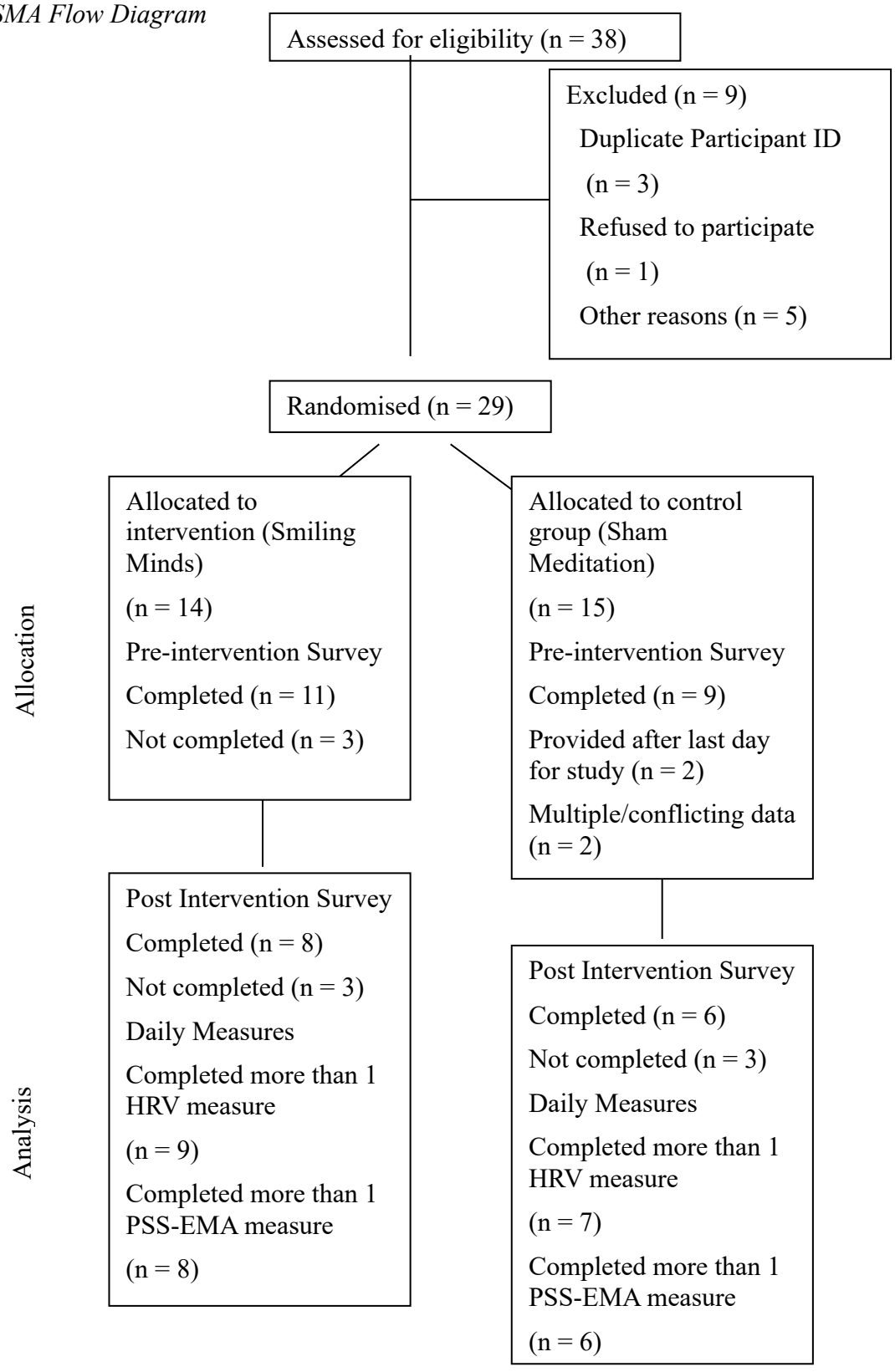


**Table 1**

*Baseline demographics*

| Variable | Intervention ($n$ = 8) | Control ($n$ = 6) | $p$ |
|---|---|---|---|
| Gender | | | |
| Male | 1 (12.5%) | 1 (16.7%) | 1.00 |
| Female | 7 (87.5%) | 5 (83.3%) | 1.00 |
| Age Group | | | |
| 18-24 | 6 (86%) | 6 (100%) | 1.00 |
| 35-44 | 1 (17%) | 0 (0%) | 1.00 |
| Previous Mindfulness Practice | | | |
| Focused Meditation | 3 (37.5%) | 1 (16.7%) | 0.80 |
| Mindful Movement (Yoga) | 1 (12.5%) | 1 (16.7%) | 0.80 |
| No | 3 (37.5%) | 3 (50%) | 0.80 |
| Other | 0 (0%) | 1 (16.7%) | 0.80 |
| Previous Mindfulness Practice Frequency | | | |
| 1-2 times a month | 1 (12.5%) | 1 (16.7%) | 0.80 |
| 1-2 times a week | 2 (25%) | 1 (16.7%) | 0.80 |
| 3-4 times a week | 1 (12.5%) | 1 (16.7%) | 0.80 |
| 5-6 times a week | 1 (12.5%) | 0 (0%) | 0.80 |
| At least once a day | 1 (12.5%) | 0 (0%) | 0.80 |
| N/A | 2 (25%) | 3 (50%) | 0.80 |
| Number of Assignments Due (Mean, SD) | 2.00 (0.76) | 3.83 (2.14) | 0.09 |

#### 4.5.1 Pre-post data.

Of the 29 participants, 20 provided pre-intervention measures of stress and burnout, 18 provided post-intervention measures and 14 provided both pre- and post-intervention measures. A mixed-effects model for PSS-10 revealed no main effects for

Intervention Group, Total Meditations, or Number of assignments and there were also no significant interaction effects.

The model for emotional exhaustion found the interaction between Intervention Group and Total Meditations was significant ($b$ = -1.42, $SE$ = .61, $t$(11.28) = -2.35, $p < .05$). However, there were no significant main or interaction effects for cynicism or personal accomplishment scores. Hypothesis 1 was partly supported.

### 4.5.2 Daily data

Of the 29 participants, 21 provided more than one HRV measures and 20 provided more than one PSS-EMA measures. A linear effects model analysis did not identify any significant predictors or interactions affecting HRV. Specifically, HRV didn't vary significantly with changes in assignment score (H2), or when comparing the intervention and control groups (H4, H5). PSS-EMA also didn't vary significantly with assignment score (H3) or when comparing the intervention and control groups (H6). However, there was a significant interaction between intervention group and cumulative meditation indicating a reduction in PSS-EMA score for the intervention group with increased completed meditations ($b$ = -.47, $SE$ = .22, $t$(125.40) = -2.17, $p < .05$) (H7). Thus hypotheses 2, 3, 4, 5 and 6 were not supported whilst 7 was supported.

## Discussion

This study aimed to examine if focused meditation could mitigate the increase in stress associated with multiple assignment due dates among university students.

With regard to self-reported burnout, whilst the study didn't show improvements in burnout due to meditation alone, it did find that in the meditation group, increased meditation sessions in the intervention group was associated with reduced emotional exhaustion. This partially supports previous studies showing the benefits of mindfulness practices on burnout levels and aligns with the dose-response relationship where greater

participation in mindfulness practices area associated with improved psychological outcomes (Asuero et al., 2014; Carmody & Baer, 2008; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). Improvements in emotional exhaustion support theories suggesting that focused meditation improves attentional regulation and body awareness leading to improved emotion regulation (Bährer-Kohler, 2013; Melamed et al., 2006). According to the job-demand-resources (JD-R) model of burnout, in this way meditation enhances personal resources and helps manage emotional responses more effectively (Demerouti et al., 2001).

A lack of effect on cynicism and personal accomplishment could reflect the timeframe required to affect these outcomes. According to the Leiter and Maslach model, burnout starts with emotional exhaustion which subsequently leads to cynicism which, over time, leads to a reduction in personal accomplishment (Leiter & Maslach, 1988; Maslach & Jackson, 1981). One study found that in females, of which the majority of the sample was, emotional exhaustion develops first and influences cynicism which, in turn, influences personal accomplishment (Houkes et al., 2011). As this study took place over a two-week period, any effect on emotional exhaustion levels may not yet have influenced cynicism and personal accomplishment levels.

Regarding perceived stress, while the number or proximity of assignments due did not seem to measurably affect perceived levels of stress, meditation was associated with reduced levels of daily perceived stress when compared to the control group. The study also showed a dosage relationship with a greater number of meditation sessions conducted by those in the meditation group having a greater reduction on pre- and post-intervention stress levels and daily measures of perceived stress. This supports the previous research indicating that meditation, and mindfulness more broadly, can improve levels of perceived stress (Bährer-Kohler, 2013; Melamed et al., 2006).

While a lack of effect on HRV does not support several studies that have found improvements in HRV with meditation and support the use of HRV as a stress measure, it does align with reviews with mixed-results from research into mindfulness and HRV (Bährer-Kohler, 2013; Brown et al., 2021; Buckland, 2022; Melamed et al., 2006).This could indicate a lack of reliability of the HRV measure due to participants taking measures unsupervised causing possible errors in measurement. However, it could also indicate that HRV and PSS-EMA measure different stress constructs. Lastly, some research indicates that it takes time for meditation to affect HRV values, however, a recent meta-analysis, that also found no significant relationship between mindfulness-based interventions and HRV, found that intervention duration was not a significant moderator (Brown et al., 2021).

While this study sought to fill research gaps by using EMA and physiological measures of stress it did have limitations. The small sample size and short duration of the study afforded by the use of psychology students during the short assignment period could explain the lack of relationships found with cynicism personal accomplishment and HRV. The useable sample size was also affected by a lack of adherence to the program. Additionally, to achieve a daily measure from the students necessitated the use of a smartphone camera at home in an unsupervised environment which could affect the reliability of the HRV measures. Lastly, the assignment didn't take into account the affect of the difficulty of assignments on the level of stress they may cause.

This study provides partial support for the benefits of meditation in preventing increases and reducing perceived stress and emotional exhaustion in students during stressful assignment periods. It demonstrated a dose-relationship between the two, reduced the heterogeneity of research in the field by using a single mindfulness modality, whilst also using self-report and physiological measures of stress. In future, a

longer program may allow the measure of any changes in cynicism, personal accomplishment. Additionally, further research should also seek to examine the mechanisms behind the effectiveness of meditation in preventing and reducing stress and burnout.

# Chapter 5: Meditation as a preventative measure for burnout in students during the assignment period and the role of rumination and worry– A randomised experimental study (Study 3)

## Rationale for Study

After the promising findings of the last randomised experimental studies, this was repeated in the next semester. However, to build on the previous findings, measures of rumination and worry were also included in this study. The systematic review had found the majority of burnout research was atheoretical and this study aimed to move the literature forward by examining the relationship between focused meditation, worry, rumination, perceived stress, biophysiological measures of stress (HRV) and measures of burnout whilst still focusing on prevention.

## Introduction

Workplace stress is an important topic of research across the world. It was thought that the main issues causing stress, were the emotional challenges of working with people in a caregiving role, subsequent research found that common job-related stressors were more highly correlated with burnout than human interaction stressors (Maslach et al., 2001). As such, burnout is now thought to be the result of continued exposure to work stress (Kumar & Mellsop, 2013). Although not ‘workers’, students’ academic work includes structured activities such as lectures and submitting assignments that can be considered as ‘work’(Lin & Huang, 2014). Burnout in students shares many similarities with occupational burnout and also includes chronic stress leading to decreased motivation and emotional exhaustion (Lin & Huang, 2014). Students often must juggle multiple assignments with casual work and extracurricular activities which have been found to significantly contribute to academic burnout

(Salanova et al., 2010). As such, this study will examine burnout by looking at students during a busy assignment period.

When measuring stress and burnout, previous studies often looked at stress and burnout levels before and after an intervention to see if they are effective in reducing burnout. These types of studies tend to be retrospective in nature and subject to participant bias with people's summaries of their own experiences and states often being inaccurate portrayals of their actual experiences and states (Beal & Weiss, 2003). Additionally, pre- post- surveys do not accurately examine the variance and covariance of the same variables overtime within the same participant (Beal & Weiss, 2003). Perceived stress levels can be dynamic with variables such as proximity to assignment due dates and the number of upcoming assignments varying throughout the assignment period and pre-post- measurements may not accurately reflect this. To measure perceived stress levels during the assignment period, this study will use daily PSS-EMA surveys and a weighted assignment score to account for the fact that both the number of assignments and the proximity of their due date are likely to affect the level of perceived stress on any particular day.

A second issue with the current research is that it tends to heavily rely on self-report surveys alone (Chu et al., 2024). Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions (Naczenski et al., 2017; Shirom & Melamed, 2006). Research has started to look at physiological measures of burnout which largely focus on the body's physiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body

experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS activation due to stress including increased heart rate, decreased heart rate variability (HRV) and increased blood pressure (Bährer-Kohler, 2013; Melamed et al., 2006).

In healthy individuals, the heart rate represents the overall effect of the neural outputs of the sympathetic nervous system, which accelerates it, and the parasympathetic system, which slows it (Shaffer et al., 2014). The outputs of these two parts of the autonomic nervous system are reflected in beat-to-beat difference in the heart, HRV (Raymond Trevor et al., 2009). The chronic stress symptoms associated with burnout is thought to be due to the results of sustained activation of the sympathetic nervous system and several studies have shown that HRV can be used to measure this (Castaldo et al., 2015). More specifically in preparations for tests, students exhibited changes in HRV in preparation prior to stressful tests (Raymond Trevor et al., 2009). The gold-standard for measuring HRV uses an electrocardiogram (ECG) to measure R-peaks and requires the use of multiple electrodes placed on the torso to measure the electric potential created by the heart's activity (Wittenberg et al., 2020). The resulting inter-beat intervals can be analysed in the frequency domain or time domain. Spectral analysis (in the frequency domain) provides advantages as it provides frequency and amplitude information to quantify oscillations over a time period allowing the attempted identification of mechanisms affecting HRV (Shaffer et al., 2014). For example, high frequency measures are associated with the parasympathetic nervous system while low frequency measures with the sympathetic nervous system (Shaffer et al., 2014). However, time domain measures are simpler to calculate and have

been correlated with power measures in several studies (Shaffer et al., 2014). Two of the main measures using time domain analysis are the standard deviation between normal-to-normal intervals (SDNN) and root mean square of successive differences between normal heart beats (RMSSD)(Shaffer et al., 2014). Both have been found to measure acute stress in short measures (Pereira et al., 2017). However, while RMSSD is thought to measure the parasympathetic nervous system activation, SDNN is to measure the joint parasympathetic and sympathetic modulation of heart rate (Carnethon et al., 2006). As this study aims to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis will be used. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory™ application and smart phone camera sensor has been found to provide a very strong to almost perfect correlation the ECG results (Moya-Ramon et al., 2022). As meditation has been found to both increase the parasympathetic nervous system activation and decrease sympathetic nervous system, and SDNN measures the impact of both, it will be used to measure the effectiveness of the intervention.(Carnethon et al., 2006; Tang et al., 2009).

Mindfulness practices are the most reported intervention for burnout and has been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). It has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body

sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events (Garland et al., 2011; Hölzel et al., 2011). While research into meditation has increased recently, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research (Chu et al., 2024) Specifically, methodological heterogeneity in meditation traditions and implementations surrounding the definition of meditation pose issues with the interpretation and integration of the research outcomes (Davidson & Kaszniak, 2015). To allow for a validated approach to the examination of meditation, a clear definition is required (Przyrembel & Singer, 2018). A systematic review examining the effectiveness of meditation found that only a small minority used a single form of meditation as an intervention with the overwhelming majority using interventions such as MBSR which combines several components including yoga and mindful eating which can confound the results (Chu et al., 2024). This study seeks to remove some of the heterogeneity found in mindfulness and burnout research by using a pure focused meditation program without other mindfulness components.

As such, this study will use the Smiling Minds App which is a free, not-for-profit, evidence based preventative mental wellbeing smart phone application recommended by the Australian Government Department of Health and Aged care (Department of Health Disability and Aging, 2024; Smilng Mind, 2024). It has been found to reduce stress and burnout in workers in a randomised controlled trial (Lanz et al., 2019). Sham meditations have also been used in these studies as an effective control

condition and this study will use one modelled on previous studies (Zeidan et al., 2010). A previous randomised controlled trial looking at the effectiveness of the Smiling Minds™ App at improving stress and burnout levels in students during the assignment period found significant improvements in PSS-10, MBI-SS and PSS-EMA scores when compared to a sham meditation (Chu et al., 2025). This study aims to build on these results.

Additionally, this study extends on the previous one by examining possible pathways responsible for the effectiveness of meditation at preventing stress and burnout. Two factors that are thought to mediate the relationship between meditation and psychological well-being are worry and rumination. These are two common forms of repetitive negative thinking (RNT) and together, these have also been termed perseverative cognition (PC) (McCarrick et al., 2021). While the research regarding the overlap between rumination and worry is inconsistent, Watkins, Moulds and Mackintosh propose that rumination and worry involve the same repetitive thought process but about different content (Watkins et al., 2005). Worry tends to be future focused and is associated with anxiety, whist rumination tends to be past focused and is associated with depression (McCarrick et al., 2021; Watkins et al., 2005). When considered together as perseverative cognition, worry and rumination are thought to contribute to a prolonged stress response (Brosschot et al., 2006). The Perseverative Cognition Hypothesis proposes that preservative cognition results in a state of moderate, chronic levels of stress including chronic activation of the immune, hypothalamic pituitary adrenal and cardiovascular systems (Brosschot et al., 2006). As burnout is defined as the presence of chronic stress, it is proposed that worry and rumination (PC) lead to burnout.

This study aims to fill several gaps in meditation and burnout research and build on the previous study by Chu, et al. (2024) by examining the relationship with rumination and worry. It will use both pre- and post- test measures and EMA techniques to analyse the effects of meditation on stress, burnout, rumination and worry both within participant in a time series and between groups whilst taking into account the effect of different assignment dates. It will use both self-report and physiological measures to track stress over time and will use a single intervention of focused meditation rather than a combination of several mindfulness components. Lastly, by using EMA techniques, it will look at meditation as a way to prevent excessive increases in stress brought on by assignments rather than being used as a treatment.

### 5.2.1 Hypotheses

It is hypothesised that the meditation group will show reduced perceived stress and burnout from pre-test to post-test. It is hypothesised that whilst proximity to assignment due dates will result in increases in stress, these increases will be less for the meditation group. In addition, it is predicted that the number of meditation sessions completed will enhance this effect.

#### 5.2.1.1 Hypothesis 1

The intervention group will show a decrease in PSS-10, MBI-SS (EE), MBI-SS(CY), Ruminative Responses Scale (RRS), and Penn State Worry Questionnaire (PSWQ) and an increase in MBI-SS(PA) from the start to the end of the study.

#### 5.2.1.2 Hypothesis 2

Across the daily measures, an increase in the assignment score, based on the number of assignments due and their proximity in time, would correlate with a decrease in HRV.

#### 5.2.1.3 Hypothesis 3

Across the daily measures, an increase in the assignment score would correlate with an increase in PSS-EMA.

#### 5.2.1.4 Hypothesis 4

Across the daily measures, those in the meditation group would experience less of a decrease in HRV.

#### 5.2.1.5 Hypothesis 5

The effect on HRV will increase with the number of meditations performed for the meditation group.

#### 5.2.1.6 Hypothesis 6

Across the daily measures, those in the meditation group will experience less of an increase in PSS-EMA due to assignment stress.

#### 5.2.1.7 Hypothesis 7

This effect on PSS-EMA would increase with the number of meditations performed for the meditation group.

## Method

### 5.3.1 Study Design

This study was an online randomised experimental study using both a pre-, post- and ecological momentary assessment (EMA) designs. It was a repeated measures design using an intervention and control group. The independent variable was the doing a focused meditation program versus a sham meditation. The dependent varibles were the Perceived Stress Scale (10- item and EMA), Maslach Burnout Inventory – Student Scale, The Ruminative Resposne Scale, Penn State Worry Questionnaire and SDNN

Heart Rate Variability. The study flow is shown in Figure 11 and the study planner/schedule in Figure 12.

Participants were randomised based on their date of birth with those born between the 1st and 16th inclusive of the month being assigned to the intervention group and those born on the 17th to 31st being assigned to the control group. The intervention group was provided with instructions for the use of the Smiling Minds smart phone application study program consisting of 5 meditation sessions ranging from 4 minutes and 20 seconds to 7 minutes (Figure 13).

Participants were asked to do one meditation daily and cycle through these for the period of their participation.

The control group were provided with pre-recorded audio files containing a 'sham meditation' to do daily. These were the same length as the corresponding Smiling Minds meditation but instead participants were told to, approximately every 4 minutes, to 'take deep breaths as we sit in meditation'. In a similar use of a sham meditation, participants unanimously answered that they felt they were truly meditating (Zeidan et al., 2010).

To maximise participation, participants were able to start the program on any day during the assignment period with the final day being the same for all participants.

Prior to commencing the meditation program and on the last day of the program, participants were asked to do self-report measures of stress, burnout rumination and worry. Additionally, each morning prior to their meditation session, participants were asked to measure stress using HRV using the Welltory smart phone app and smart phone camera and do a short self-report measure of perceived stress.

**Figure 11**

*Study Flow*

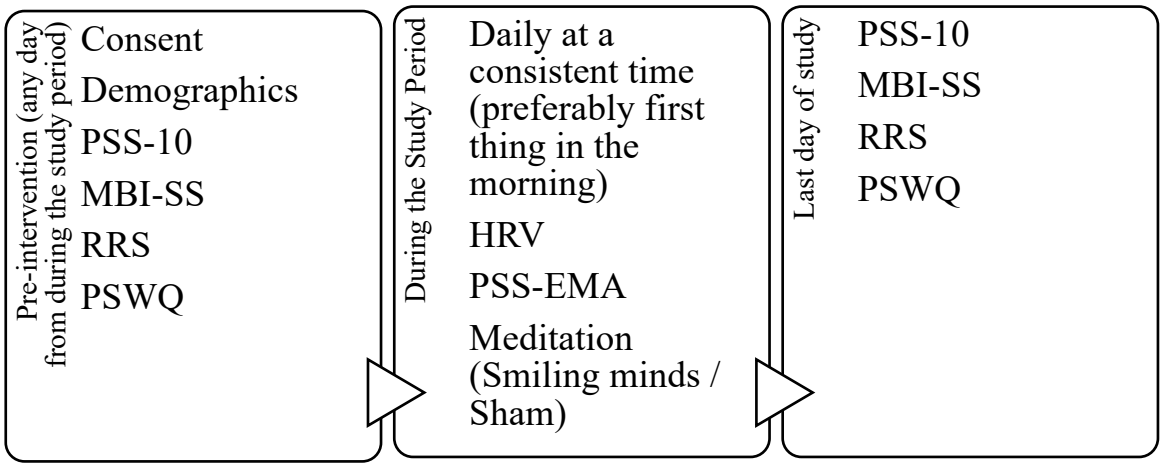


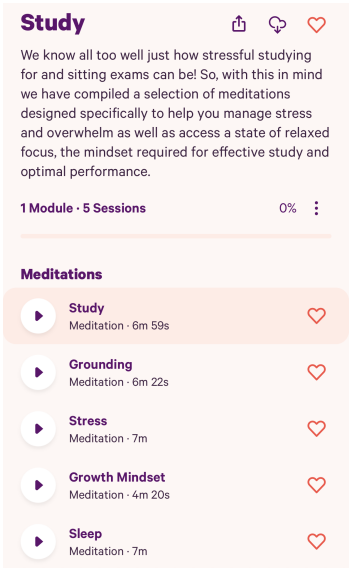
**Figure 12**

*Study Planner*



**Figure 13**

*Smiling Minds Study Program*




### 5.3.2 Participants

Participants were first year psychology students recruited via the university Research Participation System. Once on the study site, they were provided with a participant information sheet and informed consent page. Participants were required to be over the age of 18 years and be proficient in English. Participants were provided with 4 credits toward their semester grade on completion of the study.

### 5.3.3 Ethics Statement

The study was approved by the low Human Research Ethics Subcommitee in the School of Psychology at the University of Adelaide (App 23/77).

### 5.3.4 Measures

#### 5.3.4.1 Perceived Stress Scale – 10 item (PSS-10).

The PSS-10 contains 10 questions regarding thoughts and feelings to measure perceived stress. Using a Likert Scale ranging from “0 - never” to “5 - very often”, it asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (46, 47). Four of the

questions are reversed scored. A review of its validity found that it had internal consistency (α > .70) in all 12 studies used and satisfactory test-retest reliability (48). It has been shown to have strong validity in student populations (Smith et al., 2014).

#### 5.3.4.2 Maslach Burnout Inventory – Student Scale (MBI-SS)

The MBI-SS is a modified version of the MBI that measures burnout dimensions of exhaustion, cynicism and professional efficacy (Schaufeli et al., 2002). It has been frequently used with university students and, using the Rasch Measurement Model, has been found to have adequate levels of structural validity, reliability and scalability (Pérez-Mármol & Brown, 2019).

#### 5.3.4.3 Ruminative Responses Scale (RRS)

The RRS is a 22 item self-report questionnaire using a four-point Likert Scale ranging from "1 – almost never" to "4 – almost always" and has been shown to have high internal validity α = .90 (Luminet, 2003; Nolen-Hoeksema et al., 1994).

#### 5.3.4.4 Penn State Worry Questionnaire (PSWQ)

The PSWQ is a 16-item self-report questionnaire designed to measure the generality, excessiveness and uncontrollable dimensions of worry. It shows good internal consistency (α = .91) and, in tertiary student samples, correlates positively with measures of psychological constructs associated with pervasive worry such as perfectionism and generalised anxiety disorder (Meyer et al., 1990).

#### 5.3.4.5 Perceived Stress Scale – Ecological Momentary Assessment (PSS-EMA)

This is a brief adapted version of the PSS containing 4-items and shows high internal consistency reliability and significant correlations with several criterion validity measures (Murray et al., 2023).

#### 5.3.4.6 Heart Rate Variability (HRV)

As this study aimed to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis was required. As such, HRV was measured using the Welltory smartphone app and smartphone camera. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to provide a very strong to almost perfect correlation with the ECG results (Moya-Ramon et al., 2022). Additionally, research into the validity of 'ultra-short measures' of HRV have found that using ECG, that for SDNN, single measures of at least 30 seconds, are sufficient to obtain reliable readings of SDNN when compared to the gold standard of 240 – 300 seconds (Munoz et al., 2015). The Welltory app uses a 60 second ultra-short SDNN recording.

#### 5.3.4.7 Assignment Stress Score.

To account for the different number and due dates for assignments, participants were asked to provide the due dates of their assignments. The sum of the reciprocal of the days to the due date was calculated for each day they participated to provide a measure of stress expected due to the number of assignments due dates coming up and the proximity to these dates.

$$Assignment\ Stress\ Score = \sum_{i=1}^{n} \left( \frac{1}{D_i + 1} \right)$$

Where:

$D_i$ is the number of days until the $i$-th assignment is due

$n$ is the total number of assignments due

#### 5.3.4.8 Cumulative Meditation Score

Each day, participants were asked to log which meditation they did. This was used to calculate the number of meditations they had done up until the current date and used to examine the effect of cumulative meditation sessions and account for participants doing a a different number of meditations due to missing days or different start days.

### 5.3.5 Data analysis

The data was extracted from Qualtrics and the tester participant IDs were removed. For anonymity, participants created their own participant ID and self-reported this each session. Participants that did multiple and different initial surveys were excluded. Entries that had conflicting participant IDs were examined and were consolidated if possible. Total scores for PSS-10, MBI-SS, RRS, PSWQ and PSS-EMA were calculated.

Due to the higher attrition rate, the mixed-effects model that was originally planned for was not suitable. Instead, the analysis focused on the relationship between baseline PSS-10, MBI-SS, RRS and PSWQ scores to ascertain a relationship between stress, burnout, rumination and worry. Participant's self-reported current mindfulness practices and dosage were then compared with these baselines scores, to determine if those who currently meditated exhibited reduced stress, burnout, rumination and worry.

## Results

**Figure 14**

*Participant Flow Diagram*

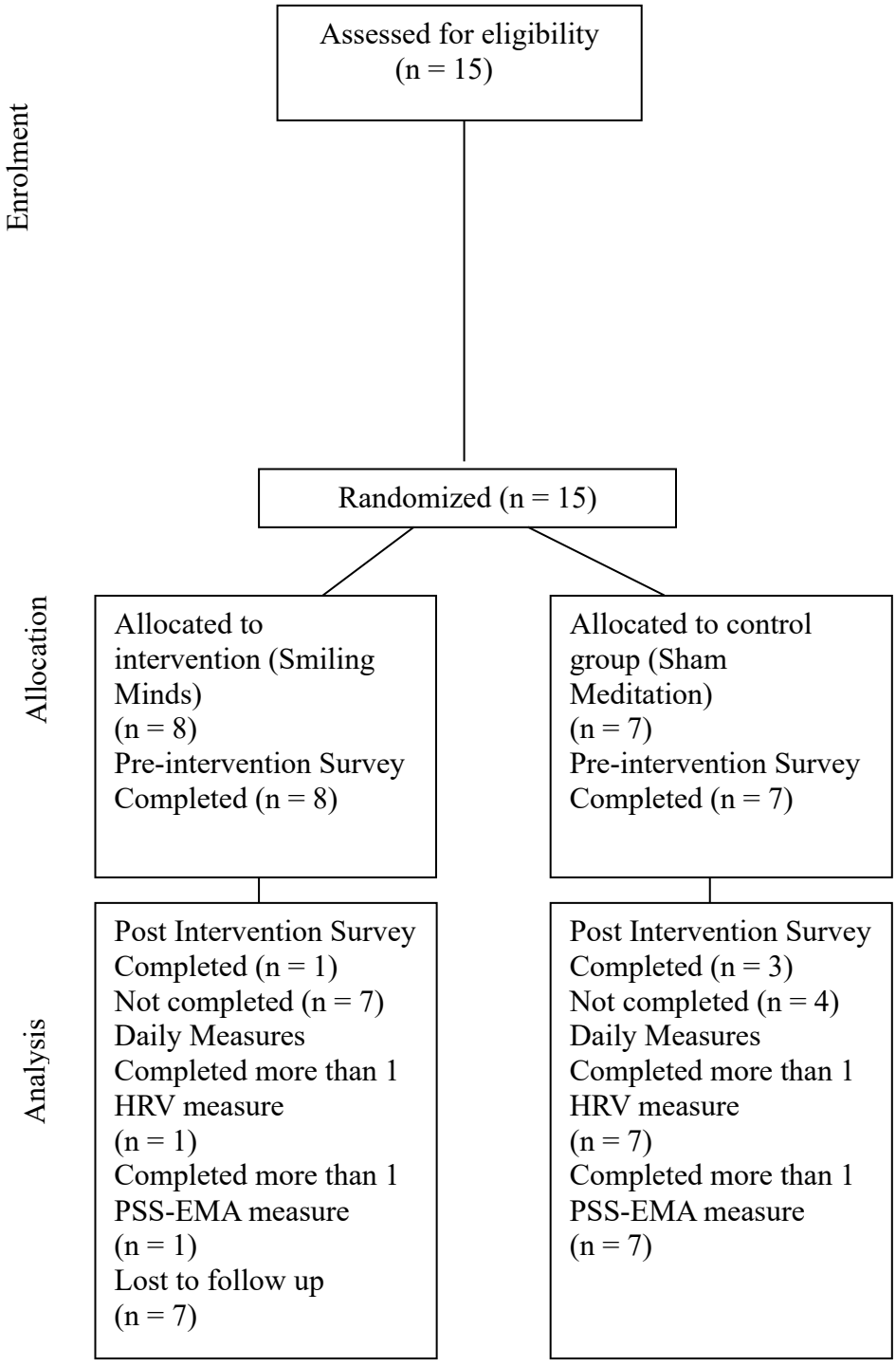


**Table 2**

*Demographics Table*

| Variable | Intervention Group (n = 8) | Control Group (n = 7) | *p* |
|---|---|---|---|
| Gender | | | |
| Male | 1 (12.5%) | 1 (14.3%) | 1.00 |
| Female | 7 (87.5%) | 6 (85.7%) | 1.00 |
| Age Group | | | |
| Under 18 | 0 (0%) | 1 (14.3%) | .179 |
| 18-24 | 7 (87.5%) | 4 (57.1%) | .179 |
| 25-34 | 1(12.5%) | 0 (0%) | .179 |
| 35-44 | 0 (0%) | 2 (28.6%) | .179 |
| Current Mindfulness Practice | | | |
| Focused Meditation | 2 (25%) | 1 (11.1%) | 1.00 |
| Mindful Movement (Yoga) | 2 (25%) | 2 (22.2%) | 1.00 |
| No | 5 (62.5%) | 6 (66.7%) | 1.00 |
| Other | 0 (0%) | 0 (0%) | 1.00 |
| Current Mindfulness Practice Frequency | | | |
| 1-2 times a month | 1 (12.5%) | 0 (0%) | 1.00 |
| 1-2 times a week | 1 (12.5%) | 0 (0%) | 1.00 |
| 3-4 times a week | 1 (12.5%) | 0 (0%) | 1.00 |
| 5-6 times a week | 0 (0%) | 1 (14.3%) | 1.00 |
| At least once a day | 0 (0%) | 1 (14.3%) | 1.00 |
| N/A | 5 (62.5%) | 5 (71.4%) | 1.00 |
| Number of Assignments Due (Mean, SD) | 3.57 (SD = 1.99) | 3.83 (SD = 2.14) | 0.095 |

### 5.4.1 Pre-post data.

Of the 15 participants, 15 provided pre-intervention measures of stress and burnout, 4 provided post-intervention measures and 4 provided both pre- and post-intervention measures (Figure 14; Table 2). Due to these low numbers and only one participant in the intervention group, the proposed mixed-model analysis was not suitable.

Due to the limited data available, an analysis of the baseline data provided was conducted to examine the levels of stress and burnout in the student population and the relationship between levels of stress, burnout, rumination and worry. A further analysis was conducted to examine if self-reported current mindfulness activities at baseline were correlated with levels of stress, burnout, rumination and worry.

With respect to the relationships between stress, burnout, rumination and worry, stress was moderately negatively correlated with personal accomplishment ($r$ = -.53, $p$ < .05), weakly positively correlated with emotional exhaustion ($r$ = .29, $p$ < .05), and worry ($r$ = .35, $p$ < .05). Emotional exhaustion was moderately positively correlated with depersonalisation ($r$ = .40, $p$ < .05) and moderately negatively correlated with personal accomplishment ($r$ = -.51, $p$ < .05) while personal accomplishment was moderately correlated with worry ($r$ = -.45, $p$ < .05).

Examining the effects of current mindfulness practices, of the 15 participants that undertook the baseline survey, 10 participants state that they did not currently engage in mindfulness practices, whereas 5 participants did currently engage in mindfulness practices. One currently practiced focused meditation only, two currently practiced mindful movement (i.e. yoga) and two participants currently practiced both focused meditation and mindful movement. A permutation-based analysis of variance is a non-parametric alternative to the multivariate analysis of variation (MANOVA) test

for sets of variables that do not meet the assumptions of MANOVA (Cornell Statistical Consulting Unit). The analysis was conducted using R-Studio with 999 permutations was run due to the small sample size and found no overall multivariate differences between participants who did and did not report doing currently mindfulness practice across stress, burnout, worry and rumination $F(1,13) = .54$, $p < .703$, $R^2 = .04$. Follow-up univariate permutation ANOVAs found no significant differences between groups for perceived stress, depersonalization, personal accomplishment, worry or rumination. However, there is a significant difference for emotional exhaustion with participants who practiced mindfulness reporting lower emotional exhaustion ($M = 15.6$, $SD = 6.91$) when compared to those who did not ($M = 22.7$, $SD = 5.95$, $F(1,13) = 4.38$, $p < .05$).

Of the 15 participants, 8 provided more than one HRV measures and more than one PSS-EMA measures. An analysis found a weak negative correlation between PSS-EMA scores and HRV (Spearman's rho = -.24 $p < .05$). However, as only one participant was in the intervention group, a comparison between the groups was not possible. Despite this, a linear mixed effects analysis found that even for the control group listening to sham meditations, each additional meditation conducted was associated with a significant reduction in perceived stress levels but a non-significant decrease in HRV ($\beta = -0.44$, $p < .05$). Additionally, in the control group, the Assignment Due Date Weighted Value was negatively correlated with perceived stress counterintuitively indicating that as assignment due dates approached, perceived stress seemed to reduce ($\beta = -2.23$, $p < .05$).

## Discussion

This study aimed to examine if focused meditation could mitigate the increase in stress, worry and rumination associated with multiple assignment due dates among university students. However, due to high attrition rates and a disproportionate

allocation to the control group, a comparative analysis between the intervention and control groups was unable to be conducted. However, the baseline data and daily data provided by those in the control group was able to be analysed but due to PERMANOVA analysis used, this cannot be generalised outside the sample.

The results show that perceived stress is associated with greater emotional exhaustion. This supports the theory that perceived stress and burnout are related. According to the Leiter and Maslach model, burnout starts with emotional exhaustion which subsequently leads to cynicism which, over time, leads to a reduction in personal accomplishment (Leiter & Maslach, 1988; Maslach & Jackson, 1981). As burnout is seen to be chronic perceived stress, the connection with emotion exhaustion could be an indicator of the early onset of burnout.

The results also show that perceived stress is associated with worry but not rumination. This partly supports the Perseverative Cognition Hypothesis which proposes rumination and worry contribute to prolonged stress response (Brosschot et al., 2006). However, it does not support studies showing a relationship between rumination and perceived stress. These results could indicate that worry and rumination may differ in their relationship with stress, although the small sample size means that caution should be exercised in drawing these conclusions.

Research into the differences between worry and rumination suggests that worry is uniquely associated with a decreased perceived effectiveness of coping efforts whereas rumination, after controlling for worry, predicts disengagement of coping efforts. It has been proposed that worry is a form of problem solving but despite worriers being able to produce effective solutions, they lack the confidence in these solutions and have low perceived control over the problem-solving process (Davey, 1994). As the Appraisal Theory of stress proposes that stress is the result of an

imbalance between coping resources and stressors, a reduced confidence in coping abilities would likely result in increased perceived stress (Lazarus, 1984).

However, it could also reflect differences in the way the RRS and PSWQ are framed. The RRS asks participants to respond with respect to when they feel sad, blue or depressed whilst the PSWQ asks participants to answer with respect to what is typical for them (McEvoy et al., 2013). As the participants in this study were not necessarily experiencing sadness or depression, the PSWQ may be more applicable in this context. Additionally, the specific stressor examined in this study was the presence of upcoming assignment due dates. As this stressor is in the future, it would make sense that worry, which tends to be future focused, would be more of a factor than rumination, which tends to be focused on the past (McCarrick et al., 2021; Watkins et al., 2005). According to the Perseverative Cognition Hypothesis, it is this elevated level of worry that is thought to result in a prolonged stress response resulting in burnout (Brosschot et al., 2006).

However, the finding that current mindfulness practices were not associated with lower stress, rumination and worry scores at baseline does not support previous studies that indicate that mindfulness has positive effects on these factors (Chu et al., 2024; Chu et al., 2025; Delgado et al., 2010; Hawley et al., 2014; Ramel et al., 2004). This finding could be due to the small sample size.

However, the finding that those who practiced mindfulness, had lower emotional exhaustion scores at baseline supports the notion that mindfulness practices can reduce emotional exhaustion and that emotional exhaustion is often one of the earlier indicators of potential burnout. Though this should be cautiously interpreted due to the small sample size, it does support previous studies finding a link between mindfulness practice and reduced emotional exhaustion (Hülsheger et al., 2013; Li et

al., 2017). It is argued that burnout starts with emotional exhaustion which subsequently leads to cynicism which, over time, leads to a reduction in personal accomplishment (Leiter & Maslach, 1988; Maslach & Jackson, 1981). One study found that in females, of which the majority of the sample was, emotional exhaustion develops first and influences cynicism which, in turn, influences personal accomplishment (Houkes et al., 2011). It is thought that mindfulness improves surface acting, a component of emotion regulation which, in turn, reduces emotional exhaustion (Hülsheger et al., 2013).

The relationship between cumulative meditation sessions during the study and perceived daily stress levels was also unexpected and could be indicative of a placebo effect. This is supported by the findings of stress reduction in the control group, also. Alternatively, the requirement to just stop and sit for a few minutes each day, even for a sham meditation, may have provided protective general relaxation effects. Future studies should not only examine if meditation applications reduce stress increases when compared to a sham meditation but if a sham meditation still improves stress levels in its own right.

Whilst this study was unable to fulfil its original research aims due to a small sample size and large attrition rates, a cross-sectional analysis of the baseline data showed a relationship between perceived stress, worry and emotional exhaustion. Whilst these results should be interpreted with caution due to the small sample size, future research to continue to analyse the potential role of worry in prolonging and elevating perceived stress levels leading to burnout.

**Acknowledgements**

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## Author contributions

P Chu was the primary author with the assistance of thesis supervisors and the University of Adelaide, C Semmler and F Kerr. M Chu and H Chu for provided survey testing, proof reading and review.

## Conflicts of interest

P Chu is the founder and director of Design Your Life PTY. LTD. which provides exercise, yoga, and meditation services to both individuals and as part of corporate wellness programs.

# Chapter 6: Meditation and burnout: Exploring the attentional control and perseverative cognition pathway (Study 4)

## Rationale for Study

From its origins, burnout research was founded on clinical observations before progressing toward self-report measures. Due to this, most research was not concerned with examining mechanisms or the theories behind them. This was shown in the systematic review which identified a lack of theory and mechanisms involved in the relationship between mindfulness and and burnout. This lack of theory and mechanisms weakens the study of interventions making it difficult to refine them or predict who would most benefit from them. This study sought to address this gap by developing and testing a new model of burnout involving attentional control and perseverative cognition.

## Abstract

Mindfulness practices are the most reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout. However, the research into this relationship has been largely atheoretical with very few studies detailing how and why meditation should be effective. One proposed mechanism responsible for the benefits of meditation is via an increase in attentional control resulting in a better ability to shift attention away from negative thoughts and emotions and inhibit being drawn back toward them resulting in a reduction in rumination. This is important as rumination has been implicated in prolonging stress and burnout. Participants will be recruited via snowball sampling via email and text message and be directed toward an online study site. They will be asked to conduct a meditation habits survey, the Attentional Network Test, the Rumination Response Scale, the Perceived Stress Scale – 10-item and the Burnout Assessment Tool.

We propose a model for the role of rumination and use structural equation modelling to ascertain the relationship between meditation habits, attention control, rumination, perceived stress and burnout. Confirmation of this pathway will allow for further research and intervention development targeting the increase in attentional control and the reduction in rumination for the prevention and treatment of prolonged stress and burnout.

## Introduction

Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions (Naczenski et al., 2017; Shirom & Melamed, 2006). Mindfulness practices are the most reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout, however, the research into this relationship has been largely atheoretical with very few studies detailing how and why meditation should be effective (Chu et al., 2024; Hölzel et al., 2011; Sedlmeier et al., 2012).

Mindfulness is an umbrella term reflecting the experience of being present in the moment (Van Dam et al., 2018). It is not a unitary construct and includes many different practices in many different contexts (Kabat-Zinn, 1990). Conversely, meditation denotes a specific set of practices where one is mindful during a specific moment and comprises of two broad types (Lutz et al., 2015). Focused meditation involves practicing the deliberate focusing of attention on a particular element such as the breath, sensation, sound, mental image, word, phrase, or object (Davidson & Kaszniak, 2015; Lutz et al., 2015). Open meditation, on the other hand, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015).

Two factors that are thought to mediate the relationship between meditation and psychological well-being are worry and rumination. These are two common forms of repetitive negative thinking (RNT) and together, these have also been termed perseverative cognition (PC) (McCarrick et al., 2021). The research regarding the overlap between rumination and worry is inconsistent with some researchers proposing that rumination and worry involve the same repetitive thought process but about different content (Watkins et al., 2005). Worry tends to be future focused and is associated with anxiety, whist rumination tends to be past focused and is associated with depression (McCarrick et al., 2021; Watkins et al., 2005).

Rumination involves repeatedly thinking about information from the past that is negative and is comprised of two components; reflective pondering and brooding (Nolen-Hoeksema et al., 2008; Treynor et al., 2003). One systematic review found that rumination mediated the relationship between mindful-based interventions and stress, anxiety, depression and global psychopathological symptoms (Gu et al., 2016). Specifically, when compared to relaxation therapy, mindfulness meditation's ability to reduce distress was found to be mediated by reductions in rumination .(Hsu et al., 2015; Jain et al., 2007; Willis & Burnett, 2016). Further evidence for the importance of rumination comes from studies that have found that those who ruminate tend to have higher levels of perceived stress and increased levels of burnout (Bianchi & Schonfeld, 2016; Košir et al., 2015; Liu et al., 2021). The Response Style theory proposes that rumination, in particular brooding, promotes and prolongs distress by interfering with problem solving and preventing instrumental behaviour so individuals become fixated on their feelings and problems without acting to improve their mood (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Rumination can also prevent the use of distracting activities which would otherwise reduce their distress  generated by rumination (Nolen-

Hoeksema, 1991). Lastly rumination can result in a depressed mood which further focuses an individual on negative thoughts and emotions resulting in greater distress (Nolen-Hoeksema, 1991). Hence, reducing rumination may free resources required for problem solving and instrumental behaviour whilst also allowing for distracting activities which reduce distress and burnout symptoms.

Worry also involves repetitive negative thoughts which are instead focused on the future and used to anticipate and avoid danger (Capobianco et al., 2018). One environmental risk factor for burnout is a perception of a lack of control and uncertainty (Bährer-Kohler, 2013). It has been found those who have less tolerance for uncertainty, tend to worry more and, additionally, people often use worry as a way to regain a sense of control (Freeston et al., 1994). The Reflexive Adaptation Process (RAP) proposes that worry prolongs stress by focusing attention toward threat-related stimuli depleting the cognitive resources required for the flexible control needed to return cognition to its original threat-free state (Roussis & Wells, 2008). Thus, a lack of control in the workplace can lead to increased worry resulting in prolonged stress and burnout.

When considered together as perseverative cognition, worry and rumination are thought to contribute to a prolonged stress response (Brosschot et al., 2006). The perseverative cognition hypothesis proposes that perseverative cognition results in a state of moderate, chronic levels of stress including chronic activation of the immune, hypothalamic pituitary adrenal and cardiovascular systems (Brosschot et al., 2006). As burnout is defined as the presence of chronic stress, it proposed that worry and rumination (PC) lead to burnout. Additionally, in line with the Conservation of Resources theory, it is thought that resources are allocated to negative thoughts and emotions, such as with rumination and worry, rather than relevant tasks leading to poor job performance and burnout (Hobfoll & Freedy, 1993; Liu et al., 2021).

One way to reduce PC is through an increase in attentional control. Attentional control comprises of two aspects, the ability to maintain attention and the ability to return after being distracted (MacDonald & Olsen, 2020). These distractions can be from the environment, from self-generated information or from previously learned behaviour (von Bastian et al., 2020). Attention is thought to comprise three brain networks, alerting, orienting and executive control (Posner & Petersen, 1990). The initial capture and sustainment of attention is conducted by the alerting system while the orienting system anticipates the direction of a specific stimuli (Posner & Petersen, 1990). However, it is the last system that is the most relevant to examining the effects of meditation, the executive control network. This is now thought to be responsible for refreshing information, switching between stimuli (attentional juggling/attention shifting), and refraining from shifting or updating attention to another stimulus (inhibition)(Miyake et al., 2000).

However, much of the literature examining the relationship between attentional control and rumination is cross-sectional and some propose that rumination causes deficits in attentional control while others suggest that a third-variable, such as mood, accounts for the relationship (Pepper, 2017). The resource depletion account proposes that when someone is ruminating it uses attentional resources and depletes them for future attention shifting toward positive thoughts or emotions (Whitmer & Gotlib, 2013). Neuroimaging studies have also found that those who have high levels of brooding showed high activation of the right dorsolateral prefrontal cortex (Vanderhasselt et al., 2011). This part of the brain is thought to allow people to disengage from negative thoughts to limit rumination (Vanderhasselt et al., 2011). The attentional control theory of anxiety (ACT), proposes that worry disrupts the balance between the “bottom-up” (stimulus-driven) attentional system and the “top-down”

(goal-directed) attentional system resulting in the exhaustion of cognitive capacity leading to reduced cognitive efficiency and performance (Eysenck et al., 2007; Fox et al., 2015). This suggests that those who worry and ruminate end up needing to recruit more attentional control and exhaust their capacity.

Others believe that it is a deficit in attentional control that causes worry and rumination as reduced attentional control leads to a decreased ability to block or disengage from negative, non-task oriented thoughts (Joormann et al., 2007). The impaired disengagement hypothesis proposes that those who have an impaired ability to exert attentional control are unable to disengage from negative thoughts and feelings are more likely to endure ongoing rumination (Daches et al., 2010; DeJong et al., 2019). In one study, a fear conditioning procedure was used to induce deficits in attentional control and this was associated with greater worry and difficulties controlling negative intrusive thoughts (Fox et al., 2015). It is likely that both pathways are present resulting in a vicious cycle (Koster et al., 2011).

On the other hand, improvements in attentional control correlate with improvements in the ability to suppress worry-related intrusive thoughts (Fox et al., 2015). This could be by replenishing attentional resources due to worry and rumination or by removing any deficit in the first place. This concept of attention and attentional control features heavily in the meditation and mindfulness literature and the practice of focusing attention on an element and return to it when distracted, as practiced during meditation, is thought to improve attentional control (Hölzel et al., 2011; Lutz et al., 2008). This relationship has been supported by various studies showing improvements in cognitive tests measuring executive attention (Hölzel et al., 2011; Lutz et al., 2015). Supporting neurological findings also suggest that meditation produces enduring brain function changes with neuroimaging studies have found that experienced meditators

demonstrate greater activation in the anterior cingulate cortex (ACC) (Hölzel et al., 2011; Slagter et al., 2007). In Shapiro et al.'s model, attention is identified as a fundamental component of mindfulness and that meditation results in the improvement of sustained attention, attention shifting and inhibition (Shapiro et al., 2006). Additionally, the Liverpool Mindfulness Model, proposes that during meditation one is required to sustain attention on an object using the alerting network, return from mind wandering using the executive attention network and return attention back to the original task using the orienting network (Malinowski, 2013). In a randomised controlled trial, those who did meditation showed improvements in cognitive tests of attention switching, orienting and executive attention (Vieth & Von Stockhausen, 2022). Thus, as focused meditation encourages the practice of sustaining attention and returning from distractions, it is thought to strengthen the attentional networks responsible for these tasks.

These improvements in attentional networks are proposed to be behind the reduction in worry and rumination associated with meditation. In focused meditation, attention is focused on a neutral object, such as breathing, which results in the continual distraction from ruminative thoughts back to the neutral objec t(Wolkin, 2015). It is also thought that once an individual becomes more experienced with meditation, their attentional focus is broadened and thoughts are non-judgementally accepted and let go of rather than being ruminated upon (Wolkin, 2015). The Attentional Scope Model of Rumination proposes that a narrowed focus of attention can lead to a predisposition to ruminate by promoting a persistent, narrow focus on negative thoughts while a broader attentional scope increases the likelihood of the thoughts shifting away and reduce the chances of them becoming repetitive (Whitmer & Gotlib, 2013).

While studies have examined meditation, and more broadly mindfulness, as a treatment for stress and burnout, little has been done to explore the mechanisms behind this relationship. This study proposes that mindfulness, and focused meditation specifically, will be associated with greater attentional control, which will be associated with reduced brooding rumination and worry and less perceived stress and symptoms of burnout.

### 6.3.1 Hypotheses

Attentional control and Reduced rumination and worry mediate the relationship between meditation and perceived stress and symptoms of burnout.

This was pre-registered on the the Open Science Framework (OSF) at https://osf.io/sdfep/.

## Method

### 6.4.1 Study Design

An online observational study using self-report scales and a self-administered behavioural test with no blinding or randomisation was used.

### 6.4.2 Participants

Participants were recruited via snowball sampling using e-mail and text-messages to provide a link to the study hosted on Inquisit Web (Millisecond Software) as well as using Prolific (*Prolific*). Once on the study site, they were provided with a participant information sheet and informed consent page. Participants were required to be over the age of 18 years and be proficient in English. Recruiting commenced in May 2025 and was completed on August 2025. The participant demographics are in Table 3.

**Table 3**

*Demographics of Participants*

| Variable | Participants ($n$ = 196) |
|---|---|
| Gender | |
| Male | 104 (53.1%) |
| Female | 88 (44.9%) |
| Other | 4 (2%) |
| Age Group | |
| Under 18 | 0 (0%) |
| 18-24 | 53 (27%) |
| 25-34 | 47 (24%) |
| 35-44 | 35 (17.9%) |
| 45-54 | 27 (13.8%) |
| 55-64 | 24 (12.2%) |
| 65+ | 10 (5.1%) |
| Occupation | |
| Current healthcare worker | 16 (8.2%) |
| Previous healthcare worker | 27 (13.8%) |
| Current corporate executive | 9 (4.6%) |
| Previous corporate executive | 10 (5.1%) |
| Current military member | 16 (8.2%) |
| Previous military member | 24 (12.2%) |

### 6.4.3 Measures

All materials used in the study are available on the OSF https://osf.io/sdfep/ .

#### 6.4.3.1 Meditation habits questionnaire

To assess the meditation habits of participants, were asked a series of question about the type of practice they do, how effective they find it, how often they practice and for what duration.

#### 6.4.3.2 Attention Network Test (ANT)

As meditation is thought to affect the alerting, orienting and executive attention networks, the ANT was used. The ANT is a computer delivered test designed to test the networks of attention outlined by Posner (Posner & Petersen, 1990). The ANT tests the efficacy of the alerting network using response time (RT) to a warning signal, the orienting network is tested using RT with accompanying cues to where the target will occur and the executive network is tested using a central stimulus surrounded by incongruent, congruent and neutral flankers(Fan et al., 2002). The test consists of 4 cue conditions (no cue, centre cue, double cue and spatial cue), 3 flanker conditions (neutral, congruent and incongruent), 1 practice block and 3 experimental blocks with 96 trials(Fan et al., 2002). The ANT was delivered online using the Inquisit Web software, which runs in most browsers using most devices https://www.millisecond.com/download/library/ant (Millisecond Software).

#### 6.4.3.3 Ruminative Responses Scale (RRS)

The RRS is a 22 item self-report questionnaire using a four-point Likert Scale ranging from “1 – almost never” to “4 – almost always” and has been shown to have high internal validity $\alpha = .90$ (Luminet, 2003; Nolen-Hoeksema et al., 1994).

#### 6.4.3.4 Penn State Worry Questionnaire (PSWQ)

The PSWQ is a 16-item self-report questionnaire designed to measure the generality, excessiveness and uncontrollable dimensions of worry. It shows good internal consistency ($\alpha = .91$) and, in tertiary student samples, correlates positively with

measures of psychological constructs associated with pervasive worry such as perfectionism and generalised anxiety disorder (Meyer et al., 1990).

#### 6.4.3.5 Perceived Stress Scale – 10 item (PSS-10)

The PSS-10 contains 10 questions regarding thoughts and feelings to measure perceived stress. Using a Likert Scale ranging from "0 - never" to "5 - very often", it asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (Cohen, 2012; Cohen et al., 1983). Four of the questions are reversed scored. A review of its validity found that it has internal consistency ($\alpha > .70$) in all 12 studies used and satisfactory test-retest reliability (Lee, 2012). It has been shown to have strong validity in student populations (Smith et al., 2014).

#### 6.4.3.6 Burnout Assessment Tool – Work Related Version (BAT)

The BAT is made up of the BAT-C (Core) and BAT-S (Secondary). The BAT-C has 23 questions and four core dimensions; exhaustion, mental distance, emotional impairment and cognitive impairment. The exhaustion component uses 8 questions to assess both mental and physical exhaustion. The mental distance component uses 5 questions to measure if a participant is psychologically distancing themselves from work. The emotional impairment component uses 5 questions to measure if emotional impairment is present during intense emotional reactions. Lastly, the cognitive impairment component uses 5 questions to measure memory issues, concentration deficits and reduced cognitive performance. The BAT-S has 10 questions and includes two secondary dimension; psychological complaints and psychosomatic complaints. All the items use a 5-point Likert scale (Schaufeli, 2019; Schaufeli et al., 2020). The internal consistency for the BAT-C was found to be good as a whole and for each subscale. ($\alpha_{total} = .95$; $\alpha_{exhaustion} = .92$; $\alpha_{mental\ distance} = .91$; $\alpha_{cognitive\ impairment} = .92$; $\alpha_{emotional}$

$_{impairment}$ = .90). For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; Schaufeli et al., 2020). For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; Schaufeli et al., 2020).

### 6.4.4 Data analysis

The meditation habits questionnaire results were used to obtain an understanding of the number of participants who practice mindfulness techniques, the types they practice, and the average reported time spent doing focused meditation per week. These measures should be correlated with scores on the PSS-10, the RRS and the ANT-R.

The results from the ANT-R were examined for each of the attention networks. The alerting effect is calculated using the difference between the mean RT for correct responses in the no cue condition and the mean RT for correct responses in the double cue condition. The orienting effects are calculated using the difference between the mean RT for correct responses in the centre cue condition and the mean RT for correct responses in the spatial cue condition. The conflict effect (executive control) is calculated using the mean RT for correct responses in the incongruent condition and the mean RT for correct responses in the congruent condition.

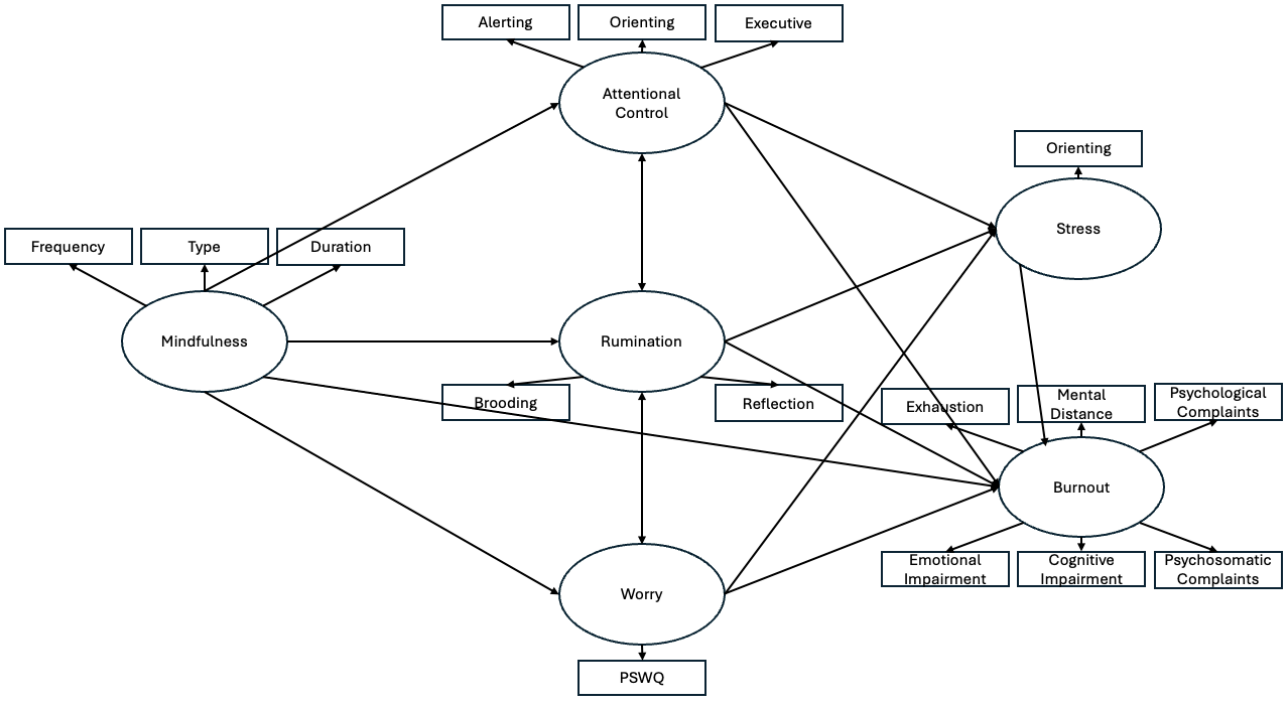
A meta-analysis of meditation studies and attentional control found meditation led to greater alerting effects ($\kappa$ = 77, g = 0.158, SE = 0.050, z = 3.14, p = .002) and executive control ($\kappa$ = 155, g = 0.203, SE = 0.031, z = 6.54, p < .001) but not orienting effect ($\kappa$ = 21, g = −0.086, SE = 0.074, z = − 1.16, p = .248)(Sumantry & Stewart, 2021). This study did not specifically look at time spent meditating but did find in a moderator analysis that the time spent significantly moderated the effect of meditation on alerting effect (Sumantry & Stewart, 2021).

A study examining attention networks and brooding rumination found that executive control, and not alerting effect and orienting effect, were negatively moderately correlated with brooding measures in the RRS ($r(n) = -.29, p < 0.05$) (DeJong et al., 2019).

Structural equation modelling was conducted, using R Studio and the lavaan, dplyr, tidyr, purr, readr, tibble, ggplot2, lmtest, gvlma and gridExtra packages, and used to analyse the relationship between the amount of average reported time spent doing meditation, the scores for alerting effects, orienting effects and conflict effects on the ANT, the brooding rumination score and the PSS-10 and MBI-GS scores. The predicted relationships are shown in Figure 15 (RStudio, 2020). It is predicted the indirect pathway through the mediators of attention control and rumination will be significant with the indirect path through conflict (executive function) and rumination having the greatest effect. The direct pathway is still predicted to be significant with increased meditation time correlating with reduced PSS-10 and MBI-GS scores as the attentional control/rumination pathway is thought to be one of several pathways between meditation and stress and burnout.

**Figure 15**

*Proposed attentional control pathway*




## Results

The data were cleaned and any test data prior to the commencement of participant recruiting was removed. Entries for participants who had not consented to the study data being used as outlined *(n* = 18) or did not have answers for the surveys were also removed (*n* = 20).

RStudio was used to calculate PSS-10 total scores, BAT scores (including sub-dimension), RRS scores (including brooding and reflection dimensions), PSWQ total scores and ANT Alerting, Orienting and Conflict scores. It was found that many entries consisted of scores for Mindfulness Habits, RRS, PSWQ, PSS-10 and BAT (*n* = 276*)* but not ANT (*n* = 196). Several participants had reported issues using the Inquisit software which might indicate the reason behind this. Additionally, the Inquisit software required the use of a computer with a keyboard, rather than a smartphone or tablet which might also explain some of the missing ANT data.

The pre-registered model was tested. Of note, the pre-registered model had two errors in the diagram. Additionally, due to an error in the use of OSF, the registered report was uploaded but not registered. However, no changes were made between upload and registration. The observed variable loading onto stress should have read 'PSS-10' not orienting and secondly, there should have been a direct path from mindfulness to stress. After correcting for these errors, the pre-registered model did not converge after 1,363 iterations.

### 6.5.1 Exploratory Analysis

Given the lack of support for the pre-registered model, an exploratory analysis was undertaken. Due to the lack of convergence, the model modification method of removal of measurement indictors was conducted (Xiong et al., 2025). In this method, the weakest factor is removed and the model retested. The weakest factor was that of Type_movement, followed by Type_other, followed by Type_focused (frequency was the next weakest but type was treated as one observed variable so type variables were removed first). Lastly Type_mixed was removed. Although, global fit measures improved modestly as types were removed, all of these models had the variance-covariance matrix for the estimated parameters as not positive definite.

Thirdly, mindfulness was a simplified version of the pre-registered model replacing the latent mindfulness construct with a composite variable consisting of z-scored self-reported mindfulness minutes per week using data from those who had stated they practiced mindfulness ($n$ = 172), and using the PSS-10 as an observed variable as it was a latent variable with a single loading which created instability. Those who did not practice had a score of 0 for this factor. The decision to substitute the composite variable was to maintain as close to the theoretical model as possible while retaining a conceptually meaningful operationalisation of the mindfulness measure, and

to remove the issues with the observed mindfulness variables not loading onto the latent mindfulness variable. The normality, skewness, and kurtosis were assessed for all observed variables. Inspection of the histograms, density plots, and descriptive statistics indicated that most variables approximated a normal distribution. The tested model fit was acceptable ($\chi^2(45) = 59.40$, $p > .05$, CFI = .977, TLI = .967, RMSEA = .043 [90% CI: .000, .071], and SRMR = .050).

With respect to measurement, BAT components loaded well onto the burnout latent variable ($\lambda = .63–.75$, $p < .05$), while brooding ($\lambda = .64$, $p < .05$) and reflection ($\lambda = .78$, $p < .05$) loaded strongly onto rumination. ANT loadings were very small and non-significant.

Mahalanobis distance plots identified a number of (n = 16) outliers exceeding 3SDs from the mean, pointing to extreme scores that could potentially disproportionately influence the model fit and path estimates. To minimise the impact of these outliers whilst preserving the sample size, the values exceeding 3SD were Winsorised to 2SD. Post-Winsorisation, the fit indices improved and indicated an adequate fit to the data ($\chi^2(45) = 48.60$, $p > .05$, CFI = .991, TLI = .987, RMSEA = .031 [90% CI: .000, .082], and SRMR = .074).

Meditation minutes did not significantly predict attentional control, rumination, worry, stress, or burnout. However, higher worry predicted greater rumination ($\beta = .54$, 95% CI [.06, .14], $p < .05$), and rumination was positively associated with both stress ($\beta = .36$, 95% CI [.35, 1.16], $p < .05$) and burnout ($\beta = .61$, 95% CI [.43, 1.11], $p < .05$). Worry also directly predicted burnout ($\beta = .19$, 95% CI [.00, .09], $p < .05$) but not stress. Altogether, the model accounted for 31% of the variance in rumination, 17% in stress, 57% in burnout, and minimal variance in attentional control and worry.

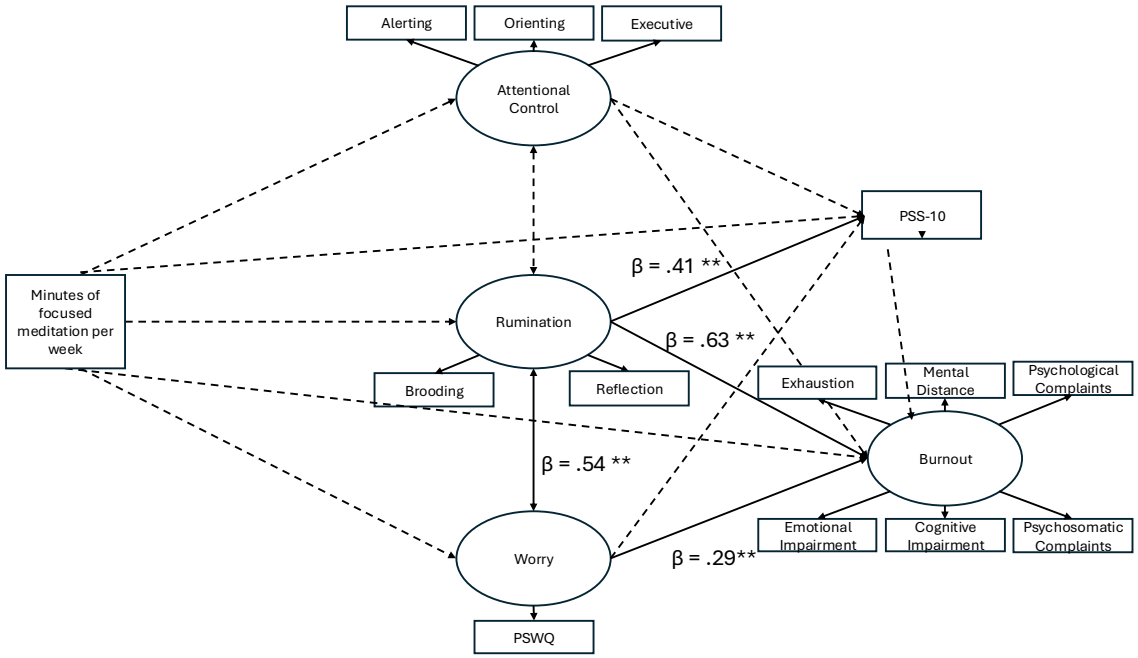
SEM assumption checks were performed. A visual inspection of scatterplots showed approximate linearity between predictors and outcomes, and residual-versus-fitted plots displayed no strong systematic patterns. Durbin–Watson tests indicated independence of errors with no strong evidence of autocorrelation. Breusch–Pagan tests were all nonsignificant supporting homoscedasticity. Histogram and Q-Q plots displayed approximate normality, though the exhaustion component of the BAT showed skew.

The same analysis was conducted for participants who had exclusively reported having conducted focused meditation (n = 82). The tested model showed acceptable overall fit ($\chi^2(45) = 48.60$, $p > .05$, CFI = .991, TLI = .987, RMSEA = .031 [90% CI: .000, .082], SRMR = .074) and is shown in Figure 16.

With respect to structural paths, the results were similar: meditation minutes did not significantly predict attentional control, rumination, worry, stress, or burnout. However, worry significantly predicted rumination ($\beta = .54$, 95% CI [.06, .14], $p < .05$). Rumination, in turn, was strongly associated with stress ($\beta = .41$, 95% CI [.34, 1.46], $p < .05$) and burnout ($\beta = .62$, 95% CI [.35, 1.43], $p < .05$). Worry also directly predicted burnout ($\beta = .29$, 95% CI [.02, .14], $p = .05$) but not stress. Altogether, the model accounted for 28% of the variance in rumination, 23% in stress, and 65% in burnout, while explaining minimal variance in attentional control.

**Figure 16**

*SEM diagram for focused meditation practitioners*




SEM assumption checks were conducted and scatterplots and residuals-versus-fitted plots showed approximately linear relationships. The Durbin–Watson tests showed independence of errors for all outcomes. Breusch–Pagan tests showed homoscedasticity overall with the exception of the emotional impairment component of the BAT. Histogram and Q–Q plots suggested approximate normality, although several BAT components (mental distance, cognitive impairment, emotional impairment) exhibited skew and kurtosis. Consistent with this, the GVLMA global tests flagged violations in skewness and kurtosis for most outcomes.

## Discussion

Whilst this study sought to determine the mechanism by which mindfulness practice can lead to reduced stress and burnout, it found no significant relationship between self-reported mindfulness minutes practice and stress and burnout. This does not align with previous studies and reviews that have demonstrated a reduction in stress

and burnout in those who conduct mindfulness practice (Chu et al., 2024; Hölzel et al., 2011; Sedlmeier et al., 2012). These findings may highlight an issue with using mindfulness quantity as a measure of mindfulness. Even when the model was restricted to only focused meditation minutes in an aim to have a more homogeneous measure of mindfulness, mindfulness minutes still did not predict worry, rumination, attentional control, stress or burnout. In a previous study, it was found that mindfulness quantity did not predict improved long term health outcomes, whilst mindful quality did. (Goldberg et al., 2014).

This study also found no effect of attentional control on stress, burnout, worry or rumination. This contrasts with the Attentional Control Theory that posits that greater attentional control should buffer against worry and rumination and assist in emotional regulation (Eysenck et al., 2007)). This result could reflect issues of mixing self-report measures such as the PSWQ and BAT with objective measures such as the ANT used in this study. Previous studies using both self-report (Attention Control Scale; ACS) and reaction time measures of attention (ANT) have found relationships between self-report measure with self-report measures of anxiety but not with the ANT (Reinholdt-Dunne et al., 2013).

Instead, the study identified rumination as a central mechanism with high levels of worry predicting high levels of rumination and in turn strongly predicting both stress and burnout. This verifies the interconnected nature between rumination, worry, stress and burnout. The present findings highlight a clear cognitive risk pathway from worry to rumination and, in turn, to both stress and burnout. The strong links between worry, rumination and stress is consistent with the perseverance cognition hypothesis which posits that ongoing engagement with stressors, such as rumination, lead to prolonged physiological and psychological activation (Brosschot et al., 2006). The finding that

rumination as the dominant predictor of burnout also indicates that burnout is not only a reaction to current stress levels but also a downstream consequence of sustained rumination.

This study extends on the previous literature by combining the analysis of attentional control, worry, rumination, stress and burnout. This integrated approach underscores the possibility that reducing worry and rumination may have the dual benefit of lowering both stress and burnout whereas interventions that focus solely on stress management may not fully address the burnout risk.

Limitations in the measurement of mindfulness in this study make it difficult to fully understand the implication of mindfulness practices in reducing stress and burnout. This stems from the long-standing issue of the difficulties in defining and measuring mindfulness. The debate on whether mindfulness should be treated as a state, a trait or a practice has been long standing. What is clear here, is that a self-reported measure of duration of practice in isolation may not be sufficient to capture the benefits of mindfulness practices.

Whilst the relationship between mindfulness practice and stress and burnout was not able to be established in this study, it did highlight the relationship between attentional control, worry, rumination, stress and burnout. Future interventions and treatments for burnout should examine the pathway to reduce burnout by reducing worry and burnout and potentially increasing attentional control. Additionally, future research should examine the effectiveness of mindfulness practices in doing this and the impact of quality of mindfulness practice in conjunction with quantity as well as state measures of mindfulness.

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**Author contributions**

P Chu was the primary author with the assistance of thesis supervisors at the University of Adelaide, C Semmler and F Kerr. M Chu and H Chu for provided proof reading and review.

**Conflicts of interest**

P Chu is the founder and director of Design Your Life PTY. LTD. which provides exercise, yoga, and meditation services to both individuals and as part of corporate wellness programs.

**Data availability**

The data that support the findings of this study are openly available in the Open Science Framework (OSF) at https://osf.io/sdfep/.

# Chapter 7: Conclusion

## The Significance of Burnout and the Rationale for this Thesis

The prevalence of burnout has increased across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). After the SARS pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health.

Burnout has significant impact to the individual, the workplace and society in general. Individuals experience emotional exhaustion, cynicism, and reduced efficacy, while organisations suffer the costs of absenteeism, reduced productivity, medical errors and staff turnover (Hassard et al., 2014). This has a substantial cost to society making burnout research not merely an academic pursuit but a public health priority.

This thesis was originally undertaken to attempt to address this challenge by examining ways to prevent burnout. However, after some initial research, several limitations in the current research were found, and the aim moved toward building on and advancing the field of burnout research whilst also using meditation as a test case for prevention.

## Building on the Historical Conceptualisation of Burnout

Burnout research is a relatively young but increasingly critical field, reflecting the demands of modern work and the rising recognition of stress-related health outcomes. Its origins in the 1970s were primarily observational, emerging from clinical descriptions of exhausted professionals working in high-demand contexts. The early case studies offered vivid accounts of exhaustion, disillusionment, and reduced

motivation (Freudenberger, 1974). These early contributions gave burnout visibility as a psychological phenomenon, but they were largely descriptive, providing limited empirical grounding.

By the 1980s and 1990s, burnout had become a measurable construct, yet much of the research remained tied to observational and correlational designs. The shift toward measurement marked an important milestone. Research had shifted the field into a more empirical era by formalising burnout as a multidimensional construct resulting in the Maslach Burnout Inventory (MBI), which remains the most widely used tool to this day (Maslach & Jackson, 1981; Maslach et al., 2001). Other instruments followed, such as the Shirom–Melamed Burnout Measure (SMBM) and the Bergen Burnout Indicator (BBI)(Feldt et al., 2014; Shirom & Melamed, 2006). Yet the systematic review conducted in this thesis confirmed that despite decades of refinement, burnout research still relies almost exclusively on a small set of self-report scales, with physiological measures appearing in only a handful of studies. This transition from narrative description to psychometric measurement represented an important advance, but it also anchored the field heavily in self-report methodologies and symptom descriptions, rather than in explanatory mechanisms. As shown in the systematic review, this reliance on a small set of self-report measures remains a central limitation today.

One of the aims of this thesis was, therefore, to move beyond sole reliance on self-report. By integrating Heart Rate Variability (HRV) alongside Ecological Momentary Assessment (EMA), it addressed the call for multi-modal measurement. This integration is not common in the field and the systematic review found that less than 10% of studies included any physiological data. This, therefore, represents a step toward conceptualising burnout under a biopsychosocial conceptual framework.

By the 1990s and early 2000s, burnout research expanded into the intervention era resulting in the popularity of mindfulness-based stress reduction (MBSR) and later interventions such as the Stress Management and Resilience Training (SMART) program (Chaukos et al., 2018; Kabat-Zinn, 1990). However, as highlighted in the systematic review, these interventions are highly heterogeneous and blend meditation with yoga, breathing techniques and psychoeducation. This makes it difficult to isolate the mechanisms of change. Additionally, effect sizes varied widely, and the methodological quality of many studies was modest.

To address this limitation, the randomised experimental study in this thesis used an intervention that isolated focused meditation as a single component. By removing the "bundling" that characterised earlier interventions, this design enabled more precise conclusions about the role of meditation itself. This methodological precision represents a contribution, offering a replicable framework for future trials and meta-analyses. As noted in the systematic review, heterogeneity was one of the most significant barriers to cumulative knowledge in the field, and this thesis provides one pathway toward resolving that barrier.

Another persistent feature of burnout research has been the dominance of pre–post designs, with limited use of randomisation and control groups. The systematic review found that control groups were often absent or poorly matched, leaving interventions open to placebo effects and expectancy biases. This thesis addressed this methodological weakness by employing randomised controlled designs with appropriate control conditions, strengthening causal inference. Moreover, rather than limiting assessment to pre- and post-intervention surveys, it employed daily measures of stress and affect, capturing fluctuations in real time.

Equally prominent in the review was the overwhelming treatment-focus of existing studies. Nearly all interventions targeted participants already experiencing elevated burnout, positioning meditation as a remedy rather than a preventive strategy. This reflected a reactive model of occupational health where one waits until stress becomes pathology before intervening. Responding to this gap, the studies utilised a novel methodology whereby meditation interventions were introduced prior to a predictable stressor, testing its role in prevention rather than treatment. This reframing is significant and suggests that meditation may function as a resilience-building practice that reduces the likelihood of burnout onset, not merely as a coping strategy once symptoms emerge.

Perhaps the most enduring limitation of burnout research has been its atheoretical orientation. Symptom descriptions remain dominant and explanatory mechanisms remain underdeveloped and despite four decades of research, there has been little progress toward a unified theory of burnout (Maslach & Schaufeli, 2017). The systematic review verified this trend. Few studies attempted to articulate how or why meditation might reduce burnout, beyond general references to stress reduction or relaxation. These studies did little to move the field toward causal understanding. In other words, while burnout was now being measured, the science remained largely descriptive.

This thesis sought to advance the field by developing and testing a novel theoretical model, centred on attentional control, rumination, and worry. Drawing on cognitive theories of attention and perseverative cognition, the model posits that meditation enhances attentional control, which reduces maladaptive rumination and worry, thereby reducing stress and burnout (Brosschot et al., 2006; Eysenck et al., 2007). While empirical support for the model was partial, it did identify rumination as

central to burnout. Accordingly, despite only partial support for the model, act of articulating and testing a complex and integrated model represents an important step forward, and its findings highlight rumination and worry as key targets for future research.

Together, the historical trajectory and the findings of the systematic review converge on four persistent limitations including a reliance on self-report measures, weak methodological designs, treatment-focused interventions and a lack of theory. Each of these has been directly addressed in this thesis. Through the development of a novel randomised experimental study methodology, the integration of biophysiological with self-report data, the testing of meditation as a preventive intervention and the development and testing of a theory-based mechanistic model, this work advances the conceptualisation of burnout. Importantly, these contributions are not isolated: each one builds upon the lessons of the systematic review, demonstrating how synthesis of existing knowledge can directly inform methodological and theoretical innovation.

In this way, the thesis positions itself within the ongoing historical arc of burnout research. Just as the field moved from observation to measurement, and from measurement to intervention, this research moves from treatment to prevention, from reliance on self-report to multi-measurement integration, and from atheoretical description to theory-driven modelling. The remainder of this concluding chapter is therefore structured around these advances.

### 7.2.1 From Self-Report to Multi-Modal Assessment

From its origins, observation, followed by measurement, has been the corner stone of how burnout has been studied and understood. The introduction of the MBI, transformed burnout into a set of clinical observations into a construct that could be quantified and tracked across populations (Maslach & Jackson, 1981). From then on,

MBI's three dimension, emotional exhaustion, depersonalisation and reduced personal accomplishment, became the standard. Other instruments followed, such as the SMBM, and the BBI and the BAT broadening the field's psychometric repertoire (Feldt et al., 2014; Shirom & Melamed, 2006).

Yet, despite these advances, the systematic review found that burnout research is overwhelmingly reliant on a narrow set of self-report scales. Across the reviewed studies, over 90% use only self-report data and physiological measures appeared in less than 10%. This imbalance leaves burnout research with three major weakness. It is difficult to establish burnout as a distinct construct, burnout research is vulnerable to the risks of bias and subjectivity inherent in self-report measures and a lack of insight into the underlying mechanisms that questionnaires alone cannot capture.

#### 7.2.1.1 Conceptual Critiques of Self-Report Measures

There have been long standing questions regarding the distinctiveness of burnout. Burnout has several overlapping symptoms with depression such as low energy, inability to concentrate, fatigue and sadness (Bianchi & Schonfeld, 2016). It also shares several common symptoms with anxiety such as relentless, headache and emotional exhaustion (Bährer-Kohler, 2013; Melamed et al., 2006). As self-report questionnaires largely capture self-observed symptomology, they make it difficult to differentiate between these conditions. The systematic review highlighted this limitation: when almost all studies use the same few questionnaires, it becomes impossible to know whether the results reflect real features of burnout or just the way those questionnaires are designed.

The second issue with self-report measure is bias. Self-report is vulnerable to common method variance, defensive bias and recall errors. Common method variance occurs when predictor and outcome variables are collected from a self-report instrument

and can artificially inflate the relationships between constructs (Podsakoff et al., 2003). In the context of burnout research, this means that associations between stress, burnout and other related outcomes may partly reflect shared method variance rather than true psychological links. In terms of defensive bias, it has been found that, in the context of a work stress survey, employees avoid reporting accurately for fear of negative ramifications from management (Greulich et al., 2024). Lastly, considering the reliance on pre-post- study design found in the systematic review, recall errors may also unduly affect the results of burnout research.

The third weakness of self-report measures is mechanistic bias. Self-report tools capture the experience of burnout but are unable to reveal the biological or mechanistic processes underlying that experience. Burnout has been associated with dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis and autonomic nervous system function (Eriksson & Wallin, 2004; Melamed et al., 2006). Without physiological or behavioural markers, however, these processes remain invisible in most studies and burnout research remains descriptive and limited to surface-level symptoms rather than theory and mechanisms.

#### 7.2.1.2 Moving to Multi-Modal Measurements

One significant contribution of this thesis is to directly address this measurement imbalance. Recognising that burnout is both a subjective experience and a biological process, the studies integrated self-report with biophysiological measures, particularly heart rate variability (HRV). The chronic stress symptoms associated with burnout is suspected to be caused by sustained activation of the sympathetic nervous system and this is reflected in HRV measurements (Raymond Trevor et al., 2009). However, the systematic review found that HRV has been largely absent from burnout studies. The randomised experimental study outlined in this thesis demonstrates a novel

approach of incorporating HRV measures alongside measures of self-reported perceived stress by asking participants to use software on their existing smartphones in conjunction with their smartphone camera.

This novel approach allowed for cost effective, easy to use, self-administered daily measures of HRV using EMA. This, combined with daily PSS-EMA measures of daily perceived stress, allowed for the capture of daily fluctuations in stress. This has the advantage of reducing recall bias by collecting data close to the moment of experience and allows researchers to dynamic processes of stress. The self-administered and cost-effective deployment of measuring apparatus also allows for greater sample sizes, daily measures and a more naturalistic environment when compared to using HRV ECGs in a laboratory setting.

#### 7.2.1.3 Evidence from the Thesis

The findings of the first randomised experimental study were mixed and highlighted both the value and the challenges of adopting multi-modal assessment. On one hand, participants in the meditation group reported reductions in perceived stress, and within this group, higher levels of engagement with the meditation practice predicted greater reductions. This dose-response pattern was observable in both pre-post measures and daily EMA, supporting the sensitivity of subjective tools for capturing changes in perceived stress over short interventions. However, effects on burnout were less clear: while there was some evidence that increased meditation predicted lower emotional exhaustion, there were no changes in cynicism or personal accomplishment. This aligns with theoretical accounts suggesting that exhaustion is the first burnout dimension to respond to interventions, with the other components likely requiring longer exposure to show change.

By contrast, HRV indices showed no significant intervention effects. The lack of findings here should be interpreted cautiously. As noted in the discussion, HRV is highly sensitive to multiple confounds and may not reliably capture change in unsupervised, smartphone-based assessments. Moreover, HRV and perceived stress may reflect different aspects of the stress response, meaning that divergence between the two measures is not necessarily contradictory but rather informative. Finally, it is possible that physiological adaptations to meditation emerge only with longer or more intensive practice, as suggested by inconsistencies in the broader mindfulness-HRV literature.

Taken together, these findings illustrate both the promise and the limitation of moving beyond self-report. The use of EMA enabled the detection of dose–dependent patterns in daily stress that would have been invisible in pre/post designs, while HRV provided a complementary perspective that underscored the difficulty of capturing subtle physiological changes in naturalistic field conditions. Ultimately, these studies underscore that progress in burnout research depends on triangulation: single-method studies risk producing incomplete or misleading conclusions, whereas multi-modal designs, even when findings are mixed, provide the most balanced and informative account of how stress and burnout unfold.

#### 7.2.1.4 Feasibility and Challenges of Physiological Data Collection

Introducing HRV into a student sample also allowed the thesis to test the feasibility of biophysiological monitoring in non-clinical populations. Whilst it demonstrated a novel way to collect daily HRV data, in combination with daily PSS-EMA data away from the laboratory environment, compliance challenges were noted. Additionally, while the self-collection of HRV data at home provided advantages or daily collection in a natural environment, when compared to traditional laboratory EEG

measures, it is not known if the divergence between the self-reported data and the HRV data was due to a fundamental difference in what they were measuring or individual measurement issues. These limitations highlighted the practical difficulties of deploying physiological measures outside laboratory settings. Nevertheless, the studies demonstrated that it is possible to integrate HRV with self-report at scale, offering a methodological pathway for future research.

This issue notwithstanding, the divergence between self-report and physiology observed in the results is itself could constitute a critical finding. It suggests that burnout may manifest differently at subjective and biological levels which studies that rely soley on self-report are unable to detect.

#### 7.2.1.5 Implications for Burnout Research and Future Directions

The integration of multi-modal measurements of stress and burnout makes three key contributions to the existing burnout literature. It provides a pathway forward away from self-report measures of burnout toward a more objective combination of self-report and biophysiological measurements. It enhances methodological rigour by reducing reliance on self-report measurements which are subject to bias and error. It also opens pathways toward the mechanisms behind burnout by providing insights into the stress-regulatory systems involved.

The inclusion of EMA techniques helped to bridge the gap between burnout as a process and a state as well as examining the dosage-response relationship between interventions and burnout.

These advances are not purely academic. Given the risk of defensive bias in workers surveyed about workplace stress, regular HRV measurements in the workplace, in conjunction with surveys, could help to flag issues of systemic burnout within high risk workplaces in order to provide preventative support.

Another promising direction is multimodal measurement, combining wearable sensors, smartphone-based EMA, and traditional surveys. With advances in digital health technology, it is increasingly feasible to capture high-resolution data on stress, sleep, activity, and affect in real-world contexts. Burnout research can leverage these tools to move beyond snapshots and toward continuous monitoring.

While the integration of HRV and EMA represents a step forward, it is not without limitations. HRV is influenced by multiple factors, such as caffeine, sleep, physical activity, making interpretation complex. The prevalence of burnout has increased across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). With the events of the SARS pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health and inflammatory biomarkers could provide complementary insights into HPA axis and immune function, broadening the biological picture of burnout.

Finally, integrating physiology into prevention trials, particularly in high-risk groups such as healthcare professionals and first responders, could establish whether interventions like meditation have measurable effects on stress-regulatory systems. This would not only strengthen causal claims but also bridge the gap between psychology, physiology, and occupational health.

In summary, burnout research has been held back by its dependence on self-report, a limitation confirmed in the systematic review and demonstrated in the present studies. By combining self-report with HRV and EMA, this thesis has shown both the feasibility and necessity of multi-modal measurement. While these findings are

preliminary and require replication in larger and more diverse samples, they provide a clear demonstration that burnout can and should be studied using multi-modal designs.

### 7.2.2 From Treatment to Prevention

As burnout became more widely recognised as a health concern in the 1980s and 1990s, the research focus shifted from describing and measuring the syndrome toward developing interventions designed to alleviate it. This marked the beginning of the "treatment era" of burnout science. MBSR is was one of the first structured mindfulness-based progress tested for its impact on stress and wellbeing and by the early 2000s, had been used in studies promising reductions in stress, anxiety and burnout, particularly in healthcare (Kabat-Zinn, 1990). Later on, other intervention such as SMART further demonstrated perceived improvements (Chaukos et al., 2018). In the systematic review, MBSR, modified versions of it, were used in the majority of studies with SMART being the next most used.

The systematic review also highlighted that almost the entire body of burnout intervention research was treatment-focused. Across the studies, nearly all targeted participants were already experiencing burnout and the goal was framed as symptom reduction. The emphasis was squarely on treating burnout once it had manifested, rather than asking how burnout might be prevented in the first place.

#### 7.2.2.1 Treatment Alone is Insufficient

There are clear problems with an exclusively treatment-focused approach to burnout. First, it reinforces the view of burnout as an occupational disease that must be managed once it has already developed, rather than a preventable risk factor that can be mitigated earlier. This medicalised framing has significant consequences: it encourages reactive interventions that arrive late in the stress process, often when individuals are

already in distress and potentially experiencing comorbid conditions such as depression or anxiety.

Second, treatment approaches neglect the structural realities of high-risk occupations. Arguably, professions such as healthcare, emergency response and the military are characterised by unavoidable and chronic stressors. These include job demands such as amount of travel, potential or lack thereof for growth, physical demands, working condition, hazards, public interaction, human-computer interaction, daylight exposure, shift work, ambient noise, competitive environment, risk of injury (self or other), severity of deadlines and public scrutiny (Bährer-Kohler, 2013; Wilkie, 2018). It also includes emotion work, including emotional dissonance, where workers are required to express emotions which are not genuinely felt (Zapf et al., 2001). Healthcare workers are often required to be caring and nurturing even when they do not feel so inclined, emergency responders are routinely placed in emotionally triggering situations with an inability to express their natural responses and the military are often required to suppress emotions in combat to increase their likelihood of survival (Abraham, 2000; Arsenault, 2015; Bonanno, 2004; Zapf et al., 2001). From this, it may be argued that burnout is highly likely in these fields, if not unavoidable. Even in the students who were the participants in the randomised experimental study, the increased in stress during the assignment period and during examinations is predictable and largely unavoidable. In such contexts, treatment becomes inadequate even when interventions succeed in alleviating symptoms in the short-term, the unrelenting occupational stressors quickly reassert themselves and individuals cycle back into burnout.

Thirdly, treatment-focused approaches can be costly and inefficient. From both organisational and societal perspectives, the financial and human toll of waiting until

symptoms reach crisis point is unsustainable. Burnout has been attributed to increase in absenteeism, medical errors and employee turnover which all have both a human cost and a financial one (Aiken et al., 2004; Argentero et al., 2008; Formanoy et al., 2016; Hassard et al., 2014; Poghosyan et al., 2010; Shanafelt et al., 2002; Tei et al., 2014; West et al., 2010; Williams et al., 2007). Given the cost, prevention measures could drastically reduce the impact of burnout on workers, workplaces and society in general.

Lastly, there is a theoretical rationale for prioritising prevention. Stress-inoculation models and resilience frameworks argue that proactive, prevention strategies can build the capacity to withstand future stressors (Meichenbaum, 2017). Mindfulness, with its emphasis on changes to attentional control and emotion regulation is well suited to serve this preventive role. Rather than being positioned only as a "treatment" once exhaustion and cynicism have already taken hold, meditation can be conceptualised as a resilience-building intervention that mitigates the risk of burnout onset.

For these reasons, prevention is not merely a desirable alternative but a necessary evolution in burnout science. It reflects the occupational realities of high-risk professions, aligns with public health principles of proactive care, and addresses the unsustainable costs of treatment-only models.

#### 7.2.2.2 Evidence from the Thesis

The randomised experimental studies in this thesis provided a novel design methodology with the aim to test the preventive properties of meditation. By identifying a predictable period of increased stress, the study introduced meditation prior to the increase of stress. The study provides a proof of concept and a methodology to test ways to prevent burnout. This could be used in high-risk occupations prior to

predictable stressful periods such as emergency service personnel prior to a period of shift work, or with military members prior to deployment, for example.

The findings were modest but important. Participants in the meditation group did not show broad improvements across all burnout dimensions, but greater engagement with meditation predicted reductions in emotional exhaustion. This is significant because exhaustion is often theorised as the earliest and most proximal dimension of burnout (Maslach & Leiter, 2016), and it may be the first to shift under preventive conditions. The absence of effects on cynicism and personal accomplishment likely reflects the short duration of the intervention and the relatively early stage of burnout risk in a student sample, rather than evidence that prevention is ineffective.

The second aspect of the study design, EMA, also provided further nuance in analysing meditation as preventative intervention. Participants who meditated more frequently reported lower perceived stress across the study period, particularly during the peak stress window of assignment deadlines. The dose-response pattern observed here is critical and suggests that preventive meditation does not simply reduce stress retrospectively but may help modulate its development during predictable high-risk periods. Physiological measures (HRV) did not show preventive effects in this trial, echoing the broader inconsistency in the HRV literature. This highlights that preventive effects may first emerge at the subjective level before becoming physiologically detectable. These findings highlight the strength of EMA in detecting dynamic stress responses that would have been invisible in simple pre–post designs.

Taken together, the findings show that prevention is both possible and challenging. They provide preliminary evidence that meditation can reduce stress and exhaustion during predictable high-demand periods, but they also reveal the limitations of short-term interventions and the difficulty of detecting physiological change.

Crucially, however, the design itself demonstrates how preventive interventions can be tested in naturalistic contexts. By situating meditation prior to stress, the randomised experimental study shifts the field away from a treatment model toward a framework of prevention.

#### 7.2.2.3 Implications of Burnout Research and Future Directions

The thesis contributes in moving burnout research from a treatment mindset to one of prevention in three important ways. Firstly, it introduces a new prevention-oriented study methodology. Delivering interventions prior to a predictable stressful period and measuring the changes in stress and burnout across time provides a novel way to test the ability for interventions to prevent burnout. Secondly, the use of EMA shows a modest dose-response relationship illustrating that meditation can help individual's escalation of stress prior to exhaustion and burnout. Lastly, it utilises emerging technologies in smartphone software and cameras to enable the daily taking of biophysiological measures to assess the effectiveness of preventive interventions.

Future research can build on this by extending preventative designs into high-risk occupational groups such as military members prior to deployment, police officers prior to their probationary phase, ambulance officers prior to their first shifts and healthcare workers prior to starting at hospitals. They could also include longer programmes that continue to measure participants for longer during the predicted stressful period. Lastly, investigation and use of other biophysiological measures that can be deployed into the home and used daily would provide further evidence of adaptation and prevention of burnout and stress.

Historically burnout research has been overwhelmingly focused on treatment after the fact. This thesis contributes to the necessary paradigm shift toward prevention through the development of a methodology that allows the testing of preventive

interventions. Whilst the findings were modest, they provide the vital first steps toward reframing burnout research toward a mindset of prevention rather than purely treatment and recovery. In doing so, this thesis contributes to a paradigm shift: from burnout as a condition to be treated after the fact, toward burnout as a risk that can be anticipated, buffered, and ultimately prevented.

### 7.2.3 Moving away from Heterogeneous Bundles to Focused Meditation - Clarifying Intervention Effects.

One of the most persistent limitations highlighted in the systematic review was the heterogeneity of burnout interventions. Across the studies included, the vast majority of interventions labelled as “mindfulness-based” were in fact complex, multi-component programmes. The most frequently used was MBSR, which combines sitting meditation with body scans, yoga, breathing techniques, and psychoeducation (Kabat-Zinn, 1990). Other popular formats, such as the SMART program, blended meditation with cognitive-behavioural strategies, group discussion, or resilience education (Chaukos et al., 2018). However, the bundling of multiple elements into single interventions creates serious challenges for stress and burnout research. Firstly, it makes it difficult to compare different studies, secondly, it obscures the mechanisms behind the intervention effects and thirdly, it muddies any recommendations from the research and takes away its credibility.

This first issue is caused by the substantial variability in reported effect sizes. While, the systematic review found significant reductions in stress and burnout in several studies, the magnitude of effects varied widely across trials. Lack of standardisation in intervention content, duration and delivery makes comparison across studies problematic. Each new study brings its own idiosyncratic findings that are difficult to synthesise with others leaving the field fragmented.

Secondly, intervention heterogeneity obscures the mechanisms behind the interventions. If “mindfulness” is always delivered in a package with yoga, psychoeducation, and group support, it is impossible to know whether attentional training itself reduces burnout, or whether other elements contribute. Thus, it becomes nearly impossible to determine whether observed improvements are due to meditation or from other components such as yoga or relaxation. This also makes developing a theoretical model on the mechanisms at play difficult.

Lastly, intervention heterogeneity creates a muddiness in the research where employers are left with the vague claim that “mindfulness helps” without knowing what that practice looks like or how and why it works. It has been argued that mindfulness hype has outpaced the evidence and heterogenous interventions contribute to this notion. In turn, this can undermine the credibility of the field and make workplaces less likely to employ potentially useful burnout prevention programs. If burnout research is to progress and gain credibility, it is important to move toward a position where the active components are identified and isolated. This will also allow us to identify whether there is a synergistic or amplification effect from specific interaction between any of the components in future work.

One major contribution of the thesis was to directly address this issue by testing meditation as a single, isolated component. The randomised experimental studies deliberately used focused meditation in the absence of yoga, education and other stress management techniques which may interfere with the measurements. The intervention was instead standardised and delivered using a smartphone application to allow for a more consistent intervention. It was also compared against a control group who received a ‘sham’ meditation recording of equal duration to further reduce the other conflating elements such as the placebo effect or the effect of merely sitting and

pausing each day. This intervention choice in the design reduces confounds allowing for a clearer interpretation of the results, provided a replicable framework and contributed to theoretical clarify by testing whether focused meditation alone could influence burnout.

#### 7.2.3.1 Evidence from the Thesis

As outlined, the findings of the randomised experimental study were modest but informative. On self-report and EMA measures, participants who engaged more consistently in meditation practice reported reductions in perceived stress. This was particularly evident in the daily EMA data, which captured fluctuations in stress across the study period. A dose–response relationship was observed: more frequent meditation predicted lower stress levels, especially during the high-demand period of assignment deadlines. This suggests that meditation alone can exert meaningful, if modest, effects on subjective stress trajectories.

In terms of burnout, effects were limited but not absent. While no significant changes were observed in cynicism or personal accomplishment, a greater meditation dose was associated with reductions in emotional exhaustion. Exhaustion is often theorised as the earliest and most malleable dimension of burnout, and this finding supports the idea that meditation may help buffer the most proximal aspects of stress (Maslach & Leiter, 2016).

While HRV measures did not show significant intervention effects, this might indicate that short-term focused meditation, in isolation, may not be sufficient to create measurable changes in autonomic regulation.

The main point is that by isolating focused meditation, this randomised experimental study provides clearer evidence than many bundled multi-modal interventions. While the results were not as strong as predicted, they are unambiguous

in that any effect is more than likely caused by focused meditation alone. Without the noise of other type of mindfulness interventions, focused meditation was found to have benefits to perceived stress and emotional exhaustion but did not yield any physiological effects within the studied timeframe.

#### 7.2.3.2 Implications for Burnout Research and Future Directions

This contribution advances burnout research in five ways. The implications of this research to the field are in providing methodological clarity, conceptual precision, theoretical advancement, practical relevance, and scientific credibility. By removing other components, the RCT provides a cleaner test case for future reviews and a platform from which other researchers can build by isolating specific interventions for the prevention of burnout. It provides a firm definition of what the intervention is. Focused meditation is focusing on a specific stimulus such as the breath. This removes some of the issues caused by the differences in the definitions of 'mindfulness' and the variability that causes between studies. This also enables theoretical advancement. By showing that focused meditation in isolation can impact emotional exhaustion but not other burnout dimensions, it contributes to the theory-building surrounding the mechanisms of burnout. By demonstrating the difference between self-reported perceived stress and biophysiological markers of stress, it helps advance the theories of the development of and effect of stress on the mind and body. It provides practical relevance. The focused meditation that was tested in the randomised experimental study is available freely to the general public and is endorsed by the Australian Government Department of Health. It provides an accessible program for individuals and employers to use and helps them make informed decisions based on scientific evidence rather than vague promises of 'mindfulness'. This in turn, contributes to the scientific credibility of mindfulness and burnout research.

Historically, burnout interventions have been muddied by the ambiguity of bundled programmes, where meditation is delivered alongside a range of other techniques. This has left the field with suggestive but inconclusive evidence, unable to identify mechanisms or build cumulative knowledge. While the results of the randomised experimental study conducted were modest, it advanced the field by demonstrating what focused meditation alone can achieve. The methodological precision provides a contribution in its own right and provides a replicable framework for future studies, moves the burnout research field toward intervention homogeneity and contributes to the scientific credibility of the field. Lastly, it provides an accessible and tested tool for employers and employees to use to help in reducing perceived stress and burnout.

### 7.2.4 Toward a Burnout Theory – Rumination, Worry and Attentional Control

#### 7.2.4.1 The Atheoretical Legacy of Burnout Research and Why it Matters

From its genesis in the 1970, burnout research was founded by clinical observations before moving toward self-report measures. As such, most research was designed to measure burnout or the effectiveness of interventions for treatment and was largely not concerned with mechanisms or theories behind it. The systematic review showed that even now, burnout research remains atheoretical with the majority of studies testing interventions and reporting symptom changes rather than attempting to explain the mechanisms through which burnout develops or interventions exert their effects. This absence of theory weakens the study of the interventions. While studies may show that interventions reduce burnout scores, without understanding why, it is difficult to refine these interventions, predicts who will benefit most and under what conditions or identify the processes most in need of change.

From a practical perspective, the understanding of the mechanisms behind burnout can provide opportunities for interventions to target these mechanisms. This insight can also assist in the development of preventive measures rather than just the treatment of symptoms. For example, if burnout is largely driven by rumination and worry, then interventions should target these processes directly. By doing so, the progression of burnout can be preventive before it becomes an issue.

#### 7.2.4.2 Contribution of this thesis – Testing a Novel Model of Burnout

This thesis attempted to move beyond description and effectiveness of interventions by developing and testing a new model of burnout centred around attentional control, rumination and worry. The model integrated two theoretical perspectives, attentional control theory and the perseverative cognition hypothesis.

Attentional Control Theory proposes that stress will impair the efficiency of executive attention biasing cognition toward threat-related stimuli and reducing the ability to disengage from distracting information (Eysenck et al., 2007). In the context of burnout and occupational stress, the deficits in attentional control can limit a worker's ability to shift focus away from intrusive work-related concerns leaving them susceptible to burnout. On the other hand, mindfulness meditation is thought to strengthen the ability to focus and improve attentional control (Hölzel et al., 2011).

The Perseverative Cognition Hypothesis argues that prolonged unwanted thinking about stress, through rumination about the past or worry about the future, sustains the stress response long after the stressors have passed (Brosschot et al., 2006). In the burnout context, the rumination and worry sustain the stress response and become a mechanism that contributes to chronic stress and eventually burnout.

This thesis sought to bring these two perspectives together by proposing that burnout develops when deficits in attentional control allow rumination and worry to

dominate leading to burnout. In this way, individuals who struggle to regulate attention may be more prone to cycles of rumination and worry, which in turn prolongs the stress response leading to burnout. Conversely, it proposed that meditation can improve attentional control thus reducing worry and rumination, reducing stress and preventing the development of burnout.

This integration represents a novel synthesis of theories in burnout research. While attentional control and perseverative cognition have been studied separately in relation to anxiety and depression, they have not been combined into a single explanatory model for burnout. This was an important advance from much of the meditation-burnout literature which tended to report the outcome improvements without specifying mechanisms. In contrast, this proposed model articulated a causal pathway that could be empirically tested.

#### 7.2.4.3 Evidence from the Thesis

While the model tested was a novel advance to the literature, the results from the study were not as clear as anticipated.

Self-reported meditation minutes were not significantly related to stress, burnout, rumination or worry. This diverged from the earlier randomised experimental study which demonstrated a reduction in perceived stress and emotional exhaustion. One possible explanation is that self-reported mindfulness minutes does not capture the quality or depth of mindfulness engagement highlighting again, the difficulties in measuring mindfulness.

Attentional control was not associated with stress, burnout, rumination or worry, either. This challenges the predictions drawn from Attentional Control Theory. It may be reflective of the methodological challenges in combining subjective and objective attention measures.

However, the study did find that rumination was the central mechanism behind burnout. High levels of worry predicted greater rumination which in turn predicted both stress and burnout. This aligned with the perseverative cognition hypothesis and positions rumination as the central mechanism in the development of burnout.

#### 7.2.4.4 Implications for Burnout Theory and Future Directions

As rumination appears to be central to the development of burnout, future research should focus on interventions which can help to reduce ruminations. These could involve mindfulness-based programs that emphasise decentring and acceptance, rather than attentional training alone, and rumination focused CBT techniques designed to break the cycles of perseverative thought.

Future research could also combine the two study methods used here in terms of using a prescribed focused meditation program over a period of time to test its effects on attentional control, rumination and worry. Additionally, other measures of attentional control could be used along with the ANT.

This thesis moves burnout research beyond descriptive measurement and intervention testing, toward explanatory theory. The proposed model, integrating attentional control, rumination, and worry, provided a novel framework. The findings did not fully support the model: mindfulness practice and attentional control showed no significant relationships with outcomes. But the evidence was decisive in one respect: rumination consistently emerged as the central cognitive mechanism linking stress to burnout.

## Limitations

While this thesis advances the field of burnout research across measurement, intervention, and theory, it is also important to acknowledge its limitations.

### 7.3.1 Sample Characteristics and Generalisability

A major limitation for the randomised experimental study was the reliance on student samples. Whilst originally the intent was to focus on four main high-risk occupations, healthcare, emergency services workers, military personnel and corporate executives, the ability to ethically run studies with these populations proved problematic. As such, the choice to use students as a proxy was a pragmatic one. Students face predictable stressors which provided a useful natural setting for the study. However, the homogeneity of the sample of young, educated and predominantly female participants limits to generalisability to broader populations. Furthermore, the relatively small sample sizes and high dropout rates limit the statistical power of the analyses.

### 7.3.2 Measurement Issues

A second set of limitations concerns measurement. The thesis sought to address the field's reliance on self-report by incorporating ecological momentary assessment (EMA) and smartphone-based physiological measures. Yet, self-report still formed the core of most measures, including burnout, stress, rumination, and worry. Self-report is vulnerable to several well-documented biases: defensive bias, where individuals under-report stress in sensitive contexts; recall errors, particularly in pre–post designs; and common method variance, which can inflate associations between constructs when both predictor and outcome are measured the same way.

The physiological component, while innovative, also presented challenges. HRV was chosen as a non-invasive marker of autonomic function and stress regulation, but the feasibility of smartphone-based HRV collection in naturalistic settings proved problematic. Whilst the novel idea to use smartphones to measure daily HRV enabled the conduct of EMA in a natural setting, it also meant that participants were not supervised during the measurements which could have led to measurement issues.

Rather than conclusively showing that meditation does not affect physiology, the results may reflect the difficulty of detecting subtle changes in unsupervised, field-based assessments.

Another measurement issue was evident in the delivery of the ANT. Several participants reported software issues that precluded them from conducting the ANT which meant there was a substantial amount of missing data.

Lastly, whilst focused meditation sessions were prescribed in the randomised experimental studies, this was not possible for the Attentional Control / Rumination study. Mindfulness practice was operationalised as the number of minutes meditated, but this crude metric likely underestimates the complexity of mindfulness engagement. Quality of practice, the extent of decentring or non-judgemental awareness achieved, and individual differences in receptivity to meditation are all factors that may be more important than raw practice time. As such, the null findings linking practice minutes to stress, burnout, or rumination should be interpreted cautiously.

### 7.3.3 Design and Control Issues

The short duration of the interventions was another limitation. Interventions were deliberately aligned with predictable stress periods, such as assignment deadlines, to test prevention. This design was methodologically innovative, but it restricted the intervention window to a few weeks. While sufficient to detect changes in perceived stress and emotional exhaustion, it is unlikely that such brief exposure would affect more stable dimensions of burnout such as cynicism or personal accomplishment, or produce measurable changes in autonomic function. Longer interventions may be necessary to capture these slower-moving outcomes. Additionally, as daily assessments placed burden on participants, leading to missing data and uneven adherence, a longer intervention may have proved even more difficult to conduct. Lastly, the preferred

stressful period was the examination period, however, due to constraints with the Undergraduate Research Participation System whereby students are awarded marks for their participation, the study was required to be conducted during the teaching phase of the semester and not during the examination phase.

These limitations are largely the natural constraints of an attempt to advance burnout research using newly developed and untested methodologies whilst operating within the limited resources of a PhD thesis. However, they do point directly to pathways forward for future research including testing interventions on high-risk occupational groups with larger sample sizes, refining multimodal measurements, and using more precise measures for meditation in testing the attentional control / rumination model.

## Synthesis – From Description to Prevention and Theory

Taken together, the contributions of this thesis mark a series of steps along the historical trajectory of burnout research, moving the field beyond its descriptive and atheoretical origins toward more rigorous, preventive, and mechanistic science.

The first advance addressed the reliance on self-report tools such as the MBI. While valuable, these tools cannot capture underlying mechanisms and are vulnerable to bias. By integrating EMA with smartphone-based HRV, this thesis tested a multi-modal framework that brings burnout research closer to capturing the dynamic, biological, and experiential processes underlying stress. Although the HRV results were not significant, the studies demonstrated that physiological and subjective measures could be combined in a naturalistic setting. This is a step that is both conceptually and methodologically important.

The second advance is moving burnout research from one focused on treatment toward one examining prevention. The systematic review showed that most studies

viewed intervention as a treatment. While the effects were modest, the preventive design marked an important methodological innovation, aligning burnout research with broader public health principles that emphasise early intervention and prevention.

The third advance sought to address the issue of heterogeneity of mindfulness interventions. By moving away from bundled programs such as MBSR and toward focused meditation in the randomised experimental studies and using a control group, the thesis provided methodological precision and conceptual clarity. The results showed modest but consistent dose-response effects on perceived stress and emotional exhaustion, suggesting that meditation itself, rather than confounded multiple different interventions, can produce measurable benefits. Although physiological changes were not detected, the clarity of the design advances the credibility of the field and provides a replicable framework for future research.

The fourth advance moved burnout research toward theoretical development. The field has long lacked explanatory models and interventions have been implemented without a clear understanding of how they work. This thesis proposed and tested a novel model centred on attentional control, rumination, and worry. The findings did not support attentional control or mindfulness practice as key mechanisms, but they identified rumination as the most consistent predictor of stress and burnout. In so doing, the thesis moved the field's focus toward theoretical development and highlighted perseverative cognition as the most promising target for intervention and further theory-building.

Individually, each advance addresses one of the persistent weaknesses highlighted in the systematic review: the over-reliance on self-report, the treatment bias of interventions, the heterogeneity of mindfulness programmes, and the absence of theory. Collectively, they form a progression: from self-report to multimodal

assessment, from treatment to prevention, from heterogeneous bundles to focused interventions, and from atheoretical description to explanatory models. This trajectory moves burnout research forward and positions this thesis as part of the next stage in its development.

## Future Directions

The advances presented in this thesis, moving from self-report to multi-modal assessment, from treatment to prevention, from bundled interventions to single interventions, and from atheoretical description to theory-driven models, represent important but preliminary steps in moving burnout research forward. Each addresses one of the structural weaknesses of the burnout literature, but each also opens opportunities for future research.

### 7.5.1 Expanding Multi-modal Measurement

One of the most striking findings of the systematic review was the near-total reliance on self-report questionnaires. This thesis has demonstrated the feasibility of supplementing these tools with other, more objective measures like HRV and ANT reaction time measures.

While incorporating HRV was an important step away from exclusive use of self-report questions and in the inclusion to biophysiological measures, HRV represents only one example of this measure and is also affected by other confounds such as caffeine, sleep and physical activity. Stress and burnout has also been linked to increased cortisol levels, elevated blood pressure, inflammation makers, cholesterol levels, fasting glucose and triglyceride levels (Bhatia & Tandon, 2005; Gerber et al., 2016; Grossi et al., 2005; Kivimäki et al., 2013; Landsbergis et al., 2013; Melamed et al., 2006; Melamed et al., 1999). These represent other potential measures of stress and burnout that could be included in future studies. The integration of multiple biological

measures could help determine whether meditation and related interventions act primarily on autonomic, neuroendocrine, or immune pathways, or whether their effects are primarily psychological.

Secondly, whilst the use of smartphone based HRV measurement was a novel approach to providing daily HRV data in the home environment, it came with compliance challenges and possible data quality issues. Wearable sensors are becoming more ubiquitous in the workplace and could provide access to continuous HRV monitoring, sleep tracking and physical activity metrics that could provide longitudinal data on stress process in the workplace. For high-risk occupations, such monitoring could provide a time-based map of stress exposures to form the basis of early intervention systems.

In sum, the future of burnout measurement lies in multi-modal measures which not only address the limitations of self-report questionnaires but also advance the field toward a mechanistic and theory backed understanding of how stress and burnout develop and how they can be prevented.

### 7.5.2 Continuing the Focus on Prevention to High-Risk Occupations

While the development of the novel study design allowed for the focus on prevention by targeting a predictable stressful period was useful, it was limited by the reliance on student samples and short intervention windows. Future research should now take this design into occupational environments where the burnout risk is most acute.

High-risk occupations such as healthcare, emergency response and the military all have inherent stressors such as shift work, exposure to trauma, emotional labour and life-and-death responsibility. As these burnout associated stressors are often inevitable, treatment in isolation is not a viable option. Prevention-oriented studies, such as the

ones conducted here, should therefore be conducted with these populations even if such research is logistically and ethically more challenging.

Preventive trials should integrate organisational as well as individual outcomes. Burnout has consequences for absenteeism, medical errors, and productivity (Carod-Artal & Vázquez-Cabrera, 2012; Turek, 2021; Van Bogaert et al., 2014). Interventions should therefore measure not only self-reported stress and physiological outcomes but also workplace performance indicators, healthcare error rates, and retention metrics. This would demonstrate to organisations of the larger organisational benefits as well as the human ones.

The interventions also, should not be limited to meditation. Whilst this research focused on mindfulness as a test case, preventive frameworks should also test alternative interventions such as cognitive-behavioural approaches, physical activity and organisational reforms. Comparative trials would allow identification of the most effective and scalable preventive strategies, ensuring that prevention does not become synonymous with one technique but with a broad set of proactive approaches.

These extensions of measures and interventions could, thus be implemented, through longitudinal prevention trials embedded in organisational cycles. For example, interventions could be introduced to medical interns prior to their first clinical rotations, to police recruits prior to first probationary field assignments, or to military personnel prior to a deployment. Such studies would allow testing whether preventive interventions buffer stress trajectories during known high-demand periods. Importantly, such programs, if shown as effective, could be directly implemented within these fields as a routine part of training.

### 7.5.3 Focusing on the Individual Ingredients of Multi-modal Interventions

Whilst this thesis critiqued the use of multi-modal interventions, they were shown to be effective. The studies here focused on one ingredient of these multi-modal intervention, focused meditation. Future research should build on this by focusing on each key ingredient of the multi-modal interventions to compare and assess their effectiveness.

This would involve testing meditation, yoga, psychoeducation, relaxation and group support separately and in combination. Such studies would clarify which elements contribute the most to the prevention of burnout and whether certain components interact synergistically. They should also compare the dosage requirements for each component to establish dose-response relationships. Such studies would enable the construction of more targeted interventions replacing vague recommendation with precise prescriptions which can be directly implemented in the workplace.

Lastly, these studies should be assessed against theory driven mechanisms behind burnout. This thesis tested the effect on mindfulness on attentional control, rumination and worry. Future studies should also seek to develop an understanding on how and why these mechanisms work to reduce and prevent burnout.

### 7.5.4 Advancing Theories through Mechanistic Models

While this thesis did advance a model of burnout involving attentional control, rumination and worry, this model could be built upon and improved. Additionally new models should also be developed and tested. Whilst attentional control in this work was not found to be associated with burnout, other measures of attention could be used to further understand the relationships. Additionally, models could be expanded to include other aspects that could affect burnout such as job demands and social support.

By moving toward multi-modal measurement, embedding prevention in the cycle of high-risk occupations, looking at each ingredient of multimodal interventions, and advancing mechanistic theory, the field can progress from a descriptive to an explanatory science. Such progress is urgently needed: burnout is not only an individual affliction but a systemic challenge with profound implications for healthcare, education, emergency services, and society at large.

## Conclusion

Given the high individual, workplace, societal and economic cost of burnout, the original aim of this thesis was to examine preventative measures for burnout. However, the initial literature review and subsequent systematic review, revealed a field whose history had left it as one characterised by self-report measures, treatment-focused and atheoretical. As such, the aim of the thesis became to progress the burnout research field toward multi-modal measurement, prevention, intervention precision and theoretical grounding.

Whilst the findings were modest and there were several limitations on the research, the significant of this work lies in its attempts to progress the field of research through the development and testing of novel study designs. By showing that daily multimodal assessment is feasible outside the laboratory, the thesis points toward richer methodological tools, the integration of biophysiological measures and the use of EMA. Demonstrating prevention can be studied during predictable stress periods, encourages a shift in focus from treatment to prevention. Isolating focused meditation from bundled interventions, strengthens scientific credibility and clarity. Lastly, proposing and testing an integrative model centred on rumination, it grounds the field in theories and mechanisms rather than descriptive outcomes.

Ultimately, this research affirms that burnout is not only a descriptive syndrome but a process that can be explained, predicted, and prevented. It also highlights rumination as a central component to burnout. Future research should aim to continue this journey towards a theoretical explanation of burnout and evidenced based, theory driven ways to prevent it.

# Appendix I. Study 1 – Systematic Review Protocol

## Abstract

The objective of this review is to evaluate the effectiveness of meditation in preventing burnout in emergency services workers, military personnel, corporate executives and healthcare workers. A meta-analysis will be conducted using psychological and physiological measures of stress and burnout (Ochentel et al., 2018). Burnout is framed as a state of physical and mental exhaustion encoded in a diagnosis by Z73.0 in the ICD-10-CM and negatively affects an individual's psychological and physical health (Gerber et al., 2016; Kronner; Maslach et al., 2001; Ochentel et al., 2018; Schonfeld & Bianchi, 2016; Schulz et al., 2011). It decreases work performance and affects employers through increased absenteeism and employee turnover (Formanoy et al., 2016; Kuruüzüm et al., 2008). Mindfulness intervention is the most reported intervention for burnout and has been found to offer statistically significant effects in improving stress levels and reducing burnout (Asuero et al., 2014; Auseron et al., 2018; Franco Justo, 2010; Hamilton-West et al., 2018; Montanari et al., 2019; Pérula-de Torres et al., 2019). Recent research has examined focused meditation, particular type of mindfulness training, and the role of its effects of attentional regulation and emotion regulation in reducing stress and burnout (Davidson & Kaszniak, 2015; Hölzel et al., 2011; Schmidt, 2013). Studies will be included which have participants working in high-risk areas including emergency services, the military, corporate executive management or healthcare workers who conducted a meditation intervention prior to the onset of burnout. Psychological outcomes, including Maslach Burnout Inventory (MBI), Shirom-Melamed Burnout Measure (SMBM), Health and Safety Executive (HSE), Bergen Burnout Inventory (BBI) and Perceived Stress Scale (PSS), and physiological outcomes including cortisol levels, heart rate variability, blood

pressure, stress reactivity, hypothalamic-pituitary adrenal axis (HPA) and levels of neurotransmitters (dopamine, serotonin, oxytocin and vasopressin) will be used to assess the effectiveness of the meditation intervention. The PsycINFO, PubMed and CINAHL database search and a meta-analysis will be conducted comparing data extracted from standard burnout measures and inventories and physiological measures.

## Introduction

Current studies have found an increase in the prevalence of burnout across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout (British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). With the events of the SARS-CoV-2 pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health. One systematic review found the pandemic had a significant degradation on the mental health of healthcare workers with levels of occupational burnout ranging from 3.1%-44.7% while another found this ranged between 26% and 31% (Sanghera et al., 2020; Serrano-Ripoll et al., 2020). A study on nurses, suggests that, working with COVID-19 patients seemed to correlate with higher scores in depersonalisation and emotional exhaustion, in particular (Chen et al., 2021). It is thought that negative emotions in colleagues, family members and patients can trigger similar emotions in nurses affecting their perceived stress levels and increasing vulnerability to emotional exhaustion (Joshi & Sharma, 2020). The prevalence of burnout has been increasing and the recent pandemic has made this worse.

Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions

(Naczenski et al., 2017; Shirom & Melamed, 2006). While the International Classification of Diseases (ICD) has not categorised burnout as an independent disease, it is framed as a state of physical and mental exhaustion (Kronner). Psychologically, burnout has been linked to reduced quality of sleep and life satisfaction, depressive symptoms, hypertension and anxiety (Gerber et al., 2016; Maslach et al., 2001; Schonfeld & Bianchi, 2016; Schulz et al., 2011). Physically, burnout has been linked to increased cortisol levels, elevated blood pressure and inflammation markers as well as increased cardiovascular risk factors such as total cholesterol, low-density lipoprotein cholesterol, fasting glucose and triglyceride levels (Bhatia & Tandon, 2005; Gerber et al., 2016; Grossi et al., 2005; Kivimäki et al., 2013; Landsbergis et al., 2013; Melamed et al., 2006; Melamed et al., 1999). Burnout has psychological and physical impacts which can significantly affect individual health.

Additionally, burnout decreases work performance and affects employers through increased absenteeism and employee turnover (Formanoy et al., 2016; Kuruüzüm et al., 2008). The cognitive weariness that characterises burnout, has been found to reduce executive function performance, while emotional exhaustion results in reduced empathy and an inability to invest in workplace relationships (Beck et al., 2013; Melamed et al., 2006). Burnout in medical professionals has also been associated with an increase in errors, low patient satisfaction and reduced empathy (Aiken et al., 2004; Argentero et al., 2008; Poghosyan et al., 2010; Shanafelt et al., 2002; Tei et al., 2014; West et al., 2010; Williams et al., 2007). In terms of absenteeism, it is estimated that 272 billion Euro was lost due to absenteeism due to depression and an estimated 5 million lost days due to stress (Matrix, 2013; Milczarek et al., 2009). A survey found that half of those with burnout were expecting to leave their job within the next decade, with 24% naming burnout as the primary cause (Kamal et al., 2020). On a societal

level, the European Agency for Safety and Health at Work estimated the cost of burnout at over 600 billion Euros (Hassard et al., 2014). The psychological and physical impacts of burnout coupled with the workplace and societal impacts has led to an increase of research into the condition.

Initial research into burnout has been primarily focused on human services, including healthcare and this continues to be the primary focus (Maslach et al., 2001). While initially, it was thought that the main issues were the emotional challenges of working with people in a caregiving role, subsequent research found that common job-related stressors were more highly correlated with burnout than human interaction stressors (Maslach et al., 2001). As such, burnout is now thought to be the result of continued exposure to work stress (Kumar & Mellsop, 2013). Many suggest the experience of stress contributes to burnout. In line with the Conservation of Resources theory (COR), psychological stress occurs when resources are threatened, lost or invested without an anticipated return on investment (Hobfoll & Freedy, 1993). In the context of occupational burnout, work stress is a psychological state resulting from an imbalance between work perceptions of workplace demands and coping abilities. When this is continuing and unmediated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress.

Early examinations of work stress tended to focus on the cognitive and physical demands of work (Sauter & Murphy, 1995). According to the Demand-Control model of job strain, the most stressful jobs are those with high demands where workers have a low level of control (Karasek, 1990; Pugliesi, 1999). Recent surveys have found several job demands that are thought to contribute to high levels of work stress including the amount of travel, potential or lack thereof for growth, physical demands, working condition, hazards, public interaction, human-computer interaction, daylight exposure,

shift work, ambient noise, competitive nature, risk of injury (self or other), severity of deadlines and public scrutiny (Bährer-Kohler, 2013; Wilkie, 2018). When viewed using the COR theoretical framework, many of these can be viewed as threatening or depleting resources (Hobfoll & Freedy, 1993). Healthcare workers, military personnel, emergency services workers and corporate executives are exposed to many of these demands with little control over them. Healthcare workers are often subject to physical demands, public interaction and scrutiny and risk of injury to themselves and others. Military personnel, firefighters and police officers have been rated in the top 5 most stressful occupations and expose workers to risk of injury (self and others), public interaction and public scrutiny, physical demands, shift work, high ambient noise and include competition for promotion which can cause competition and issues with potential growth (Satter, 2017). Corporate executives are also placed in the top 10 most stressful occupations and are subject to large amounts of travel, growth issues, and public interaction and scrutiny (Satter, 2017). While research into burnout initially focused on healthcare workers, there are other high-stress occupations that have similar characteristics and demands that may lead to burnout.

One particular job demand that is thought to have a particular impact on burnout is emotion work/labour. Emotion work/labour occurs when employees are required to display the appropriate emotion and accounts for additional variance in burnout above job stressors (Zapf et al., 2001). While emotion work originated in service oriented industries, the concept has been expanded to include other roles (Iszatt-White, 2013). In healthcare, workers are required to display caring and empathy toward patients and clients (Abraham, 2000). Whilst the military encourage emotion management in preparation for the realities of war (Godfrey & Brewis, 2018). One particular aspect of emotion work called emotional dissonance, expressing emotions which are not

genuinely felt in the situation, has been found to consistently correlate with emotional exhaustion (Zapf et al., 2001). Healthcare workers are often required to be caring and nurturing even when they do not feel so inclined (Abraham, 2000). Emergency responders are routinely placed in emotionally triggering situations with an inability to express their natural responses which can create emotional dissonance (Arsenault, 2015). Emotion suppression is also a common coping mechanism used by military members in combat to increase team effectiveness and the likelihood of survival (Bonanno, 2004; Zapf et al., 2001). Due to the job requirements to present a calm and professional manner in high stress situations, healthcare workers, emergency responders and military personnel often experience emotion work/labour. Despite this, the majority of research has been aimed solely at healthcare workers and this systematic review seeks to expand this to other high-risk occupations.

Another issue with the current research concerns the measurement of burnout. Some argue that self-reporting scales may be the most valid measure of burnout (Alarcon et al., 2009). There are several inventories established looking at burnout. The most used is the Maslach Burnout Inventory (MBI) which is a 22 item inventory using a five-point rating scale on three dimensions including emotional exhaustion, depersonalisation and personal accomplishment (Bährer-Kohler, 2013). Studies have found the inventory has a high internal consistency for each factor and results of confirmatory factor analyses have supported the three factor model (Kitaoka-Higashiguchi et al., 2004). Additionally external validity has been examined through comparison with work characteristics such as job demands and decision authority (Kitaoka-Higashiguchi et al., 2004; Taris et al., 1999). The Shirom-Melamed Burnout Measure (SMBM) is similar but is based on the Conservation of Resources theory and instead uses the dimensions of physical fatigue, emotional exhaustion and cognitive

weariness and has demonstrated validity and reliability in several studies (Shirom & Melamed, 2006). Another inventory that has been used is the Bergen Burnout Inventory (BBI) which uses a three-factor structure including an emotional, cognitive and behavioural aspect shown to have validity in longitudinal studies including group and time invariance (Feldt et al., 2014; Salmela-Aro et al., 2011). Additionally, as many propose that burnout is the result of prolonged work stress, self-report measures of stress may also be useful in examining burnout such as the Stress Reactivity Scale (SRS) and Perceived Stress Scale (PSS). Thus, the majority of research has focused on using self-report inventories to measure burnout.

However, more recently, research has looked at physiological measures of burnout which largely focus on the body's physiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS activation due to stress (Bährer-Kohler, 2013). These include increased heart rate, decreased heart rate variability and increased blood pressure (Melamed et al., 2006). Following this initial release, the hypothalamus also activates the HPA system which triggers the release of cortisol (Harvard Medical School, 2020; Melamed et al., 2006). Studies have found work-related stress is associated with increased cortisol response to waking and throughout the day (Lundberg & Hellström, 2002; Melamed et al., 1999). Those suffering burnout have been found to have reduced hippocampal neurogenesis

leading to disturbed hippocampal regulation of the HPA axis and chronic stress can lead to persistent epinephrine surges and elevated cortisol levels due to the body's cortisol receptors which remove circulating cortisol being 'turned down' through cellular changes in the hippocampus. Thus, studies have found that those affected by burnout have reduced serotonergic or dopaminergic function (Eriksson & Wallin, 2004; Harvard Medical School, 2020). Stress, including chronic stress, has also been found to affect several neurochemicals including serotonin, and the catecholamines noradrenaline, and dopamine that the HPA system releases to activate the amygdala to trigger an emotional response to the stressful event. The neuropeptide S is also released, a protein that modulates stress by increasing alertness, decreasing sleep and generating a sense of urgency and anxiety in the individual, raising glucocorticoid levels (mainly cortisol) and reinforcing the feedback loop (Joëls & Baram, 2009; Selye, 1956; Yao et al., 2018). In addition to the existing self-report measures, research has started to examine physiological responses to stress to measure burnout.

With the increasing prevalence of burnout, research has begun to look at treatment interventions. Mindfulness practices are the most reported intervention for burnout and has been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). It has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). Neuroimaging research has found those who underwent a

mindfulness-based stress reduction course had increased activation of the anterior cingulate cortex which detects distractions and activation of insula which is commonly activated during interoceptive awareness tasks (Craig, 2003; Hölzel et al., 2011; van Veen & Carter, 2002). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events (Garland et al., 2011; Hölzel et al., 2011). This is supported by findings that mindfulness is linked with increased activation in the left and right pre-frontal cortex which are associated with reappraisal (Modinos et al., 2010). Additionally, meditation, a specific form of mindfulness practice, has been associated with decreased heart rate, blood pressure, cortisol levels, breathing rate, skin conduction response and muscle tension (Carlson et al., 2007; Lazar et al., 2005; Pascoe et al., 2017; Zeidan et al., 2010).

While research into meditation has increased recently, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research. Specifically, methodological heterogeneity in meditation traditions and implementations surrounding the definition of meditation pose issues with the interpretation and integration of the research outcomes (Davidson & Kaszniak, 2015). To allow for a validated approach to the examination of meditation, a clear definition is required (Przyrembel & Singer, 2018). To ensure the ability to generalise, interpret and integrate results in this systematic review, specific attention will be paid to the definition of the meditation intervention used, the delivery of the intervention and the measures used in assessing the intervention.

This first definitional issue surrounds the use of the terms ‘mindfulness’ and ‘meditation’. While many articles appear to use these terms interchangeably this can

conflate the results and affect the generalisability of these studies. While mindfulness subsumes the practice of meditation and meditation is often included in mindfulness training, they are not the same thing (Aiken et al., 2004; Lutz et al., 2015; Verhaeghen, 2017). Mindfulness is an umbrella term which encompasses being psychologically present in any situation (Van Dam et al., 2018). It is not a unitary construct and includes many different practices in many different contexts (Joëls & Baram, 2009; Kabat-Zinn, 1990). On the other hand, meditation denotes a specific set of practice where one is mindful in that practice. For this systematic review, interventions that include meditation practices will be included, with the preference for those focusing solely of meditation.

The second definition issue impinges upon whether meditation is taken as a state, a trait or a procedure/process. Several studies have examined meditation as a state of mind that is produced by practicing meditation. In doing so, these studies often focus on what happens to the mind once a ‘state of meditation’ has been achieved (Davidson & Kaszniak, 2015). In addition to these, other studies have gone a step further to examine the long term effects of meditation, examining meditation as a ‘trait’. These studies often involve comparing an experienced meditator with a novice one to examine long-term changes (Davidson & Kaszniak, 2015). Lastly, meditation has been examined as a procedure where a participant ‘does’ meditation and the effects of this procedure are measured (Davidson & Kaszniak, 2015). As the use of meditation as a 'state' or 'trait' requires the use of an arbitrary standard for when someone is in a meditation ‘state’ or ‘trait’, this systematic review will focus on research using meditation as a procedure/process undertaken by participants.

Broadly, there are two very different types of meditation, focused and open. Focused meditation involves practicing the deliberate directing and focusing of

attention on a particular element (Lutz et al., 2015). This element can be the breath, sensation, sound, mental image, word, phrase or object (Davidson & Kaszniak, 2015). Focused meditation also involves noticing distractions such as thoughts and shifting the attention back to the object of focus (Davidson & Kaszniak, 2015). Open meditation, on the other hand, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015). As the large proportion of the literature examines focused meditation and the impact of this on attentional regulation and emotion regulation, this systematic review will focus on studies examining focused meditation as an intervention.

A preliminary search of PubMed, PEDro, PsycInfo, the Cochrane Database of Systematic Reviews and the JBI Database of Systematic Reviews and Implementation Reports was conducted. These have focused primarily on burnout in healthcare workers and this study will expand this to include workers in other high stress occupations including military personnel, emergency services workers and corporate executives. While there is no single definition of meditation agreed upon in the research, to assess the effectiveness of meditation in preventing burnout, this systematic review will only include research examining focused meditation practices examined as a procedure and exclude wider studies on mindfulness, open meditation and meditation as a state or trait. It will assess effectiveness by examining both self-report measures of burnout and stress including the Maslach Burnout Inventory, Shirom-Melamed Burnout Inventory, Bergen Burnout Inventory, Perceived Stress Scale and Stress Reactivity Scale. Additionally physiological measures including neuroimaging and the effect on the SAM and HPA axes including heart rate, blood pressure, levels of cortisol, noradrenaline, serotonin & dopamine will be included.

Given the extensive negative effects of burnout on the physiological and psychological health of individuals, workplace performance and society, employers are increasingly starting to invest in employee wellness programs, including the use of meditation. Thus, a review of the effectiveness of mindfulness in the prevention of burnout in those who are exposed to high-stress environments will aid in ensuring these programs are evidenced and implemented in line with the best outcomes.

**Review question(s)**

What is the effectiveness of meditation procedures in preventing burnout in high-risk populations?

**Keywords**

Meditation; Mindfulness; Prevention and Control; Stress, Psychological; Emergency Responders

**Inclusion criteria**

**Participants**

The review will consider studies that include emergency services workers / first responders, military personnel, health care workers and those working in corporate management.

**Intervention(s)**

While there is no single definition of meditation agreed upon in the research, this systematic review will only include research examining focused meditation practices examined as a procedure and exclude wider studies on mindfulness, open meditation and meditation as a state or trait. It will include interventions where meditation is used in conjunction with other aspects of mindfulness such as MBCT and MBSR.

### Comparator(s)

This review will consider all studies that compare meditation to groups who did not participate in a meditation program as well as pre-post, single arm study designs.

### Outcomes

This review will consider studies that include the outcomes including psychological and physiological measures of burnout. This included psychological outcomes will be the Maslach Burnout Inventory (MBI), Shirom-Melamed Burnout Measure (SMBM), Health and Safety Executive (HSE), Bergen Burnout Indicator (BBI), Stress Reactivity Scale (SRS) and Perceived Stress Scale (PSS). The included physiological outcomes will be heart rate, cortisol levels, heart rate variability, blood pressure, stress reactivity, hypothalamic-pituitary adrenal axis (HPA) and levels of neurotransmitters (dopamine, serotonin, oxytocin and vasopressin).

### Types of studies

This review will consider both experimental and quasi-experimental study designs including randomised controlled trials, non-randomised controlled trials, before and after studies and interrupted time-series studies. In addition, analytical observational studies including prospective and retrospective cohort studies, case-control studies and analytical cross-sectional studies will be considered for inclusion. This review will also consider descriptive observational study designs including case series, individual case reports and descriptive cross-sectional studies for inclusion. Studies published in English will be included. Studies published from 2010 onward will be included due to the recent developments in physiological measurement techniques.

## Materials and methods

The proposed systematic review will be conducted in accordance with the Joanna Briggs Institute methodology for systematic reviews of effectiveness evidence.

### Search strategy

The search strategy aims to locate both published and unpublished studies. An initial limited search of PsycINFO, PubMED and CINAHL will be undertaken to identify articles on the topic. The text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles were used to develop a full search strategy for PsycINFO, PubMED and CINAHL (see Appendix II). The search strategy, including all identified keywords and index terms, was adapted for each included information source. The reference list of all studies selected for critical appraisal will be screened for additional studies.

### Study selection

Following the search, all identified citations will be collated and uploaded into Covidence systematic review software and duplicates removed (Innovation). Titles and abstracts will then be screened by two reviewers. Potentially relevant studies will be retrieved in full and their citation details imported into the Joanna Briggs Institute System for the Unified Management, Assessment and Review of Information (JBI SUMARI) (Munn et al., 2019). The full text of selected citations will be assessed in detail against the inclusion criteria by two independent reviewers. The reasons for exclusion of full text studies that do not meet the inclusion criteria will be recorded and reported in the systematic review. Any disagreements that arise between the reviewers at each stage of the study selection process will be resolved through discussion, or with a third reviewer. The results of the search will be reported in full in the final systematic review and presented in a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram (Moher et al., 2009).

### Assessment of methodological quality

Eligible studies will be critically appraised by two independent reviewers at the outcome level for methodological quality in the review using standardised critical appraisal instruments from the Joanna Briggs Institute for experimental and quasi-experimental studies. Authors of papers will be contacted to request missing or additional data for clarification, where required. Any disagreements that arise will be resolved through discussion, or with a third reviewer. The results of critical appraisal will be reported in narrative form and in a table.

All studies, regardless of the results of their methodological quality, will undergo data extraction and synthesis (where possible).

Methodological quality will be assessed using the appropriate JBI Critical Appraisal Checklist for the type of study (Tufanaru et al., 2017).

### Data extraction

Data will be extracted from studies included in the review by two independent reviewers using the standardised data extraction tool.

The data extracted will include specific details about the populations, study methods, interventions, and outcomes of significance to the review objective. Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer. Authors of papers will be contacted to request missing or additional data, where required.

### Data synthesis

Studies will, where possible be pooled in a statistical meta-analysis. Effect sizes will be expressed as either odds ratios (for dichotomous data) and weighted (or standardised) final post-intervention mean differences (for continuous data) and their 95% confidence intervals will be calculated for analysis. Heterogeneity will be assessed

statistically using the standard chi-squared and I squared tests. Statistical analyses will be performed using random effect models (Tufanaru et al., 2015). Where statistical pooling is not possible the findings will be presented in narrative form including tables and figures to aid in data presentation where appropriate. A funnel plot will be generated to assess publication bias if there are 10 or more studies included in a meta-analysis. Statistical tests for funnel plot asymmetry (Egger test, Begg test, Harbord test) will be performed where appropriate.

**Assessing certainty in the findings**

The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach for grading the certainty of evidence will be followed (Schünemann, 2013) and a Summary of Findings (SoF) will be created using GRADEPro (McMaster University, 2020). The SoF will present the following information where appropriate: absolute risks for the treatment and control, estimates of relative risk, and a ranking of the quality of the evidence based on the risk of bias, directness, heterogeneity, precision and risk of publication bias of the review results.

Appendix II. Study 1 - Systematic Review Search Strategy

**PubMed**

(MBSR[tiab] OR meditat*[tiab] OR mind body[tiab] OR mind-body[tiab] OR mindbody[tiab] OR mindful*[tiab] OR relaxation[tiab] OR spiritual therap*[tiab] OR "Meditation"[mh] OR "Relaxation Therapy"[mh] OR "Breathing Exercises"[mh] OR "Mindfulness"[mh]) AND (Decreased Stress[tiab] OR Primary Mental Health Prevention[tiab] OR Prevent*[tiab] OR Preventative Health Care[tiab] OR Prevention and Control[tiab] OR Preventative Medicine[tiab] OR Protective Factors[tiab] OR Reduce Stress[tiab] OR Resilien*[tiab] OR Stress Buffer[tiab] OR Stress Reduc*[tiab] OR "Prevention and Control"[sh] OR "Preventive Medicine"[mh] OR "Preventive Health Services"[mh]) AND (Burnout[tiab] OR Burnout, Professional[tiab] OR Compassion Fatigue[tiab] OR Exhaustion[tiab] OR Job Stress[tiab] OR Occupational Neuros*[tiab] OR Occupational Stress[tiab] OR Professional Stress[tiab] OR Stress Disorder[tiab] OR Stress Injur*[tiab] OR Stress Manag*[tiab] OR Stress, Occupational[tiab] OR Work Life Balance[tiab] OR Workplace Stress[tiab] OR Work Related Stress[tiab] OR Work Stress[tiab] OR Work-life balance[tiab] OR Work-related stress[tiab] OR "Stress, Psychological"[mh]) AND (BBI[tiab] OR Bergen Burnout Indicator[tiab] OR Biophysiological Methods[tiab] OR Blood Pressure[tiab] OR blood-pressure[tiab] OR Cortisol[tiab] OR fMRI[tiab] OR Functional Magnetic Resonance Imaging[tiab] OR Health and Safety Executive[tiab] OR Heart rate[tiab] OR Heart-Rate[tiab] OR HPA[tiab] OR HSE[tiab] OR Hypothalamic-Pituitary-Adrenal[tiab] OR Maslach Burnout Inventory[tiab] OR MBI[tiab] OR Neuroimaging[tiab] OR Perceived Stress Scale[tiab] OR Physiological Process[tiab] OR Physiological Response[tiab] OR PSS[tiab] OR Psychophysiological Measures[tiab] OR Shirom-Melamed Burnout Measure[tiab] OR SMBM[tiab] OR SRS[tiab] OR Stress Reactions[tiab] OR Stress

Reactivity[tiab] OR Stress Reactivity Scale[tiab] OR Oxytocin[tiab] OR Vasopressin[tiab] OR Dopamine[tiab] OR Serotonin[tiab] OR Amygdala[tiab] OR "Physical Examination"[mh] OR "Phenomena and Processes Category"[mh]) AND (Emergency Services[tiab] OR Police[tiab] OR Law Enforcement[tiab] OR Firefighter[tiab] OR Fire Fighter[tiab] OR Ambulance[tiab] Paramedic[tiab] OR First responder[tiab] OR Rescue[tiab] OR Military[tiab] OR Defen*[tiab] OR Armed Forces[tiab] Army[tiab] OR Navy[tiab] OR Air Force[tiab] OR Marines[tiab] OR Soldier[tiab] OR Sailor[tiab] OR Airmen[tiab] Marine[tiab] OR Health Care[tiab] OR Doctor[tiab] OR Nurse[tiab] OR Social Worker[tiab] OR Hospital[tiab] Executive[tiab] OR Manage*[tiab] OR Emergency Personnel[tiab] OR Emergency Responder[tiab] OR "Emergency Responders"[mh] OR "Health Personnel"[mh] OR "Military Personnel"[mh])

**PsycINFO**

(MBSR.tw OR meditat*.tw OR mind body.tw OR mind-body.tw OR mindbody.tw OR mindful*.tw OR relaxation.tw OR spiritual therap*.tw OR Meditation.sh) AND (Decreased Stress.tw OR Primary Mental Health Prevention.tw OR Prevent*.tw OR Preventative Health Care.tw OR “Prevention and Control”.tw OR Preventative Medicine.tw OR Protective Factors.tw OR Reduce Stress.tw OR Resilien*.tw OR Stress Buffer.tw OR Stress Reduc*.tw) AND (Preventative Medicine.sh OR Primary Mental Health Prevention.sh OR Protective Factors.sh OR Burnout.tw OR Compassion Fatigue.tw OR Exhaustion.tw OR Job Stress.tw OR Occupational Neuros$.tw OR Occupational Stress.tw OR Professional Stress.tw OR Stress Disorder.tw OR Stress Injur*.tw OR Stress Manag*.tw OR Work Life Balance.tw OR Workplace Stress.tw OR Work Related Stress.tw OR Work Stress.tw OR Work-life

balance.tw OR Work-related stress.tw OR Exp Occupational Stress OR Occupational Neurosis.sh OR Work-Life Balance.sh) AND (BBI.tw OR Bergen Burnout Indicator.tw OR Biophysiological Methods.tw OR Blood Pressure.tw OR Cortisol.tw OR fMRI.tw OR Functional Magnetic Resonance Imaging.tw OR Health and Safety Executive.tw OR Heart rate.tw OR HPA.tw OR HSE.tw OR Hypothalamic-Pituitary-Adrenal.tw OR Maslach Burnout Inventory.tw OR MBI.tw OR Neuroimaging.tw OR Perceived Stress Scale.tw OR Physiological Process.tw OR Physiological Response.tw OR PSS.tw OR Psychophysiological Measures.tw OR Shirom-Melamed Burnout Measure.tw OR SMBM.tw OR SRS.tw OR Stress Reactions.tw OR Stress Reactivity.tw OR Stress Reactivity Scale.tw OR Oxytocin.tw OR Vasopressin.tw OR Dopamine.tw OR Serotonin.tw OR Amygdala.tw OR Exp Psychophysiological Measures OR Exp Physiological Processes OR Stress Reactions.sh OR Neuroimaging.sh) AND (Emergency Services.tw OR Police.tw OR Law Enforcement.tw OR Firefighter.tw OR Fire-fighter.tw OR Ambulance.tw OR Cortisol.tw OR First responder.tw OR Rescue.tw OR Military.tw OR Defen$e.tw OR Armed Forces.tw OR Army.tw OR Navy.tw OR Air Force.tw OR Marines.tw OR Soldier.tw OR Sailor.tw OR Airmen.tw OR Marine.tw OR Health Care.tw OR Doctor.tw OR Nurse.tw OR Social Worker.tw OR Hospital.tw OR Executive.tw OR Manage$.tw OR Emergency Personnel.tw OR Emergency Responder.tw OR Emergency Responders.sh OR Health Personnel.sh OR Military Personnel.sh OR Police.sh)

**CINAHL**

(TI MBSR OR AB MBSR OR TI meditat* OR AB meditat* OR TI “mind body” OR AB “mind body” OR TI mind-body OR AB mind-body OR TI mindbody OR AB mindbody OR TI mindful* OR AB mindful* OR TI relaxation OR AB relaxation

OR TI “spiritual therap”* OR AB “spiritual therap*” OR MH meditation OR MH mindfulness OR MH relaxation techniques+ OR MH mind body techniques+) AND (TI “Protective Factors” OR AB “Protective Factors” OR TI “Reduce Stress” OR AB “Reduce Stress” OR TI Resilien* OR AB Resilien* OR TI “Stress Buffer” OR AB “Stress Buffer” OR TI “Stress Reduc*” OR AB “Stress Reduc*” OR MH “Preventative Health Care”) AND (TI Burnout OR AB Burnout OR TI “Burnout, Professional” OR AB “Burnout, Professional” OR TI “Compassion Fatigue” OR AB “Compassion Fatigue” OR TI Exhaustion OR AB Exhaustion OR TI “Job Stress” OR AB “Job Stress” OR TI “Occupational Neuros*s” OR AB “Occupational Neuros*s” OR TI “Occupational Stress” OR AB “Occupational Stress” OR TI “Professional Stress” OR AB “Professional Stress” OR TI “Stress Disorder” OR AB “Stress Disorder” OR TI “Stress Injur*” OR AB “Stress Injur*” OR TI “Stress Manag*” OR AB “Stress Manag*” OR TI “Stress, Occupational” OR AB “Stress, Occupational” OR TI “Work Life Balance” OR AB “Work Life Balance” OR TI “Workplace Stress” OR AB “Workplace Stress” OR TI “Work Related Stress” OR AB “Work Related Stress” OR TI “Work Stress” OR AB “Work Stress” OR TI “Work-life balance” OR AB “Work-life balance” OR TI “Work-related stress” OR AB “Work-related stress” OR MH “Burnout, Professional+” OR MH “Stress, Occupational+” OR “MH Stress Management”) AND (TI BBI OR AB BBI OR TI “Bergen Burnout Indicator” OR AB “Bergen Burnout Indicator” OR TI “Biophysiological Methods” OR AB “Biophysiological Methods” OR TI “Blood-Pressure” OR AB “Blood-Pressure” OR TI “blood pressure” OR AB “blood pressure” OR TI Cortisol OR AB Cortisol OR TI fMRI OR AB fMRI OR TI “Functional Magnetic Resonance Imaging” OR AB “Functional Magnetic Resonance Imaging” OR TI “Health and Safety Executive” OR AB “Health and Safety Executive” OR TI “Heart Rate” OR AB “Heart Rate” OR TI HPA OR AB HPA OR TI HSE OR AB

HSE OR TI “Hypothalamic-Pituitary-Adrenal” OR AB “Hypothalamic-Pituitary-Adrenal” OR TI “Maslach Burnout Inventory” OR AB “Maslach Burnout Inventory” OR TI MBI OR AB MBI OR TI Neuroimaging OR AB Neuroimaging OR TI “Perceived Stress Scale” OR AB “Perceived Stress Scale” OR TI “Physiological Process” OR AB “Physiological Process” OR TI “Physiological Response” OR AB “Physiological Response” OR TI PSS OR AB PSS OR TI “Psychophysiological Measures” OR AB “Psychophysiological Measures” OR TI “Shirom-Melamed Burnout Measure” OR AB “Shirom-Melamed Burnout Measure” OR TI SMBM OR AB SMBM OR TI SRS OR AB SRS OR TI “Stress Reactions” OR AB “Stress Reactions” OR TI “Stress Reactivity” OR AB “Stress Reactivity” OR TI “Stress Reactivity Scale” OR AB “Stress Reactivity Scale” OR TI Oxytocin OR AB Oxytocin OR TI Vasopressin OR AB Vasopressin OR TI Dopamine OR AB Dopamine OR TI Serotonin OR AB Serotonin OR TI Amygdala OR AB Amygdala OR MH Biophysiological Methods+) AND (TI “Emergency Services” OR AB “Emergency Services” OR TI Police OR AB Police OR TI “Law Enforcement” OR AB “Law Enforcement” OR TI Fire*fighter OR AB Fire*fighter OR TI Ambulance OR AB Ambulance OR TI Paramedic OR AB Paramedic OR TI “First responder” OR AB “First responder” OR TI Rescue OR AB Rescue OR TI Military OR AB Military OR TI Defen*e OR AB Defen*e OR TI “Armed Forces” OR AB “Armed Forces” OR TI Army OR AB Army OR TI Navy OR AB Navy OR TI “Air Force” OR AB “Air Force” OR TI Marines OR AB Marines OR TI Soldier OR AB Soldier OR TI Sailor OR AB Sailor OR TI Airmen OR AB Airmen OR TI Marine OR AB Marine OR TI “Health Care” OR AB “Health Care” OR TI Doctor OR AB Doctor OR TI Nurse OR AB Nurse OR TI “Social Worker” OR AB “Social Worker” OR TI Hospital OR AB Hospital OR TI Executive OR AB Executive OR TI Manage* OR AB Manage* OR TI “Emergency Personnel” OR AB “Emergency

Personnel" OR TI "Emergency Responder" OR AB "Emergency Responder" OR MH Police OR MH "Military Personnel+" OR MH Firefighters OR MH "Health Personnel+")

Appendix III. Study 1 Systematic Review Reasons for Exclusion

**Studies excluded on full text**

Atanes, A. C., Andreoni, S., Hirayama, M. S., Montero-Marin, J., Barros, V. V., Ronzani, T. M., et al. (2015). Mindfulness, perceived stress, and subjective well-being: A correlational study in primary care health professionals. *BMC Complementary and Alternative Medicine*, *15*, 303. https://doi.org/10.1186/s12906-015-0823-0

Reason for exclusion: Wrong intervention.

Balconi, M., Fronda, G., & Crivelli, D. (2019). Effects of technology-mediated mindfulness practice on stress: Psychophysiological and self-report measures. *Stress: The International Journal on the Biology of Stress*, *22*(2), 200–209. https://doi.org/10.1080/10253890.2018.1531845

Reason for exclusion: Wrong population.

Binion, L. (2022). Managing stress through meditation? Design and development professional development case study of teachers and counselors. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *83*(4-B).

Reason for exclusion: Wrong outcomes.

Brinkmann, A. E., Press, S. A., Helmert, E., Hautzinger, M., Khazan, I., & Vagedes, J. (2020). Comparing effectiveness of HRV-biofeedback and mindfulness for workplace stress reduction: A randomized controlled trial. *Applied Psychophysiology and Biofeedback*, *45*(4), 307–322. https://doi.org/10.1007/s10484-020-09477-w

Reason for exclusion: Wrong population.

Chaix, R., Fagny, M., Cosin-Tomás, M., Alvarez-López, M., Lemee, L., Regnault, B., et al. (2020). Differential DNA methylation in experienced meditators after an intensive day of mindfulness-based practice: Implications for immune-related pathways. *Brain, Behavior, and Immunity*, *84*, 36–44. https://doi.org/10.1016/j.bbi.2019.11.003

Reason for exclusion: Wrong outcomes.

Chemali, Z., Borba, C. P. C., Johnson, K., Hock, R. S., Parnarouskis, L., Henderson, D. C., et al. (2017). Humanitarian space and well-being: effectiveness of training on a psychosocial intervention for host community-refugee interaction. *Medicine, Conflict and Survival*, *33*(2), 141–161. https://doi.org/10.1080/13623699.2017.1323303

Reason for exclusion: Wrong study design.

Edwards, D. L. (2017). Emergency responder resiliency: Predicting burnout with alexithymia, neuroticism, altruism, and sensation seeking. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *78*(6-B(E)).

Reason for exclusion: Wrong intervention.

Iglesias, S. L., Granchetti, H., Azzara, S., Carpineta, M., Pappalardo, M., Argibay, J. C., et al. (2014). [Evaluation of a pilot health promotion and stress management program for pharmacy and biochemistry students and professionals]. *Revista de Calidad Asistencial*, *29*(3), 165–171.

Reason for exclusion: Wrong language.

Jenkins, M. Y. (2012). An evidence-based application of guided imagery and its impact on resilience and stress in military/DOD nurses at risk for PTSD—A pilot project. Catholic University of America.

Reason for exclusion: Wrong intervention.

Jourabchi, Z., Satari, E., Mafi, M., & Ranjkesh, F. (2020). Effects of Benson's relaxation technique on occupational stress in midwives. *Nursing*, *50*(9), 64–68.

Reason for exclusion: Wrong study design.

Kachadourian, L. K., Harpaz-Rotem, I., Tsai, J., Southwick, S., & Pietrzak, R. H. (2021). Mindfulness as a mediator between trauma exposure and mental health outcomes: Results from the National Health and Resilience in Veterans Study. *Psychological Trauma: Theory, Research, Practice, and Policy*, *13*(2), 223–230.

Reason for exclusion: Wrong outcomes.

Kang, M., Selzer, R., Gibbs, H., Bourke, K., Hudaib, A. R., & Gibbs, J. (2019). Mindfulness-based intervention to reduce burnout and psychological distress, and improve wellbeing in psychiatry trainees: a pilot study. *Australasian Psychiatry*, *27*(3), 219–224.

Reason for exclusion: Wrong study design.

Kim, Y. A., & Park, J. S. (2016). [Development and application of an overcoming compassion fatigue program for emergency nurses]. *Journal of Korean Academy of Nursing*, *46*(2), 260–270.

Reason for exclusion: Wrong language.

Kizakevich, P. N., Eckhoff, R. P., Lewis, G. F., Davila, M. I., Hourani, L. L., Watkins, R., et al. (2019). Biofeedback-assisted resilience training for traumatic and operational stress: Preliminary analysis of a self-delivered digital health methodology. *JMIR mHealth and uHealth*, *7*(9), e12590.

Reason for exclusion: Wrong outcomes.

Klatt, M., Steinberg, B., & Duchemin, A. M. (2015). Mindfulness in Motion (MIM): An onsite Mindfulness Based Intervention (MBI) for chronically high stress work environments to increase resiliency and work engagement. *Journal of Visualized Experiments*, *101*, e52359.

Reason for exclusion: Wrong outcomes.

Liu, Y., Luo, S. X., Ye, J. L., Chen, Y. Z., Li, J. F., & Li, Y. X. (2020). The use of online MBSR audio in medical staff during the COVID-19 in China. *European Review for Medical and Pharmacological Sciences*, *24*(20), 10874–10878. https://doi.org/10.26355/eurrev_202010_23451

Reason for exclusion: Wrong outcomes.

Lynch, J., Prihodova, L., Dunne, P. J., O'Leary, C., Breen, R., Carroll, Á., et al. (2018). Mantra meditation programme for emergency department staff: a qualitative study. *BMJ Open*, *8*(9), e020685. https://doi.org/10.1136/bmjopen-2017-020685

Reason for exclusion: Wrong outcomes.

Manigault, A. W., Shorey, R. C., Hamilton, K., Scanlin, M. C., Woody, A., Figueroa, W. S., et al. (2019). Cognitive behavioral therapy, mindfulness, and cortisol habituation: A randomized controlled trial. *Psychoneuroendocrinology*, *104*, 276–285.

Reason for exclusion: Wrong population.

Pérula-de Torres, L. A., Atalaya, J. C. V., García-Campayo, J., Roldán-Villalobos, A., Magallón-Botaya, R., Bartolomé-Moreno, C., et al. (2019). Controlled clinical trial comparing the effectiveness of a mindfulness and self-compassion 4-session programme versus an 8-session programme to reduce work stress and

burnout in family and community medicine physicians and nurses: MINDUUDD study protocol. *BMC Family Practice*, *20*(1), 24.

Reason for exclusion: Wrong study design.

Ungar, M., & Jefferies, P. (2021). Becoming more rugged and better resourced: The R2 resilience program's© psychosocial approach to thriving. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.745283

Reason for exclusion: Wrong study design.

Unger, C. A., Busse, D., & Yim, I. S. (2017). The effect of guided relaxation on cortisol and affect: Stress reactivity as a moderator. *Journal of Health Psychology*, *22*(1), 29–38.

Reason for exclusion: Wrong population.

Vella, E., & McIver, S. (2019). Reducing stress and burnout in the public-sector work environment: A mindfulness meditation pilot study. *Health Promotion Journal of Australia*, *30*(2), 219–227.

Reason for exclusion: Wrong study design.

W. J., N., Sekar, L., Manikandan, A., K., M., T., G., Shriraam, V., et al. (2021). Mahamantra chanting as an effective intervention for stress reduction among nursing professionals—A randomized controlled study. *Advances in Integrative Medicine*, *8*(1), 27–32.

Reason for exclusion: Wrong intervention.

# Appendix IV. Study 1 Systematic Review Characteristics of Studies

| | Title | Population Category | Population description | Intervention | Comparison group | Outcome Measures |
|---|---|---|---|---|---|---|
| | The Impact of Mindful Meditation on Health Care Workers During the COVID-19 Pandemic. | Healthcare Workers | Health care workers included in the study: physicians, advanced practice nurses, physician assistants, nurses, therapists, medical technologists, and medical assistants. | Wellbeing mobile app | None | Perceived Stress Scale (PSS-10) |
| | Sustained resiliency building and burnout reduction for healthcare professionals via organizational sponsored mindfulness programming. | Healthcare Workers | Healthcare workers from the ohio state university wexner medical centre. | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Utrecht Work Engagement Scale (UWES); Perceived Stress Scale (PSS-unspecified) |
| | Impact of a Mindfulness-Based Stress Reduction Program on Psychological Well-Being, Cortisol, and Inflammation in Women Veterans. | Military | Women veterans | Mindfulness-based Stress Reduction (MSBR) | Active Control Condition (ACC) | Center for Epidemiological Studies Depression Scale (CES-D); Cortisol Levels; Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS- 10); PTSD Checklist - Civilian Version (PCL-C); UCLA Loneliness Scale (UCLA-LS), Cytokines, Social Provisions Scale (SPS), Combat Exposure Scale (CES) |
| | Efficacy of Transcendental Meditation to Reduce Stress Among Health Care Work Sangeeta P. ers A Randomized Clinical Trial. | Healthcare Workers | Patient-facing HCWs were recruited from Duke University and the community. | Transcidental Meditation | Access to wellness resources | Brief Symptom Inventory- 18 (BSI- 18); Connor-Davidson Resilience Scale (CD-RISC); Generalized Anxiety Disorder (GAD- 7); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI-HSS); Patient Health Questionnaire (PHQ-9) |
| | Effects of Transcendental Meditation on Academic Physician Burnout and Depression: A Mixed Methods Randomized Controlled Trial. | Healthcare Workers | Academic physicians from a midwestern metropolitan medical school and VA hospital. All subjects were MDs. | Transcidental Meditation | Care as usual | Beck Depression Inventory (BDI-II); Brief Resilience Scale (BRS); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI- HSS); Perceived Stress Scale (PSS- 10) |
| | Assessment of Virtual Mindfulness-Based Training for Health Care Professionals: Improved Self-Reported Respiration Rates, Perceived Stress, and Resilience. | Healthcare Workers | | Mindfulness in Motion (MIM) | None | Breathing Rate; Connor-Davidson Resilience Scale (CD- RISC); Perceived Stress Scale (PSS-10) |
| | Effectiveness of mindfulness-based interventions on burnout and self-compassion among critical care nurses caring for patients with COVID-19: a quasi-experimental study. | Healthcare Workers | Nurses | Modified mind-body based stress reduction (MSBR) | Care as usual | Five Facet Mindfulness Questionnaire (FFMQ); Maslach Burnout Inventory - Human Services (MBI- HSS); Self-Compassion (SCS) |
| | The impact of a mindfulness-based intervention on the quality of life of Spanish national police officers. | Emergency Services | National police officers in Mallorca (Spain). | Modified mind-body based stress reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS-10); Professional Quality of Life Scale (ProQOL); Self-Compassion (SCS) |
| | Links between stress, sleep, and inflammation: A translational perspective of resilience. | Healthcare Workers | Moderately stressed healthcare professionals | Mindfulness- Based Self- care (MBSC) | Care as usual | Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 10); Positive and Negative Affect Schdule (PANAS); Visual Analog Scale; Maslach Burnout Inventory 2-item (MBI-2), Mindful Self-Care Scale - General (MSCS-G). |
| | Assessment of burnout with implementation of a brief mindfulness intervention in palliative care clinicians. | Healthcare Workers | Inpatient palliative care group | Focused Meditation; Wellbeing mobile app | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Combating occupational nursing stress with mindfulness-based stress reduction: An evidence- based quality improvement project. | Healthcare Workers | Nurses working at a 398-bed, acute care, tertiary hospital that specializes in the care of cardiovascular, orthopedic, neurological, and oncology patient populations. | Modified mind-body based stress reduction (MSBR) | None | Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 14); HCAHPS score for "Nursing Communication" |
| 20 | Mindful moments: Use of mindfulness to reduce stress and alleviate burnout among nurse practitioners. | Healthcare Workers | nurse practitioners | Mindful Moment (MM) project | None | Copenhagen Burnout Inventory (CBI); Meditation diary/log; Perceived Stress Scale (PSS-10) |
| | Biomarker response to mindfulness intervention in veterans diagnosed with post-traumatic stress disorder. | Military | U.S military veterans of any age and from any war- participant pool was split among two locations. They were from Tuscaloosa and Minneapolis | Mindfulness-based Stress Reduction (MSBR) | Psychoeducation of PTSD symptoms | Blood sample for pro-inflammatory gene expression; Cortisol Levels; Five Facet Mindfulness Questionnaire (FFMQ); Patient Health Questionnaire (PHQ- 9); PTSD Checklist Military Version (PCL-M) |
| | Effects of mindfulness on anesthesia provider burnout. | Healthcare Workers | The participants are anesthesia providers, both anesthesiologists and CRNAs, who currently work in the perioperative setting. | Mindfulness education package | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Mindfulness, deep breathing, and body scan meditation for reducing work-related stress and improving job satisfaction among psychiatric nurses. | Healthcare Workers | Nurses | Mindfulness education and exercise intervention. | None | Perceived Stress Scale (PSS- 10); Nursing Workplace Satisfaction Questionnaire (NWSQ) |
| | The use of mindfulness-based meditation to reduce stress among healthcare workers. | Healthcare Workers | Multidisciplinary team of healthcare providers including nurses, physicians, dieticians, nursing assistants, and social workers and Hungtington Healthcare Center | Unspecified mindful meditation education and daily self-practice | None | Perceived Stress Scale (PSS- 10) |
| | Utility of mindfulness-based stress reduction to impact health promotion in nursing students: A mindful project. | Healthcare Workers | Nursing students | Mindfulness-based Stress Reduction (MSBR) | None | Perceived Stress Scale (PSS- 10); Stress Overload Scale (SOS) |
| 26 | Thirty-second mindful body scan meditation for bedside nurses. | Healthcare Workers | Nurses | mindful body scan meditation | None | Perceived Stress Scale (PSS- 10) |
| | An online resilience intervention for military personnel. | Military | All participants were members of the H4W nationwide community of post-9/11 military veterans and active duty service members | Resilient Warrior | None | Center for Epidemiological Studies Depression Scale (CES-D); Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); General Self-Efficacy Scale (GSE); Measure of Current Stress Reactivity Scale (MOCS); Patient Health Questionnaire (PHQ-9); Patient-Reported Outcomes measurement Information System (PROMIS) Sleep Scale; Perceived Stress Scale (PSS- 10); PTSD Checklist Military Version (PCL-M); PCL unspecified, General self-efficacy (GSE), Coping Expectancy Scale (CES), Measure of Current Stress Reactivity Scale - Abbreviated (MOCS-A) |
| | Synchronous mindfulness in motion online: Strong results, strong attendance at a critical time for health care professionals (HCPs) in the COVID era. | Healthcare Workers | health care professionals | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-14); Utrecht Work Engagement Scale (UWES) |
| | The impact of mindfulness training on police officer stress, mental health, and salivary cortisol levels. | Emergency Services | Sworn law enforcement officers employed by the Dane County Sheriff ÅÓs Office, Madison Police Department, and University of Wisconsin-Madison Police Department. | Mindfulness-based Resilience Training (MBRT); Modified mind- body based stress reduction (MSBR) | Waitlist | Alcohol Use Disorders Identification Test; Cortisol Levels; Oldenburg Burnout Inventory (OLBI); Patient-Reported Outcomes Measurement Information System (PROMIS®) Depression, anxiety and anger; Patient-Reported Outcomes measurement Information System (PROMIS) Sleep Scale; Perceived Stress Scale (PSS- 10); Perceived Stress Scale (PSS-14); Pittsburgh Sleep Quality Index (PSQI); PTSD Checklist - Civilian Version (PCL-C); Work Limitations Questionnaire (WLQ); Organisational and Operational Police Stress Questionnaire, Health and Behaviours Checklist (HBC) , Hair and Salivary Cortisol, Inflammatory Markers. Perceived stress scale - unspecified |
| | The impact of a tailored mindfulness-based program for resident physicians on distress and the quality of care: A randomised controlled trial. | Healthcare Workers | Resident physicians in Germany | Modified mind-body based stress reduction (MSBR) | Same coursebook without a description of practical exercises. | Copenhagen Burnout Inventory (CBI); Cortisol Levels; General Health Questionnaire (GHQ-12); Perceived Stress Scale (PSS- 10); Patient Health Questionnaire (PHQ-4), Irritation Scale, |
| | Improving stress management, anxiety, and mental well- being in medical students through an online Mindfulness-Based Intervention: a randomized study. | Healthcare Workers | Two cohorts of medical students from Italian universities. | Comprehensive Mind Body Intervention (MBI) | Waitlist | 14-Item Resilience Scale (RS- 14); Perceived Stress Scale (PSS-10); Positive and Negative Affect Schdule (PANAS); State-trait Anxiety Inventory (STAI); Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), Mind Wandering Spontaneous (MW-S), Difficulties in Emotion Regulation Scale (DERS), Resilience Scale (RS- 14), Attention Control Shifting and Distraction (AC- S and AC- D). |
| | A Smartphone App to Reduce Burnout in the Emergency Department: A Pilot Randomized Controlled Trial. | Healthcare Workers | Healthcare workers in Canada. The multidisciplinary group of participants included 38 Nurses (Registered Nurses & Licensed Practical Nurses), 17 Physicians, and 3 Respiratory Therapists | Wellbeing mobile app | Waitlist | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS) |
| | A Mobile Phone- Based Intervention to Reduce Mental Health Problems in Health Care Workers During the COVID- 19 | | We included health care workers from any medical specialty (pneumology, internal medicine, emergency, | | | Depression Anxiety Stress Scales (DASS- 21); General Self- Efficacy Scale (GSE); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI- HSS); Davidson Trauma Scale (DTS), App |
| 1 | Pandemic (PsyCovidApp): Randomized Controlled Trial. | Healthcare Workers | primary care, etc) and role (physicians, nurses, nurse assistants , etc) | PsyCovidApp | Control app | usability scale |
| | The Emergency Resiliency Initiative: A Pilot Mindfulness Intervention Program. | Healthcare Workers | Registered nurses (RNs) and patient care technicians (PCTs) | Modified mind-body based stress reduction (MSBR) | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Does the intervention of mindfulness reduce levels of burnout and compassion fatigue and increase resilience in pre-registration students? A pilot study. | Healthcare Workers | Pre-registration Therapeutic radiography students | Modified mind-body based stress reduction (MSBR) | Care as usual | Connor-Davidson Resilience Scale (CD-RISC); Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF); Maslach Burnout Inventory - Student Survey (MBI-SS); Professional Quality of Life Scale (ProQOL) |
| | Changes in hair cortisol and self-reported stress measures following mindfulness-based stress reduction (MBSR): A proof-of-concept study in pediatric hematology-oncology professionals. | Healthcare Workers | Healthcare Professionals from the hematology-oncology department from Sainte-Justine UHC | Mindfulness-based Stress Reduction (MSBR) | None | Brief Symptom Inventory- 18 (BSI- 18); Cortisol Levels; Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-10) |
| 7 | Mindfulness and compassion-oriented practices at work reduce distress and enhance self-care of palliative care teams: a mixed method evaluation of an "on the job" program. | Healthcare Workers | Participants were staff members of a palliative care center in a faith-based community hospital in Bonn, Germany | Mixture of meditation, sound bath, walking meditation, mindful stops, Metta/Tonlen practice. | None | Cortisol Levels; Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Questionnaire (PSQ); SCL-90 Symptom Checklist (SCL-90); Hospital Anxiety and Depression Scale (HAD-S), Emotion Regulation Skills Questionnaire (ERSQ-27), Work Situation (NRS), Goal Attainment Scaling (GAS) |
| | An On-the- Job Mindfulness-based Intervention For Pediatric ICU Nurses: A Pilot. | Healthcare Workers | Nurses working in the PICU at an urban pediatric academic hospital | Modified mind-body based stress reduction (MSBR) | None | Job Satisfaction Scale; Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS); Self-Compassion (SCS); Nursing Stress Scales |
| | Integration and impact of Stress Management and Resiliency Training (SMART) in a nurse residency program: A feasibility study. | Healthcare Workers | The nurses who were invited to participate in this study were part of a pilot nurse residency program study | Stress Management and Resilience Training (SMART) | Just comparison biofeedback and control | Connor-Davidson Resilience Scale (CD-RISC); Generalized Anxiety Disorder (GAD- 7); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS-14); Qualitative Interview / Assessment |
| 15 | Stress and Anxiety Management in Nursing Students: Biofeedback and Mindfulness Meditation. | Healthcare Workers | Nursing students beginning clinical training§ | Vipassane meditation; Biofeedback | control | Perceived Stress Scale (PSS-14); State-trait Anxiety Inventory (STAI); Perceived Stress Scale - unpecified |
| | Mindfulness training for stress management: a randomised controlled study of medical and psychology students. | Healthcare Workers | Medical and psychology students in their second or third term at the University of Oslo and the University of Tromsø (1) respectively , were invited to participate in the study. | Modified mind-body based stress reduction (MSBR) | Care as usual active control (Monitoring of perceptions) | Five Facet Mindfulness Questionnaire (FFMQ); General Health Questionnaire (GHQ- 12); Maslach Burnout Inventory - Student Survey (MBI-SS); Meditation diary/log; Perceived Medical School Stress (PMSS) Scale, Subjective Wellbeing Scale (SWB) |
| | A New Mental Health Mobile App for Well-Being and Stress Reduction in Working Women: Randomized Controlled Trial. | Healthcare Workers | Working women from a private hospital in Sau Paulo Brazil | Wellbeing mobile app | | Perceived Stress Scale (PSS-10); World Health Organisation well-being Index (WHO-5); Subjective symptoms of stress and well-being during the last month / at the moment |
| | Positive Effects of a Stress Reduction Program Based on Mindfulness Meditation in Brazilian Nursing Professionals: Qualitative and Quantitative Evaluation. | Healthcare Workers | Nursing professionals at Teaching Hospital Sao Paulo | Modified mind-body based stress reduction (MSBR); Stress Reduction Program (SRP) | None | Beck Depression Inventory (BDI-II); Maslach Burnout Inventory - Human Services (MBI- HSS); Perceived Stress Scale (PSS- 10); Qualitative Interview / Assessment; Satisfaction with Life Scale (SWLS); Self-Compassion (SCS); State-trait Anxiety Inventory (STAI); WHOQOL-BREF quality of life assessment; Work Stress Scale (WSS); Self- Reporting Questionnaire (SRQ) |
| | Effectiveness of a mindfulness education program in primary health care professionals: a pragmatic controlled trial. | Healthcare Workers | Primary healthcare professionals in and around Catalan | Mindfulness Education Program | Waitlist | Five Facet Mindfulness Questionnaire (FFMQ); Jefferson Scale of Physician Empathy ( JSPE); Maslach Burnout Inventory - Human Services (MBI- HSS); Short version of POMS Questionnaire , University Massachusetts Centre of Mindfulness questionnaire. |
| | Modifying resilience mechanisms in at- risk individuals: a controlled study of mindfulness training in Marines preparing for deployment. | Military | Participants were recruited from a convenience sample of two Marine infantry battalions scheduled to undergo predeployment training | Mindfulness- based Mind Fitness Training (MMFT) | Care as usual | Blood sample for pro-inflammatory gene expression; fMRI; Response to Stressful Experiences Scale |
| | Efficacy of Mindfulness-Based Cognitive Training in Surgery: Additional Analysis of the Mindful Surgeon Pilot Randomized Clinical Trial. | Healthcare Workers | Post graduate year 1 surgery residents | Modified mind-body based stress reduction (MSBR) | active control | Abbreviated Maslach Burnout Inventory (MBI); BlockEgo- Resilience Scale; fMRI; Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); National Institutes of Health Executive Abilities: Measures and Instruments for Neurobehavioral Evaluation and Research (NIH-EXAMINER); Patient Health Questionnaire (PHQ- 9); Perceived Stress Scale (PSS-10); Short Grit Scale |
| | Embracing Change: A Mindful Medical Center Meets COVID-19. | Healthcare Workers | Healthcare professionals from Ohio State University Wexner Medical Center. | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-10); Utrecht Work Engagement Scale (UWES) |
| | Stress Management and Resiliency Training (SMART) program among Department of Radiology faculty: a pilot randomized clinical trial. | Healthcare Workers | Department of Radiology physicians | Stress Management and Resilience Training (SMART) | Waitlist | Connor-Davidson Resilience Scale (CD-RISC); Linear Analogue Self- Assessment (LASA); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 14); Smith Anxiety Scale (SAS) |
| | Effect of a Brief Mindfulness- Based Program on Stress in Health Care Professionals at a US Biomedical Research Hospital: A Randomized Clinical Trial. | Healthcare Workers | Full-time health care professionals at the Clinical Center at the National Institutes of Health in Bethesda, Maryland | Mindfulness- Based Self- care (MBSC) | Care as usual | Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS-10); Positive and Negative Affect Schdule (PANAS); Visual Analog Scale |
| | A randomised controlled trial of the effects of mindfulness practice on medical student stress levels. | Healthcare Workers | Medical students at the University of Tasmania, Australia. | Spoken guided mindfulness practice | Care as usual | 14-Item Resilience Scale (RS- 14); Depression Anxiety Stress Scales (DASS-21); Perceived Stress Scale (PSS-10) |
| | A pilot study of a mind-body stress management program for student veterans. | Military | All participants were incarcerated on the Housing Unit for Military Veterans (HUMVs) in the Middlesex County correctional system | Resilient Warrior (Modified SMART-3RP) | None | Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); General Self-Efficacy Scale (GSE); Measure of Current Stress Reactivity Scale (MOCS); Patient Health Questionnaire (PHQ-8); Perceived Stress Scale (PSS- 10); Patient Reported Outcomes Information System (PROMIS) Short Form (8B) Sleep Disturbance Scale, Current Expectancies Scale (CES) |
| | A Brief Mindfulness- Based Self- Care Curriculum for an Interprofessional Group of Palliative Care Providers. | Healthcare Workers | Mixed- professional- background usual- attendees of a monthly educational con- ference in a well-established palliative care group within an academic medical center | Modified mind-body based stress reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Maslach Burnout Inventory - Human Services (MBI- HSS); Meditation diary/log; Perceived Stress Scale (PSS- 10) |
| | Mindfulness for Healthcare Providers: The Role of Non- Reactivity in Reducing Stress. | Healthcare Workers | Healthworkers at a large Midwestern (US) teaching Hospital | Mindfulness-based Stress Reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS-10); Quality of Life Inventory (QOLI) Acceptance and Action Questionnaire- II; Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF); Oldenburg Burnout Inventory (OLBI); Self-Compassion Scale - Short form (SCS-SF); PROMIS AU- |

Full sized table is available at https://osf.io/sk72j/

| | Title | Population Category | Population description | Intervention | Comparison group | Outcome Measures |
|---|---|---|---|---|---|---|
| | The Impact of Mindful Meditation on Health Care Workers During the COVID-19 Pandemic. | Healthcare Workers | Health care workers included in the study: physicians, advanced practice nurses, physician assistants, nurses, therapists, medical technologists, and medical assistants. | Wellbeing mobile app | None | Perceived Stress Scale (PSS-10) |
| | Sustained resiliency building and burnout reduction for healthcare professionals via organizational sponsored mindfulness programming. | Healthcare Workers | Healthcare workers from the ohio state university wexner medical centre. | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Utrecht Work Engagement Scale (UWES); Perceived Stress Scale (PSS-unspecified) |
| | Impact of a Mindfulness-Based Stress Reduction Program on Psychological Well-Being, Cortisol, and Inflammation in Women Veterans. | Military | Women veterans | Mindfulness-based Stress Reduction (MSBR) | Active Control Condition (ACC). | Center for Epidemiological Studies Depression Scale (CES-D); Cortisol Levels; Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS-10); PTSD Checklist - Civilian Version (PCL-C); UCLA Loneliness Scale (UCLA-LS); Cytokines, Social Provisions Scale (SPS), Combat Exposure Scale (CES) |
| | Efficacy of Transcendental Meditation to Reduce Stress Among Health Care WorkSangeeta Pers A Randomized Clinical Trial. | Healthcare Workers | Patient-facing HCWs were recruited from Duke University and the community. | Trancidental Meditation | Access to wellness resources | Brief Symptom Inventory-18 (BSI-18); Connor-Davidson Resilience Scale (CD-RISC); Generalized Anxiety Disorder (GAD-7); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI-HSS); Patient Health Questionnaire (PHQ-9) |
| | Effects of Transcendental Meditation on Academic Physician Burnout and Depression: A Mixed Methods Randomized Controlled Trial. | Healthcare Workers | Academic physicians from a midwestern metropolitan medical school and VA hospital. All subjects were MDs. | Trancidental Meditation | Care as usual | Beck Depression Inventory (BDI-II); Brief Resilience Scale (BRS); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-10) |
| | Assessment of Virtual Mindfulness-Based Training for Health Care Professionals: Improved Self-Reported Respiration Rates, Perceived Stress, and Resilience. | Healthcare Workers | | Mindfulness in Motion (MIM) | None | Breathing Rate; Connor-Davidson Resilience Scale (CD-RISC); Perceived Stress Scale (PSS-10) |
| | Effectiveness of mindfulness-based interventions on burnout and self-compassion among critical care nurses caring for patients with COVID-19: a quasi-experimental study. | Healthcare Workers | Nurses | Modified mind-body based stress reduction (MSBR) | Care as usual | Five Facet Mindfulness Questionnaire (FFMQ); Maslach Burnout Inventory - Human Services (MBI-HSS); Self-Compassion (SCS) |
| | The impact of a mindfulness-based intervention on the quality of life of Spanish national police officers. | Emergency Services | National police officers in Mallorca (Spain). | Modified mind-body based stress reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS-10); Professional Quality of Life Scale (ProQOL); Self-Compassion (SCS) |
| | Links between stress, sleep, and inflammation : A translational perspective of resilience. | Healthcare Workers | Moderately stressed healthcare professionals | Mindfulness-Based Self-care (MBSC) | Care as usual | Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS-10); Positive and Negative Affect Schdule (PANAS); Visual Analog Scale; Maslach Burnout Inventory 2- Item (MBI-2), Mindful Self-Care Scale - General (MSCS-G). |
| | Assessment of burnout with implementation of a brief mindfulness intervention in palliative care clinicians. | Healthcare Workers | Inpatient palliative care group | Focused Meditation; Wellbeing mobile app | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Combating occupational nursing stress with mindfulness-based stress reduction: An evidence-based quality improvement project. | Healthcare Workers | Nurses working at a 398-bed, acute care, tertiary hospital that specializes in the care of cardiovascular, orthopedic, neurological, and oncology patient populations. | Modified mind-body based stress reduction (MSBR) | None | Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS-14); HCAHPS score for "Nursing Communication" |
| 103 | Mindful moments: Use of mindfulness to reduce stress and alleviate burnout among nurse practitioners. | Healthcare Workers | nurse practitioners | Mindful Moment (MM) project | None | Copenhagen Burnout Inventory (CBI); Meditation diary/log; Perceived Stress Scale (PSS- 10) |
| | Biomarker response to mindfulness intervention in veterans diagnosed with post-traumatic stress disorder. | Military | U.S military veterans of any age and from any war- participant pool was split among two locations. They were from Tuscaloosa and Mimeapolis | Mindfulness-based Stress Reduction (MSBR) | Psychoeducation of PTSD symptoms | Blood sample for pro-inflammatory gene expression; Cortisol Levels; Five Facet Mindfulness Questionnaire (FFMQ); Patient Health Questionnaire (PHQ-9); PTSD Checklist Military Version (PCL-M) |
| | Effects of mindfulness on anesthesia provider burnout. | Healthcare Workers | The participants are anesthesia providers, both anesthesiologists and CRNAs, who currently work in the perioperative setting. | Mindfulness education package | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Mindfulness, deep breathing, and body scan meditation for reducing work-related stress and improving job satisfaction among psychiatric nurses. | Healthcare Workers | Nurses | Mindfulness education and exercise intervention. | None | Perceived Stress Scale (PSS-10); Nursing Workplace Satisfaction Questionnaire (NWSQ) |
| | The use of mindfulness-based meditation to reduce stress among healthcare workers. | Healthcare Workers | Multidisciplinary team of healthcare providers including nurses, physicians, dieticians, nursing assistants, and social workers and Huntington Healthcare Center | Unspecified mindful meditation education and daily self-practice | None | Perceived Stress Scale (PSS-10) |
| | Utility of mindfulness-based stress reduction to impact health promotion in nursing students: A mindful project. | Healthcare Workers | Nursing students | Mindfulness-Based Stress Reduction (MSBR) | None | Perceived Stress Scale (PSS-10); Stress Overload Scale (SOS) |
| 20 | Thirty-second mindful body scan meditation for bedside nurses. | Healthcare Workers | Nurses | mindful body scan meditation | None | Perceived Stress Scale (PSS-10) |
| | An online resilience intervention for military personnel. | Military | All participants were members of the H4W nationwide community of post-9/11 military veterans and active duty service members | Resilient Warrior | None | Center for Epidemiological Studies Depression Scale (CES-D); Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); General Self-Efficacy Scale (GSE); Measure of Current Stress Reactivity Scale (MOCS); Patient Health Questionnaire (PHQ-8); Patient-Reported Outcomes measurement Information System (PROMIS) Sleep Scale; Perceived Stress Scale (PSS-10); PTSD Checklist Military Version (PCL-M); PCL unspecified, General self-efficacy (GSE), Coping Expectancy Scale ( CES), Measure of Current Stress Reactivity Scale - Abbreviated (MOCS-A) |
| | Synchronous mindfulness in motion online: Strong results, strong attendance at a critical time for health care professionals (HCPs) in the COVID era. | Healthcare Workers | health care professionals | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-14); Utrecht Work Engagement Scale (UWES) |
| | The impact of mindfulness training on police officer stress, mental health, and salivary cortisol levels. | Emergency Services | Sworn law enforcement officers employed by the Dane County Sheriff ¿Âs Office, Madison Police Department, and University of Wisconsin-Madison Police Department. | Mindfulness-based Resilience Training (MBRT); Modified mind-body based stress reduction (MSBR) | Waitlist | Alcohol Use Disorders Identification Test; Cortisol Levels; Oldenburg Burnout Inventory (OLBI); Patient-Reported Outcomes Measurement Information System (PROMIS(R)) Depression, anxiety and anger; Patient-Reported Outcomes measurement Information System (PROMIS) Sleep Scale; Perceived Stress Scale (PSS-10); Perceived Stress Scale ( PSS- 14); Pittsburgh Sleep Quality Index (PSQI); PTSD Checklist - Civilian Version (PCL-C); Work Limitations Questionnaire (WLQ ). Organisational and Operational Police Stress Questionnaire, Health and Behaviours Checklist (HBC), Hair and Salivary Cortisol, Inflammatory Markers. Perceived stress scale - unspecified |
| | The impact of a tailored mindfulness-based program for resident physicians on distress and the quality of care: A randomised controlled trial. | Healthcare Workers | Resident physicians in Germany | Modified mind-body based stress reduction (MSBR) | Same coursebook without a description of practical exercises. | Copenhagen Burnout Inventory (CBI); Cortisol Levels; General Health Questionnaire ( GHQ- 12); Perceived Stress Scale (PSS-10); Patient Health Questionnaire (PHQ-4), Irritation Scale, |
| | Improving stress management, anxiety, and mental well-being in medical students through an online Mindfulness-Based Intervention: a randomized study. | Healthcare Workers | Two cohorts of medical students from Italian universities. | Comprehensive Mind Body Intervention (MBI) | Waitlist | 14-item Resilience Scale (RS-14); Perceived Stress Scale (PSS-10); Positive and Negative Affect Schdule (PANAS); State-trait Anxiety Inventory (STAI); Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS), Mind Wandering Spontaneous (MW-S), Difficulties in Emotion Regulation Scale (DERS), Resilience Scale (RS-14), Attention Control Shifting and Distraction (AC-S and AC- D). |
| | A Smartphone App to Reduce Burnout in the Emergency Department: A Pilot Randomized Controlled Trial. | Healthcare Workers | Healthcare workers in Canada. The multidisciplinary group of participants included 18 Nurses (Registered Nurses & Licensed Practical Nurses), 17 Physicians, and 3 Respiratory Therapists | Wellbeing mobile app | Waitlist | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS) |
| 1 | A Mobile Phone-Based Intervention to Reduce Mental Health Problems in Health Care Workers During the COVID-19 Pandemic (PsyCovidApp): Randomized Controlled Trial. | Healthcare Workers | We included health care workers from any medical specialty (pneumology, internal medicine, emergency, primary care, etc) and role (physicians, nurses, nurse assistants, etc) | PsyCovidApp | Control app | Depression Anxiety Stress Scales (DASS-21); General Self-Efficacy Scale (GSE); Insomnia Severity Index; Maslach Burnout Inventory - Human Services (MBI-HSS); Davidson Trauma Scale (DTS), App usability scale |
| | The Emergency Resiliency Initiative: A Pilot Mindfulness Intervention Program. | Healthcare Workers | Registered nurses (RNs) and patient care technicians (PCTs) | Modified mind-body based stress reduction (MSBR) | None | Maslach Burnout Inventory - Human Services (MBI-HSS) |
| | Does the intervention of mindfulness reduce levels of burnout and compassion fatigue and increase resilience in pre-registration students? A pilot study. | Healthcare Workers | Pre-registration Therapeutic radiography students | Modified mind-body based stress reduction (MSBR) | Care as usual | Connor-Davidson Resilience Scale (CD-RISC); Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF); Maslach Burnout Inventory - Student Survey (MBI- SS); Professional Quality of Life Scale (ProQOL) |
| | Changes in hair cortisol and self-reported stress measures following mindfulness-based stress reduction (MBSR): A proof-of-concept study in pediatric hematology-oncology professionals. | Healthcare Workers | Healthcare Professionals from the hematology-oncology department from Sainte-Justine UHC | Mindfulness-based Stress Reduction (MSBR) | None | Brief Symptom Inventory- 18 (BSI-18); Cortisol Levels; Maslach Burnout Inventory - Human Services (MBI- HSS); Perceived Stress Scale (PSS-10) |
| 7 | Mindfulness and compassion-oriented practices at work reduce distress and enhance self-care of palliative care teams: a mixed-method evaluation of an "on the job" program. | Healthcare Workers | Participants were staff members of a palliative care center in a faith-based community hospital in Bonn, Germany | Mixture of meditation, sound bath, walking mediation, mindful stops, Metta/Ton-lan practice. | None | Cortisol Levels; Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Questionnaire (PSQ); SCL-90 Symptom Checklist (SCL-90); Hospital Anxiety and Depression Scale (HAD- S), Emotion Regulation Skills Questionnaire (ERSQ-27), Work Situation (NRS), Goal Attainment Scaling (GAS) |
| | An On-the-Job Mindfulness-based Intervention For Pediatric ICU Nurses: A Pilot. | Healthcare Workers | Nurses working in the PICU at an urban pediatric academic hospital | Modified mind-body based stress reduction (MSBR) | None | Job Satisfaction Scale; Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS); Self-Compassion (SCS); Nursing Stress Scales |
| | Integration and impact of Stress Management and Resiliency Training (SMART) in a nurse residency program: A feasibility study. | Healthcare Workers | The nurses who were invited to participate in this study were part of a pilot nurse residency program study | Stress Management and Resilience Training (SMART) | Just comparison | Connor-Davidson Resilience Scale (CD-RISC); Generalized Anxiety Disorder (GAD-7); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 14); Qualitative Interview / Assessment |
| 65 | Stress and Anxiety Management in Nursing Students: Biofeedback and Mindfulness Meditation. | Healthcare Workers | Nursing students beginning clinical training8 | Vipassana meditation; Biofeedback | biofeedback and control | Perceived Stress Scale (PSS-14); State- trait Anxiety Inventory (STAI); Perceived Stress Scale - unpecified |
| | Mindfulness training for stress management: a randomised controlled study of medical and psychology students. | Healthcare Workers | Medical and psychology students in their second or third term at the University of Oslo and the University of Tromsø respectively, were invited to participate in the study. | Modified mind-body based stress reduction (MSBR) | Care as usual | Five Facet Mindfulness Questionnaire (FFMQ); General Health Questionnaire (GHQ- 12); Maslach Burnout Inventory - Student Survey (MBI- SS); Meditation diary/log; Perceived Medical School Stress (PMSS) Scale, Subjective Wellbeing Scale (SWB) |
| | A New Mental Health Mobile App for Well-Being and Stress Reduction in Working Women: Randomized Controlled Trial. | Healthcare Workers | Working women from a private hospital in Sau Paulo Brazil | Wellbeing mobile app | active control (Monitoring of perceptions) | Perceived Stress Scale (PSS-10); World Health Organisation well-being Index (WHO- 5); Subjective symptoms of stress and well-being during the last month / at the moment |
| | Positive Effects of a Stress Reduction Program Based on Mindfulness Meditation in Brazilian Nursing Professionals: Qualitative and Quantitative Evaluation. | Healthcare Workers | Nursing professionals at Teaching Hospital Sao Paulo | Modified mind-body based stress reduction (MSBR); Stress Reduction Program (SRP) | None | Beck Depression Inventory (BDI-II); Maslach Burnout Inventory - Human Services (MBI- HSS); Perceived Stress Scale (PSS-10); Qualitative Interview / Assessment; Satisfaction with Life Scale (SWLS); Self-Compassion (SCS); State-trait Anxiety Inventory (STAI); WHOQOL-BREF quality of life assessment; Work Stress Scale (WSS); Self-Reporting Questionnaire (SRQ) |
| | Effectiveness of a mindfulness education program in primary health care professionals: a pragmatic controlled trial. | Healthcare Workers | Primary healthcare professionals in and around Catalan | Mindfulness Education Program | Waitlist | Five Facet Mindfulness Questionnaire (FFMQ); Jefferson Scale of Physician Empathy (JSPE); Maslach Burnout Inventory - Human Services (MBI-HSS); Short version of POMS Questionnaire, University Massachusetts Centre of Mindfulness questionnaire. |
| | Modifying resilience mechanisms in at-risk individuals: a controlled study of mindfulness training in Marines preparing for deployment. | Military | Participants were recruited from a convenience sample of two Marine infantry battalions scheduled to undergo predeployment training | Mindfulness-based Mind Fitness Training (MMFT) | Care as usual | Blood sample for pro-inflammatory gene expression; fMRI; Response to Stressful Experiences Scale |
| | Efficacy of Mindfulness-Based Cognitive Training in Surgery: Additional Analysis of the Mindful Surgeon Pilot Randomized Clinical Trial. | Healthcare Workers | Post graduate year 1 surgery residents | Modified mind-body based stress reduction (MSBR) | active control | Abbreviated Maslach Burnout Inventory (MBI); Block Ego-Resilience Scale; fMRI; Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); National Institutes of Health Executive Abilities: Measures and Instruments for Neurobehavioral Evaluation and Research (NIH-EXAMINER); Patient Health Questionnaire (PHQ-9); Perceived Stress Scale (PSS-10); Short Grit Scale |
| | Embracing Change: A Mindful Medical Center Meets COVID-19. | Healthcare Workers | Healthcare professionals from Ohio State University Wexner Medical Center. | Mindfulness in Motion (MIM) | None | Connor-Davidson Resilience Scale (CD-RISC); Maslach Burnout Inventory - Human Services (MBI-HSS); Perceived Stress Scale (PSS-10); Utrecht Work Engagement Scale (UWES) |
| | Stress Management and Resiliency Training (SMART) program among Department of Radiology faculty: a pilot randomized clinical trial. | Healthcare Workers | Department of Radiology physicians | Stress Management and Resilience Training (SMART) | Waitlist | Connor-Davidson Resilience Scale (CD-RISC); Linear Analogue Self-Assessment (LASA); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 14); Smith Anxiety Scale (SAS) |
| | Effect of a Brief Mindfulness-Based Program on Stress in Health Care Professionals at a US Biomedical Research Hospital: A Randomized Clinical Trial. | Healthcare Workers | Full-time health care professionals at the Clinical Center at the National Institutes of Health in Bethesda, Maryland | Mindfulness-Based Self-care (MBSC) | Care as usual | Maslach Burnout Inventory - Human Services (MBI-HSS); Mindful Attention Awareness Scale (MAAS); Perceived Stress Scale (PSS- 10); Positive and Negative Affect Schdule (PANAS); Visual Analog Scale |
| | A randomised controlled trial of the effects of mindfulness practice on medical student stress levels. | Healthcare Workers | Medical students at the University of Tasmania, Australia. | Spoken guided mindfulness practice | Care as usual | 14-item Resilience Scale (RS-14); Depression Anxiety Stress Scales (DASS- 21); Perceived Stress Scale (PSS-10) |
| | A pilot study of a mind-body stress management program for student veterans. | Military | All participants were incarcerated on the Housing Unit for Military Veterans (HUMV) in the Middlesex County correctional system | Resilient Warrior (Modified SMART-3RP) | None | Cognitive and Affective Mindfulness Scale - Revised (CAMS-R); General Self-Efficacy Scale (GSE); Measure of Current Stress Reactivity Scale (MOCS); Patient Health Questionnaire (PHQ-8); Perceived Stress Scale (PSS-10); Patient Reported Outcomes Information System (PROMIS) Short Form (8B) Sleep Disturbance Scale, Current Expectancies Scale ( CES) |
| | A Brief Mindfulness-Based Self-Care Curriculum for an Interprofessional Group of Palliative Care Providers. | Healthcare Workers | Mixed-professional-background usual-attendees of a monthly educational conference in a well-established palliative care group within an academic medical center | Modified mind-body based stress reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Maslach Burnout Inventory - Human Services (MBI-HSS); Meditation diary/log; Perceived Stress Scale (PSS- 10) |
| | Mindfulness for Healthcare Providers: The Role of Non-Reactivity in Reducing Stress. | Healthcare Workers | Healthworkers at a large Midwestern (US) teaching Hospital | Mindfulness-based Stress Reduction (MSBR) | None | Five Facet Mindfulness Questionnaire (FFMQ); Perceived Stress Scale (PSS-10); Quality of Life Inventory (QOLI); Acceptance and Action Questionnaire-II; Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF); Oldenburg Burnout Inventory (OLBI); Self-Compassion Scale - Short form (SCS-SF); PROMIS AU- |

Appendix V. Study 2 - Registered Report

## Introduction

Current studies have found an increase in the prevalence of burnout across the world (Back et al., 2016). In 2014, it was found that 62% of respondents met the criteria for burnout, 71% of British doctors were at risk of burnout and 20% of all European workers were affected by burnout(British Medical Association, 2016; Kamal et al., 2020; Norlund et al., 2010; Shanafelt et al., 2012). With the events of the SARS-CoV-2 pandemic, there has been even more focus on burnout in healthcare workers and the impact the pandemic has had on their mental health. One systematic review found the pandemic had a significant degradation on the mental health of healthcare workers with levels of occupational burnout ranging from 3.1%-44.7% while another found this ranged between 26% and 31% (Sanghera et al., 2020; Serrano-Ripoll et al., 2020). A study on nurses, suggests that, working with COVID-19 patients seemed to correlate with higher scores in depersonalisation and emotional exhaustion, in particular (Chen et al., 2021). It is thought that negative emotions in colleagues, family members and patients can trigger similar emotions in nurses affecting their perceived stress levels and increasing vulnerability to emotional exhaustion(Joshi & Sharma, 2020). The prevalence of burnout has been increasing and the recent pandemic has made this worse.

While initially, it was thought that the main issues were the emotional challenges of working with people in a caregiving role, subsequent research found that common job-related stressors were more highly correlated with burnout than human interaction stressors (Maslach et al., 2001). As such, burnout is now thought to be the result of continued exposure to work stress (Kumar & Mellsop, 2013). Many suggest the experience of stress contributes to burnout. In line with the Conservation of

Resources theory (COR), psychological stress occurs when resources are threatened, lost or invested without an anticipated return on investment (Hobfoll & Freedy, 1993). In the context of occupational burnout, work stress is a psychological state resulting from an imbalance between work perceptions of workplace demands and coping abilities. When this is continuing and unmediated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress.

Although not 'workers' students' academic work includes structured activities such as lectures and submitting assignments that can be considered as 'work'(Lin & Huang, 2014). Burnout in students shares many similarities with occupational burnout and also includes chronic stress leading to decreased motivation and emotional exhaustion (Lin & Huang, 2014). Students often have to juggle multiple assignments with casual work and extracurricular activities which has been found to significantly contribute to academic burnout (Salanova et al., 2010). As such, this study will examine burnout by looking at students during a busy assignment period.

When measuring stress and burnout, previous studies often looked at stress and burnout levels before and after an intervention to see if they are effective in reducing burnout. These type of studies tend to be recollective in nature and subject to participant bias with people's summaries of their own experiences and states often being inaccurate portrayals of their actual experiences and states (Beal & Weiss, 2003). Additionally, pre- post- surveys do not accurately examine the variance and covariance of the same variables overtime within the same participant (Beal & Weiss, 2003). Perceived stress levels can be dynamic proximity to assignment due dates and the number of upcoming assignments varying throughout the assignment period and pre-post- measurements may not accurately reflect this. To measure perceived stress levels during the assignment period, this study will use daily PSS-EMA surveys and a weighted

assignment score to account for the fact that both the number of assignments due and their imminence are likely to affect the level of perceived stress on any particular day.

A second issue with the current research is that in tends to heavily rely on self-report surveys. Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions(Naczenski et al., 2017; Shirom & Melamed, 2006). Research has started to look at physiological measures of burnout which largely focus on the body's physiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. Repeated or prolonged stress exposure can lead to sustained activation of these axes (Garland et al., 2011; Traunmüller et al., 2018). When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) which releases epinephrine which increases heart rate and increases blood pressure (Harvard Medical School, 2020; McLeod, 2010). Physical symptoms of burnout are thought to be the result of SNS activation due to stress including increased heart rate, decreased heart rate variability and increased blood pressure (Melamed et al., 2006) (Bährer-Kohler, 2013). This study will use HRV as a physiological measure of stress.

In healthy individuals, the heart rate represents the overall effect of the neural outputs of the sympathetic nervous system, which accelerates it, and the parasympathetic system, which slows it (Shaffer et al., 2014). The outputs of these two parts of the autonomic nervous system are reflected in beat-to-beat difference in the heart, heart rate variability (HRV)(Raymond Trevor et al., 2009). The chronic stress symptoms associated with burnout is thought to be due to the results of sustained activation of the sympathetic nervous system and several studies have shown that HRV can be used to measure this (Castaldo et al., 2015). More specifically in preparations for

tests, students exhibited changes in HRV in preparation prior to stressful tests (Raymond Trevor et al., 2009). The gold-standard for measuring HRV uses an electrocardiogram (ECG) to measure R-peaks and requires the use of multiple electrodes placed on the torso to measure the electric potential created by the heart's activity (Wittenberg et al., 2020). The resulting inter-beat intervals can be analysed in the frequency domain or time domain. Spectral analysis (in the frequency domain) provides advantages as it provides frequency and amplitude information to quantify oscillations over a time period allowing the attempted identification of mechanisms affecting HRV (Shaffer et al., 2014). For example high frequency measures are associated with the parasympathetic nervous system while low frequency measures with the sympathetic nervous system (Shaffer et al., 2014). However, time domain measures are simpler to calculate and have been correlated with power measures in several studies (Shaffer et al., 2014). Two of the main measures using time domain analysis are the standard deviation between normal-to-normal intervals (SDNN) and root mean square of successive differences between normal heart beats (RMSSD)(Shaffer et al., 2014). Both have been found to measure acute stress in short measures (Pereira et al., 2017). However, while RMSSD is thought to measure the parasympathetic nervous system activation, SDNN is to measures the joint parasympathetic and sympathetic modulation of heart rate (Carnethon et al., 2006). As this study aims to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis will be used. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to have a provide a very

strong to almost perfect correlation the ECG results (Moya-Ramon et al., 2022). As meditation has been found to both increase the parasympathetic nervous system activation and decrease sympathetic nervous system, as SDNN measures the impact of both, it will be used to measure the effectiveness of the intervention.(Carnethon et al., 2006; Tang et al., 2009).

Mindfulness practices are the most reported intervention for burnout and has been found to offer statistically significant results in improving stress levels and reducing burnout (Asuero et al., 2014; Franco Justo, 2010; Montanari et al., 2019; Pérula-de Torres et al., 2019). It has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events(Garland et al., 2011; Hölzel et al., 2011). While research into meditation has increased recently, the issue of defining and measuring meditation can limit the generalisability and interpretation of this research. Specifically, methodological heterogeneity in meditation traditions and implementations surrounding the definition of meditation pose issues with the interpretation and integration of the research outcomes (Davidson & Kaszniak, 2015). To allow for a validated approach to the examination of meditation, a clear definition is required (Przyrembel & Singer, 2018). A systematic review examining the effectiveness of meditation found that only a

small minority used a single form of meditation as an intervention with the overwhelming majority using interventions such as Mindfulness-based Stress Reduction (MBSR) which combines several components including yoga and mindful eating which can confound the results (Chu et al., 2024). This study seeks to remove some of the heterogeneity found in mindfulness and burnout research by using a pure focused meditation program without other mindfulness components.

As such, this study will use the Smiling Minds App which is a free, non-for-profit, evidence based preventative mental wellbeing smart phone application recommended by the Australian Government Department of Health and Aged care (Department of Health Disability and Aging, 2024; Smilng Mind, 2024). It has been found to reduce stress and burnout in workers in a randomized controlled trial (Lanz et al., 2019). Sham meditations have also been used in these studies as an effective control conditions and this study will use one modelled on previous studies (Zeidan et al., 2010). By randomising participants and providing both with a single mindfulness component, focused meditation, it will be able to better understand the effective of meditation in preventing stress and burnout.

Most of these studies also focus on treatment of those displaying signs of burnout but not on the effectiveness of meditation for the prevention of burnout. With the majority of high-risk occupations, it is expected that employees will be exposed to high-stress environments which may lead to burnout. By using EMA techniques, this study seeks to examine the potential of focused meditation as a preventive measure to reduce the increase of stress in response to a stressful environment.

This study aims to fill several gaps in meditation and burnout research. It will use both pre- and post- test measures and EMA techniques to analyse the effects of meditation on stress both within participant in a time series and between groups whilst

taking into account the effect of different assignment dates. It will use both self-report and physiological measures to track stress over time and will use a single intervention of focused meditation rather than a combination of several mindfulness components. Lastly, by using EMA techniques, it will look at medtiation as a way to prevent excessive increases in stress brough on by assignments not just treat high levels of stress and burnout.

**Review question(s)**

It is hypothesised that the meditation group will show reduced perceived stress and burnout from pre-test to post-test. It is hypothesised that whilst proximity to assignment due dates will result in increases in stress, these increases will be less for the meditation group. In addition, it is predicted that the number of meditations sessions completed will enhance this effect.

**Keywords**

Meditation; Mindfulness; Prevention and Control; Stress, Psychological;

## Materials and methods

### Study Design

This study was an online randomised experimental study using both a pre-, post- and ecological momentary assessment (EMA) designs.

Participants were randomised based on their date of birth with those born between the 1st and 16th inclusive of the month being assigned to the intervention group and those born on the 17th to 31st being assigned to the control group. The intervention group was provided with instructions for the use of the Smiling Minds smart phone application study program consisting of 5 meditation sessions ranging from 4 minutes and 20 seconds to 7 minutes. Participants were asked to do one meditation daily and cycle through these for the period of their participation.

The control group were provided with pre-recorded audio files containing a 'sham meditation' to do daily. These were the same length as the corresponding Smiling Minds meditation but instead participants were told to, approximately every 4 minutes, to 'take deep breaths as we sit in meditation'. In a similar use of a sham meditation, participants unanimously answered that they felt they were truly meditating (Zeidan et al., 2010).

To maximise participation, participants were able to start the program on any day during the assignment period with the final day being the same for all participants.

Prior to commencing the meditation program and on the last day of the program, participants were asked to do self-report measures of stress and burnout. Additionally, each morning prior to their meditation session, participants were asked to measure stress using heart rate variability (HRV) using the Welltory smart phone app and smart phone camera and do a short self-report measure of perceived stress.

**Participants**

Participants were first year psychology students recruited via the University of Adelaide Research Participation System. Once on the study site, they were provided with a participant information sheet and informed consent page. Participants will be required to be over the age of 18 years and be proficient in English. Participants were provided with 3.5 credits toward their semester grade on completion of the study.

**Measures**

**Perceived Stress Scale – 10 item (PSS-10)**

The PSS-10 contains 10 questions regarding thoughts and feelings to measure perceived stress. Using a Likert Scale ranging from "0 - never" to "5 - very often", it asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (46, 47). Four of the

questions are reversed scored. A review of its validity found that it had internal consistency ($\alpha > .70$) in all 12 studies used and satisfactory test-retest reliability (48). It has been shown to have strong validity in student populations (49).

### Maslach Burnout Inventory – Student Scale (MBI-SS)

The MBI-SS is a modified version of the MBI that measures burnout dimensions of exhaustion, cynicism and professional efficacy (Schaufeli et al., 2002). It has been frequently used with university students and, using the Rasch Measurement Model, has been found to have adequate levels of structural validity, reliability and scalability (Pérez-Mármol & Brown, 2019).

### Perceived Stress Scale – Ecological Momentary Assessment (PSS-EMA).

This is a brief adapted version of the PSS containing 4-items and shows high internal consistency reliability and significant correlations with several criterion validity measures (Murray et al., 2023).

### Heart Rate Variability (HRV)

As this study aimed to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis was required. As such, HRV was measured using the Welltory smartphone app and smartphone camera. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to have a provide a very strong to almost perfect correlation the ECG results (Moya-Ramon et al., 2022). Additionally, research into the validity of ‘ultra-short measures’ of HRV have found that using ECG, that for SDNN, single measures of at least 30 seconds, are sufficient to obtain reliable readings of SDNN when compared to the gold standard of

240 – 300 seconds (Munoz et al., 2015). The Welltory app uses a 60 second ultra-short SDNN recording.

### Assignment Stress Score

To account for the different number and due dates for assignments, participants were asked to provide the dates of the due dates of their assignments. The sum of the reciprocal of the days to the due date was calculated for each day they participated to provide a measure of stress expected due to the number of assignments due dates coming up and the proximity to these dates.

### Cumulative Meditation Score

Each day, participants were asked to log which meditation they did. This was used to calculate the number of meditation they had done up until the current date and used to examine the effect of cumulative meditation sessions and account for participants doing a a different number of meditations due to missing days or different start days.

### Data analysis

The data was extracted from Qualtrics and the tester participant IDs were removed. For anonymity, participants created their own participant ID and self-reported this each session. Participants that did multiple and different initial surveys were excluded. Entries that had conflicting participant IDs were examined and were consolidated if possible. Total scores for PSS-10, MBI-SS and PSS-EMA were calculated. For instances where multiple entries were logged on the same day, all entries were excluded due to being unreliable. It appeared that participants entered self-reported did not align with the date logged by Qualtrics as the date of entry suggesting that participants were logging entries for past days.

A mixed-methods model was used to analyse the data in R Studio. The fixed effects included group (intervention and control), assignment stress and cumulative meditation. The interaction effects of group with assignment stress and cumulative meditation were included.

**Acknowledgements**

This review will contribute to a PhD for PC.

**Funding**

No funding provided.

**Author contributions**

P Chu was the primary author with the assistance of thesis supervisors and the University of Adelaide, C Semmler and F Kerr. M Chu and H Chu for provided survey testing, proof reading and review.

**Conflicts of interest**

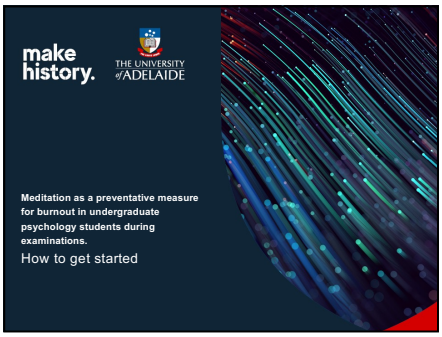
P Chu is the founder and director of Design Your Life PTY. LTD. which provides exercise, yoga, and meditation services to both individuals and as part of corporate wellness programs.

**Data availability**

The data that support the findings of this study are openly available in the Open Science Framework (OSF) at https://osf.io/sk72j/.

Appendix VI. Study 2 & 3 - Participant training presentations.

How to get started

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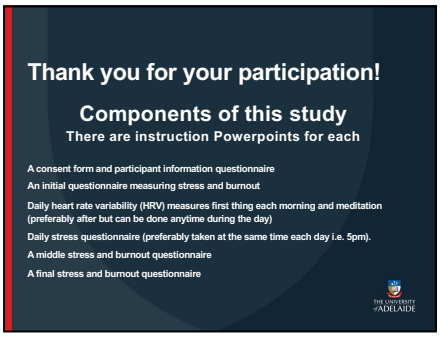


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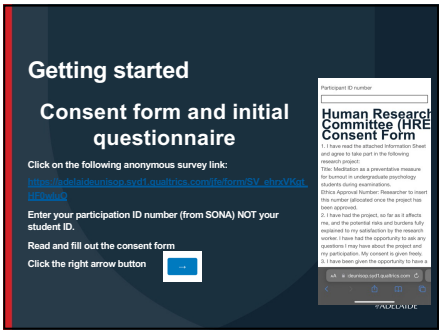


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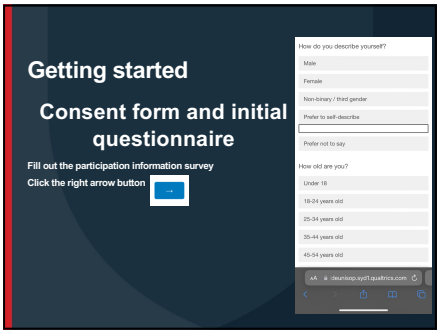


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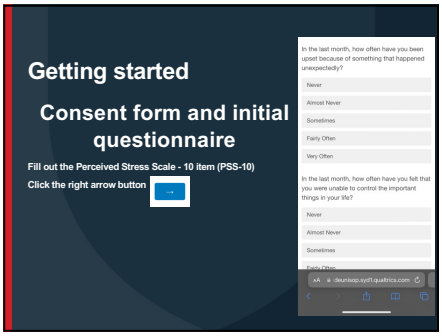


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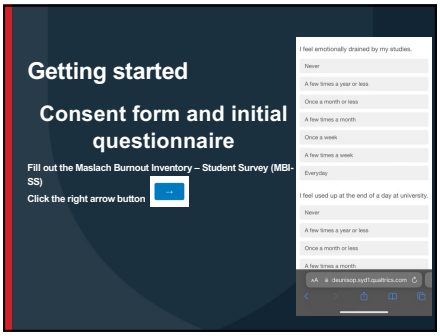


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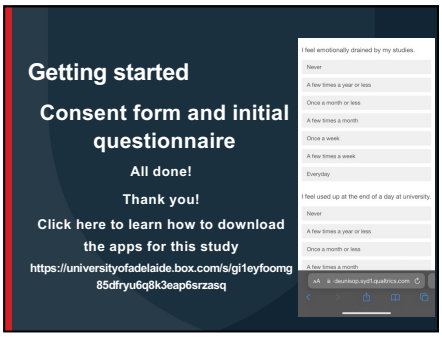
How to get started

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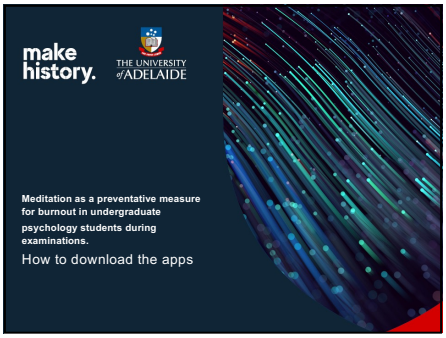
How to download the apps

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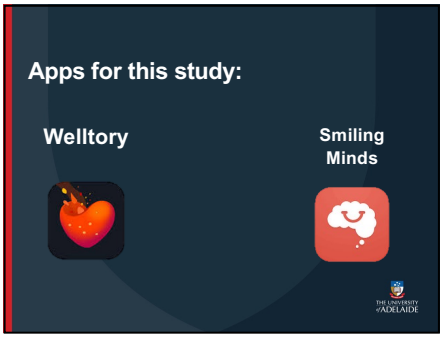


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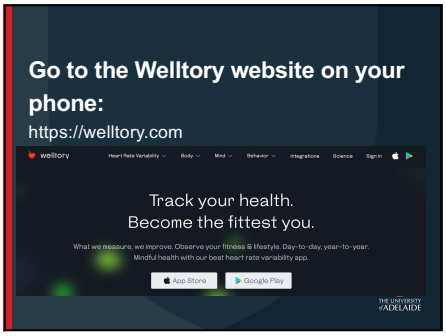


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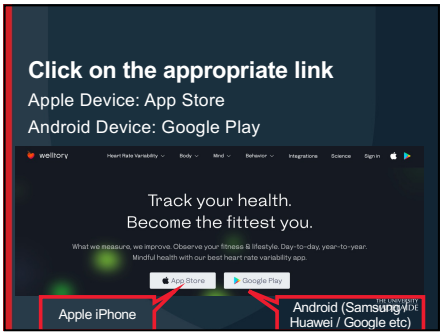


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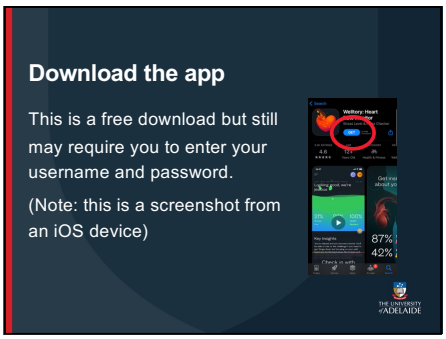


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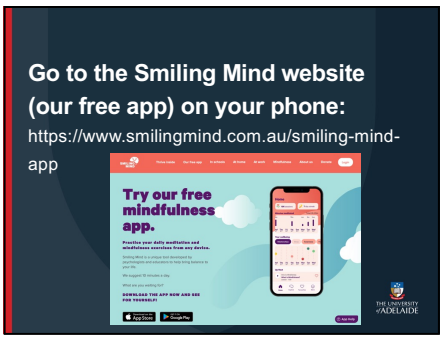


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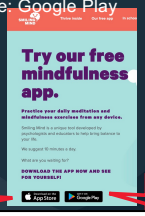
How to download the apps

**Click on the appropriate link**

Apple Device: App Store

Android Device: Google Play




Apple iPhone

Android (Samsung / Huawei / Google etc)

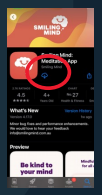
7

**Download the app**

This is a free download but still may require you to enter your username and password.

(Note: This is a screenshot from an iOS device)

Note: If you haven't downloaded it before, it will have a 'get' button

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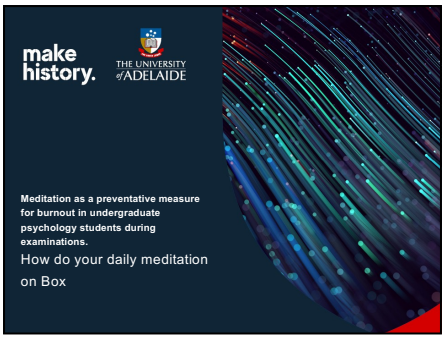
**Once you have the apps installed on your phone. See the instructions for out to set them up.**

9

How to do your daily meditation on Box - Control Group 9/16/25

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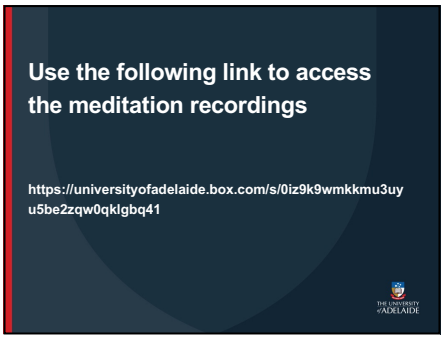


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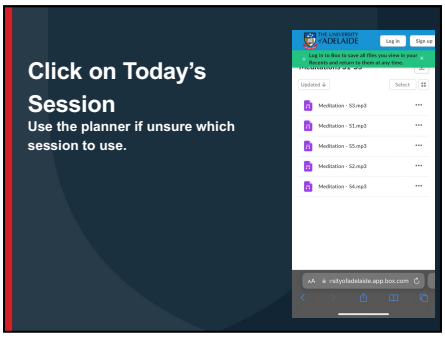


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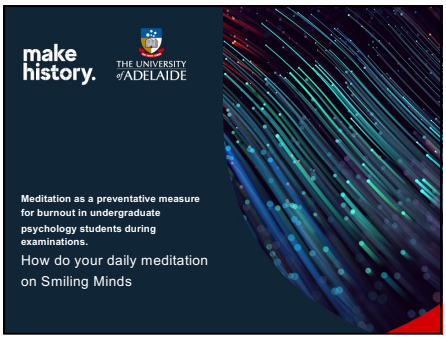
How to do your daily meditation on Smiling Minds - Intervention Group

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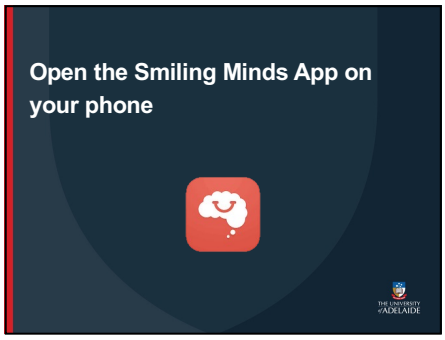


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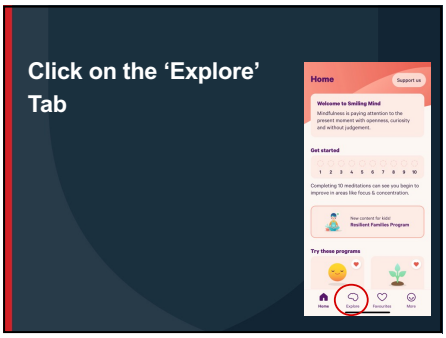


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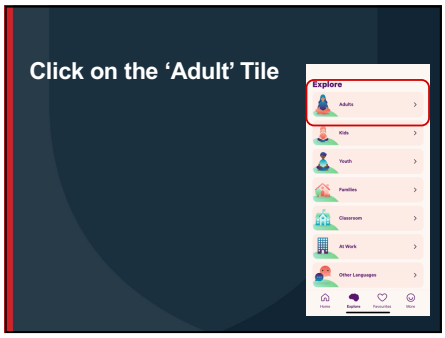


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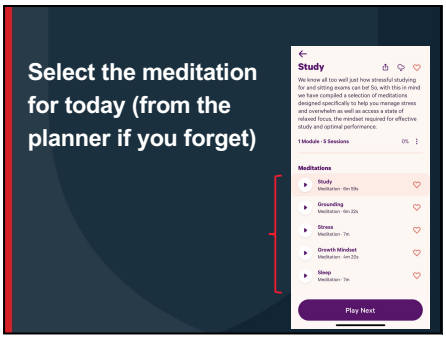


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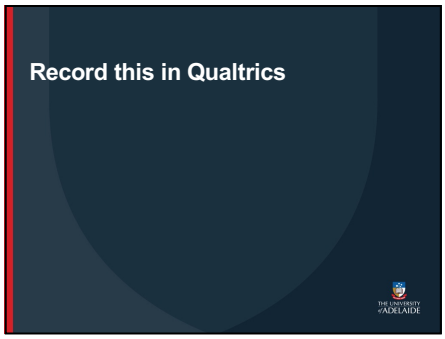


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How to take a daily HRV measurement




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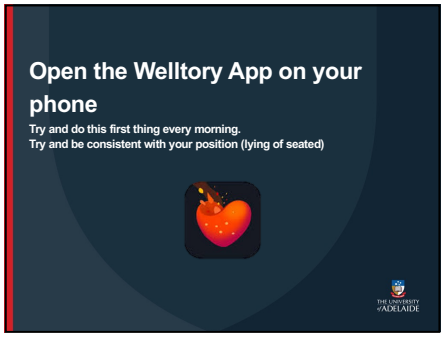


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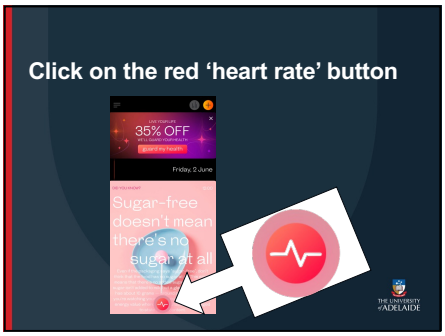


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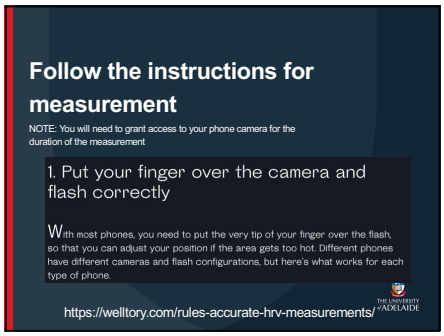


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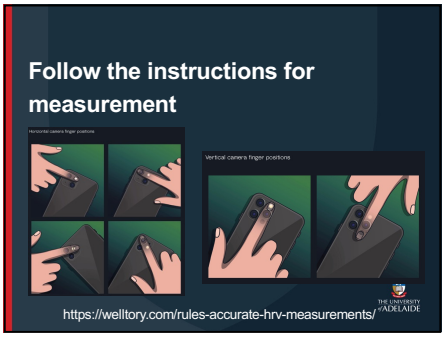


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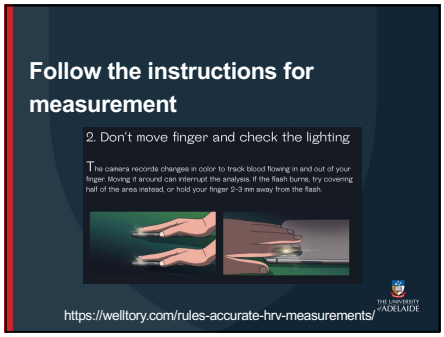


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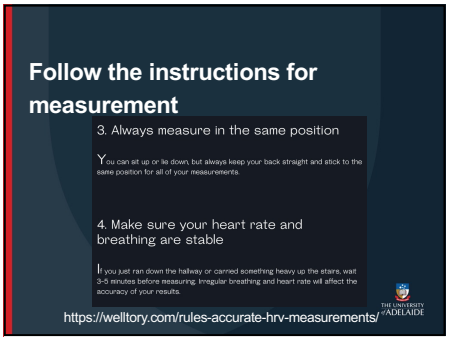
How to take a daily HRV measurement

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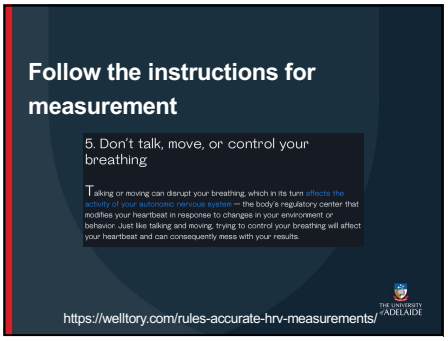


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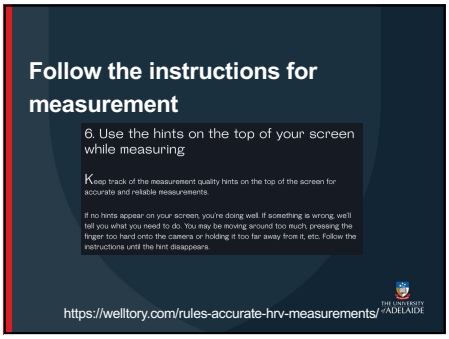


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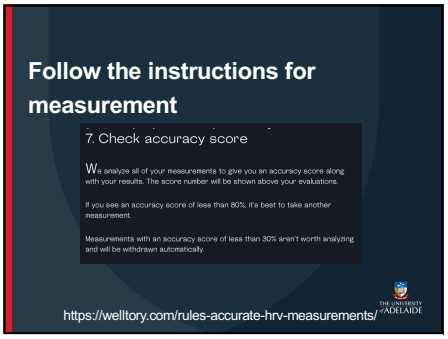


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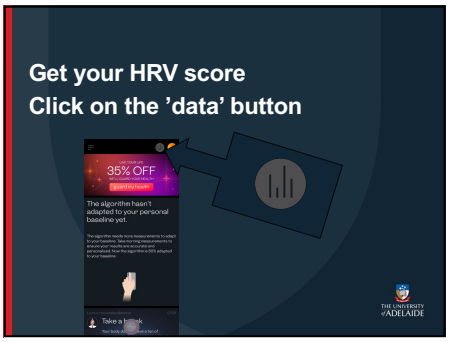


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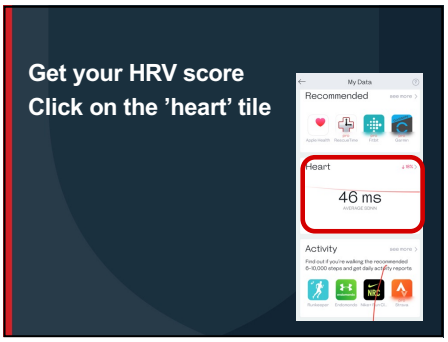


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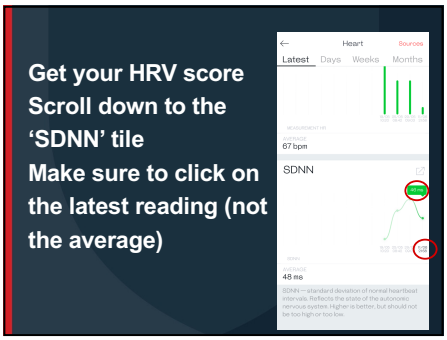
How to take a daily HRV measurement

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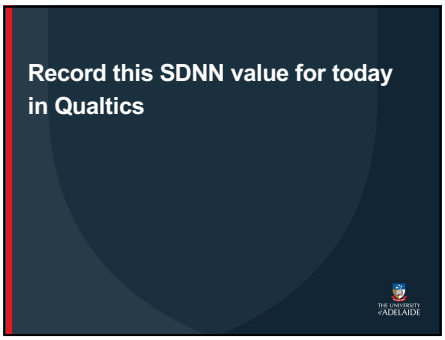


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# Appendix VII. Study 2 - Ethics Proposal




# Human Research Ethics Committee (HREC) – Consent Form

1. I have read the attached Information Sheet and agree to take part in the following research project:

| | |
|---|---|
| **Title:** | Meditation as a preventative measure for burnout in undergraduate psychology students during examinations. |
| **Ethics Approval Number:** | Researcher to insert this number (allocated once the project has been approved. |

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

4. Although I understand the purpose of the research project is to improve the quality of health/medical care, it has also been explained that my involvement may not be of any benefit to me

5. I agree to participate in the activities outlined in the participant information sheet.

   [For projects with multiple activities, it can be useful to list them and if they are optional include checkboxes for participants to indicate the activities they agree to undertake].

6. I understand my participation is voluntary and that I am free to withdraw my information from the project at any time.

   I understand that if I decide not to take part or withdraws from the project, that this will not affect medical advice in the management of my health, now or in the future.

7. I have been informed that the information gained in the project may be published in a journal article and thesis.

8. I have been informed that in the published materials I will not be identified and any personal information that could identify me will not be divulged.

9. I consent for the use of my survey and HRV data by the same or other researchers in future research projects that are in the same general area of research (stress and burnout). I understand personal information that may identify me (e.g. name, address, date of birth) will be removed or changed before it is shared with other researchers:

   Yes ☐ No ☐

10. I understand my information will only be disclosed according to the consent provided, except where disclosure is required by law.

11. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

**Participant to complete:**

Name: _____ Signature: _____ Date: _____

THE UNIVERSITY of ADELAIDE

**Human Research Ethics Committee (HREC)**

**2019 Application for ethics approval**

| Office use only | | | | | | |
|---|---|---|---|---|---|---|
| | Received: | | | | | |
| | RM No. | | | | | |
| | Ethics Approval No: | | | | | |
| | HREC | EXEC | A/P | HSc | Psych | ORECI |

## LEVEL OF ETHICAL REVIEW:

Indicate the level of ethical review that is being sought for this application:

| | |
|---|---|
| ☐ | **Full HREC review**<br>Applies to all research involving more than 'low risk research' as defined in the National Statement on Ethical Conduct in Human Research 2007 (updated 2018) |
| ☒ | **Low risk review**<br>Applies to 'low risk research' as defined in the National Statement on Ethical Conduct in Human Research 2007 (updated 2018) (referred to hereafter as *National Statement)*. Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information. |

## SECTION 1: PROJECT AND RESEARCHERS' DETAILS

**1.1 Project title:**

Meditation as a preventative measure for burnout in undergraduate psychology students during examinations.

**1.2 Provide a 1-2 sentence plain language summary of the project:**

This summary should be in plain language and suitable for release to the public.

Managing stress is an important aspect of students' academic success at University. This study will investigate a simple intervention for reduction of stress induced by exams. Undergraduate psychology students will be randomly selected into one of three groups, meditation (delivered smart phone application), 'sham meditation' course (delivered by smart phone) and a waitlist group. They will be assessed for levels of stress and burnout using self-report measures (PSS-10, MBI-SS) prior to during and after the University examination period and results compared. Additionally ecological momentary assessment techniques will be used to measure perceived stress (PSS-EMA) and physiological stress (HRV using Welltory smart phone application).

**1.3 Project timeframe:**

| | | | |
|---|---|---|---|
| **Proposed commencement date of activities that require human ethics approval**: | Jun 2023 | **Estimated completion date of the project:** | Dec 2023 |

Research must not commence without the prior written approval of the HREC. Retrospective approval cannot be provided.

**1.4 If this application is to extend a currently approved project, provide the HREC approval number:**

| | |
|---|---|
| **HREC approval number:** | NA |

An Annual Report on Project Status Form should also be completed.

**1.5 Applicant:**

The applicant may also be referred to as the principal investigator. If the project is to be undertaken by a research student, the student's primary or other supervisor at The University of Adelaide is the Applicant.

| | | | |
|---|---|---|---|
| **Applicant's title and name:** | Assoc. Prof. Carolyn Semmler | **EMPLID**: | a1154192 |

| | | | |
|---|---|---|---|
| **School or Department:** | School of Psychology | | |
| **Email:** | carolyn.semmler@adelaide.edu.au | **Phone:** | 8313 4628 |
| **Qualifications and research experience relevant to the project:** | BPsych(Hons), PhD. A/Prof Semmler has extensive human research experimentation experience leading national and international research teams in past 20 years. Lead Researcher – Applied Cognition and Experimental Psychology (ACEP) group. | | |
| **Role in the research:** | Primary supervisor | | |

### 1.6 Student projects:

If the project is to be undertaken by a research student as part of their studies, please indicate below. **Section 7** must also be completed.

| | | | | | |
|---|---|---|---|---|---|
| **Name:** | Peter Chu | **Student ID:** | A1104736 | **Program Level:** | PhD |
| **Name:** | | **Student ID:** | | **Program Level:** | |
| **Name:** | | **Student ID:** | | **Program Level:** | |

### 1.7 Other researchers:

List all researchers (other than the Applicant and students) in the table below and if applicable their University of Adelaide EMPLID. Include all co-supervisors and researchers internal and external to The University of Adelaide. **Section 7** must also be completed.

| **Names:** | **EMPLID:** |
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### 1.8 Has or will this project be submitted for approval to other HRECs?

Include the HREC's name, current status of the application (i.e. submitted, approved, deferred or rejected) and attach this documentation. The University of Adelaide accepts ethics approval granted by some other HRECs and may not require a separate ethics application. Researchers are encouraged to consult with information about Notification of ethical review and approval from other institutions to see if this applies.

☐ Yes – the project *will* be submitted for approval to:
☐ Yes – the project *has been* submitted for approval to:
☒ No

### 1.9 Has or will this project be submitted for approval to any departments or institutions?

E.g. Department of Education, prisons, government institutions, or businesses. Attach authorising correspondence and/or approval documentation to the application.

☐ Yes – the project *will* be submitted for approval to:
☐ Yes – the project *has been* submitted for approval to:
☒ No

## SECTION 2: NATURE OF THE PROJECT

### 2.1 Aims of the project:

Discuss in standard English the main research aims/hypotheses to be investigated.

The effectiveness of meditation in preventing or reducing the increase in stress associated with the examination period. It is hypothesised that for all participants stress levels will rise leading up to and during the examination period. Following this, stress levels are predicted to return to baseline. This is predicted to be reflected in an increased score on the Perceived Stress Scale (both the 10-item and the ecological momentary assessment versions) and a reduction in morning heart rate variability leading up to and during the examination period and a reduction in perceived stress scale and an increase in morning heart rate variability following the last examination. However, it is predicted that the rise in measures of stress will be less for those undertaking the smart phone meditation program and a quicker return to baseline following the last examination.

### 2.2 Rationale of the project:

Explain in standard English the rationale for the project i.e. how the research will fill any gaps or contribute new knowledge to the field.

Students have been identified as a specific group who may be experiencing g increased levels of stress and burnout due to financial strain and the need to work alongside of study (Larcombe, Baik, & Finch, 2022). Specifically, exams with large grade weightings held at the end of semester have been identified as a feature of coursework that may increase levels of distress among students.

In existing stress and burnout research, very few studies have looked at specific types of mindful training individually and often include other elements such as yoga, mindful eating and gratitudes. Additionally, most studies use mindfulness therapies as a treatment rather than a preventative measure. Lastly, most studies use self-report measures of perceived stress and burnout before and after the treatment.

This study seeks to remove some of the heterogeneity found in mindfulness and burnout research by using a pure focused meditation program without other mindfulness components It will also improve upon previous work by ensuring that there is an active placebo condition as well as a wait-list control. Lastly, this study will seek to add to this literature by using ecological momentary assessment techniques, self-report measures and physiological measures of stress (HRV) to measures stress levels throughout the study as well as before and after.

### 2.3 Background to the project:

Briefly discuss any previous research of relevance and cite no more than 4 key references.

Current studies have found an increase in the prevalence of burnout across the world (Back, Steinhauser, Kamal, & Jackson, 2016).

In line with the Conservation of Resources theory (COR), psychological stress occurs when resources are threatened, lost or invested without an anticipated return on investment (Hobfoll &

Freedy, 1993). When this is continuing and unmediated, it can lead to burnout with some going one step further by defining burnout as a form of chronic work stress.

Research has started to look at physiological measures of burnout which largely focus on the body's physiological response to stress. The body's two major physiological stress networks are the sympathetic-adrenal-medullary (SAM) axis and the hypothalamic-pituitary-adrenal (HPA) axis. When the body experiences stress, the hypothalamus activates the sympathetic nervous system (SNS) and physical symptoms of burnout are thought to be the result of SNS activation due to stress including increased heart rate, decreased heart rate variability and increased blood pressure (Bährer-Kohler, 2013; Melamed, Shirom, Toker, Berliner, & Shapira, 2006).

Mindfulness practices are the most reported intervention for burnout and has been found to offer statistically significant results in improving stress levels and reducing burnout and has been proposed to exert its effects through several key components including attention regulation, body awareness, emotion regulation and facilitating a change in perspective of the self (Hölzel et al., 2011). As mindfulness practice usually involves noticing distractions and bringing the attention back to body sensations, such as breathing or sensory experiences related to emotions, it can increase an individual's ability to regulate attention and increase body awareness (Hölzel et al., 2011). This increase in body awareness has been proposed to lead to greater emotional awareness and thus, contribute to emotion regulation which has been proposed to underlie the stress reduction benefits of mindfulness by contributing to a positive reappraisal of stress events (Garland, Gaylord, & Fredrickson, 2011; Hölzel et al., 2011).

**2.4 Have there been any preliminary studies? If YES, provide the project title and HREC approval number(s):**

**2.5 Research methodology:**

Describe how the study will be undertaken and explain what interactions will occur between researchers and participants. Include a description of the research methodology and how this will achieve the research aims. For example, you could include a justification of why the sample size/sampling method will yield valid and reliable results. Where appropriate, please refer back to the aims described in 2.1 when describing the methodological approach.

Method

Undergraduate psychology students will be recruited and randomly into assigned into one of three groups, a meditation group, a group given study skills training and a waitlist control group.

The meditation group will the study meditation program using the Smiling Minds smart phone application. This consists of 5 meditation sessions ranging from 4mins and 20 seconds to 7 minutes. Participants will be asked to cycle through this program 6 times for a period of 2 weeks prior to the examination period and for the examination period itself (30 days).

The 'sham meditation' group will listen to a pre-recorded audio file using the 'sham meditation' protocol. They will be asked to listen to this each day for a 30 day period.

Measures of stress and burnout will be taken 2 weeks prior to the examination period, during the examination period and after exams.

Self-report measures of stress and burnout.

Traditional self-report measures of stress and burnout will be taken at baseline (2 weeks prior to examinations), during examination period, 4 weeks after the last examination.

<u>Perceived Stress Scale – 10 item (PSS-10).</u>

The PSS-10 is the 10 item variant of the Perceived Stress Scale developed by Cohen, Kamarck, and Mermelstein (1983). A review of validity studies on the PSS scales have found they have acceptable psychometric properties and have been empirically validity for university students (Lee, 2012). The test takes approximately 10 minutes.

Maslach Burnout Inventory – Student Scale
The MBI-SS is a modified version of the MBI that measures burnout dimensions of exhaustion, cynicism and professional efficacy (Schaufeli, Martínez, Pinto, Salanova, & Bakker, 2002). It has been frequently used with university students and, using the Rasch Measurement Model, has been found to have adequate levels of structural validity, reliability and scalability (Pérez-Mármol & Brown, 2019). The test takes approximately 10 minutes.

Ecological Momentary Assessment measurements.
In addition, participants will be asked to provide daily measurements through their smart phone including the following each morning:

Perceived Stress Scale – Ecological Momentary Assessment (PSS-EMA).
This is a brief adapted version of the PSS containing 4-items and shows high internal consistency reliability and significant correlations with several criterion validity measures (Murray et al., 2023). The test takes approximately 1 minute.

Heart Rate Variability (HRV)

In healthy individuals, the heart rate represents the overall effect of the neural outputs of the sympathetic nervous system, which accelerates it, and the parasympathetic system, which slows it (Shaffer, McCraty, & Zerr, 2014). The outputs of these two parts of the autonomic nervous system are reflected in beat-to-beat difference in the resting heart rate, heart rate variability (HRV)(Raymond Trevor, Dana, Mike, & Rollin, 2009).

The chronic stress symptoms associated with burnout is thought to be due to the results of sustained activation of the sympathetic nervous system and several studies have shown that HRV can be used to measure this (Castaldo et al., 2015). More specifically in preparations for tests, students exhibited changes in HRV in preparation prior to stressful tests (Raymond Trevor et al., 2009).

The gold-standard for measuring HRV uses an electrocardiogram (ECG) to measure R-peaks and requires the use of multiple electrodes placed on the torso to measure the electric potential created by the heart's activity (Wittenberg et al., 2020). The resulting inter-beat intervals can be analysed in the frequency domain or time domain. Spectral analysis (in the frequency domain) provides advantages as it provides frequency and amplitude information to quantity oscillations over a time period allowing the attempted identification of mechanisms affecting HRV (Shaffer et al., 2014). For example high frequency measures are associated with the parasympathetic nervous system while low frequency measures with the sympathetic nervous system (Shaffer et al., 2014). However, time domain measures are simpler to calculate and have been correlated with power measures in several studies (Shaffer et al., 2014).

Two of the main measures using time domain analysis are the standard deviation between normal-to-normal intervals (SDNN) and root mean square of successive differences between normal heart beats (RMSSD)(Shaffer et al., 2014). Both have been found to measure acute stress in short measures (Pereira, Almeida, Cunha, & Aguiar, 2017). However, while RMSSD is thought to measure the parasympathetic nervous system activation, SDNN is to measures the joint parasympathetic and sympathetic modulation of heart rate (Carnethon et al., 2006).

As this study aims to build on previous literature by using daily measures in addition to pre- and post- tests during a stressful period, we have sort to use a non-invasive method for measuring HRV that can be self-administered daily without specialist equipment using time domain analysis. Measuring pulse rate variation using photoplethysmography technology has been found to be reliable for subjects at rest and the Welltory application and smart phone camera sensor has been found to have a provide a very strong to almost perfect correlation the ECG results (Moya-Ramon, Mateo-March, Peña-González, Zabala, & Javaloyes, 2022). As meditation has been found to both increase the parasympathetic nervous system activation and decrease

sympathetic nervous system, as SDNN measures the impact of both, it will be used to measure the effectiveness of the intervention.(Carnethon et al., 2006; Tang et al., 2009). Research into the validity of 'ultra-short meaures' of HRV have found that using ECG, that for SDNN, single meaures of at least 30 seconds, are sufficient to obtain reliable readings of SDNN when compared to the gold standard of 240 – 300 seconds.(Munoz et al., 2015). The Welltory app uses a 60 second ultra-short SDNN recording.

The test takes approximately 30 seconds minute to set up, 1 minute to test and 30 seconds to record (2 minutes total).

**2.6 Location(s) of the research:**

Include details of all sites where the project will be undertaken and locations of participants.

University of Adelaide and via smartphone

**2.7 If research is to be conducted with or about participants living outside Australia outline any local legislation, regulations, permissions or customs that need to be addressed before the research can commence. Outline the steps taken to ensure that this has been adequately considered and addressed.**

See *National Statement Chapter 4.8.* Attach authorising correspondence and/or approval documentation to the application. If you are travelling to a region classified as level 3 or 4 according to the Department of Foreign Affairs and Trade, travel approval may be required. See The University of Adelaide's travel safety information in the HSW Policy and Handbook.

NA

## SECTION 3: PARTICIPANTS AND RECRUITMENT

**3.1 Who will be the participants in this project?**

Participants also includes data about people or human tissue samples.

Participants will be undergraduate students studying at the University of Adelaide through SONA Systems website run by the school of psychology.

**3.2 Does the planned or anticipated recruitment of participants target, focus on, or include as a group, any of the following population groups? Select as many as relevant.**

This question is to capture the planned or foreseeable recruitment of participants from these population groups, rather than their incidental inclusion. Select as many groups as applicable to the research.

| Participant group | | Participant group | |
|---|---|---|---|
| **Aboriginal and Torres Strait Islander people** | ☐ | **People who may be involved in illegal activities** | ☐ |
| **Children and young people** | ☐ | **People with a cognitive impairment, an intellectual disability or a mental illness** | ☐ |
| **Defence Force personnel** | ☐ | **Primary or secondary school students** | ☐ |
| **People highly dependent on medical care who may be unable to give consent** | ☐ | **University students** | ☒ |
| **People in dependent or unequal relationships** | ☐ | **Women who are pregnant and the human fetus** | ☐ |
| **People in other countries** | ☐ | **None of these participant groups** | ☐ |

**3.3 What is the number of participants?**

The study will aim for at least 50 participants condition (total 150)

**3.4 What is the age range of participants?**

18-65

**3.5 If this research involves children under 18 years of age, describe how the researcher/s comply with the University's Child-Safe Environment Policy:**

See *National Statement* Chapter 4.2. Specific requirements for research activities involving children are highlighted in Section 2.4 of the University's Child-Safe Environment Policy.

NA

**3.6 What is the participant selection and exclusion criteria?**

*See National Statement Chapter 3.1.14 – 3.1.15.*

Participants must be psychology students completing examinations over the period.
Participants must have access to a compatible smartphone.
Participants must be able to conduct meditation program through their smartphone. This includes, but is not limited to, the ability to understand English to a proficient level and being able to conduct audio-based meditation training.

**3.7 Where will participants be recruited or sourced from?**

Any use of snowball sampling for recruitment should only be in the passive form. That is participants may be asked to discuss the research with friends/contacts who they think may be interested in volunteering to be participants. Those new participants should then contact the research team to volunteer.

Undergraduate psychology research participation pool (SONA Systems)

**3.8 What materials will be used to recruit participants and how will they be used?**

Provide details of any posters, flyers, participant information sheets, consent forms, advertisements, emails and letters that will be used. Include a listing of any online or physical sites the advertisements will be posted. See *National Statement Chapter 3.1.20.*

Participants have access to information about the study on SONA. Flyers will be placed on pin boards within the research precinct of the Hughes building

**3.9 How and by whom will initial contact with participants be made?**

If recruitment is to be conducted by a third party, please describe how this will take place. Any use of snowball sampling for recruitment should only be in the passive form. That is participants may be asked to discuss the research with friends/contacts who they think may be interested in volunteering to be participants. Those new participants should then contact the research team to volunteer.
It is generally preferred initial contact is made in low pressure ways, such as email or post. If the initial approach will be made in another way, e.g. face to face, provide a justification.

Participants will be approached using the processes of the Undergraduate psychology research participation pool through SONA Systems. No other recruitment method will be used.

**3.10 Will any personal information including names, contact details, email addresses of participants etc. be accessed for purposes of recruitment? If yes, outline how and by whom this information will be accessed:**

Researchers must ensure that personal information is not accessed without the consent of the individual.

No personal information will be accessed for recruitment. Credit for participation will be assigned and processed via the Undergraduate psychology research participation pool through SONA Systems.

**3.11 Describe how, when and what information about the proposed research activities will be provided to participants and any third parties:**

A person's decision to participate in research must be based on sufficient information, an understanding of research and the implications of participation. Use of the participant inNformation sheet (which includes contacts for complaints) and consent form templates which cover the information required by the *National Statement* is required. For online surveys, the information sheet must be incorporated into the survey preamble. Where research is being conducted overseas, it would be helpful to participants if a local, 'independent' person is also included as a contact for complaint. These documents are to be attached to the application. See *National Statement Chapter 2.2*.

All elements of the study participation and recruitment process will be explained to participants via email and the participant information sheet.

**3.12 How and when will consent be obtained from participants and any third parties?**
See *National Statement Chapter 2.2 and Chapter 3.1 Element 3*. Templates for consent forms should be modified to suit the nature of the project.

Consent will be obtained following recruitment via the online questionnaire and the provision of the participation information sheet.

**3.13 For participants not fluent in English or who have difficulty understanding English, what arrangements will be made to ensure comprehension of the research information?**

No participants who fall into this category will be accepted as per the exclusion criteria as the meditation programs are provided in English via audio recording.

**3.14 Will the researcher(s) be taking photographs or recordings of participants using audio tape, film/video, or other electronic medium? If so, how will these be used?**
This information should be provided to participants in the participant information sheet and the consent form.

No.

**3.15 In reference to Question 2.5, indicate all research activities in the study and where applicable outline the approximate time commitment required of participants.**

Consult the definitions of research methods for guidance on selecting the method(s) applicable to the project:

| Research method/activity | | Participant time | Research method/activity | | Participant time |
|---|---|---|---|---|---|
| **Action research** | ☐ | | **Interventional** | ☒ | 1 hour 35mins 3 seconds |
| **Biospecimen analysis** | ☐ | | **Interview** | ☐ | |
| **Body organs, tissues or fluids** | ☐ | | **Observational** | ☐ | |
| **Clinical Trial** | ☐ | | **Phlebotomy (Blood sampling)** | ☐ | |
| **Data linkage** | ☐ | | **Survey** | ☒ | 1 hour |
| **Drugs or isotopes**<br>If this is selected, a Drugs to be Administered Form is to be completed. | | | **Textual analysis**<br>(including medical records, academic records, personal documents) | | |
| **Epidemiological** | ☐ | | **Use of data sets** | ☐ | |
| **Ethnographic** | ☐ | | **Other** | ☒ | HRV via PPG Smartphone application + camera: 30 mins |
| **Focus group** | ☐ | | | | |

**3.16 Provide a description of each of the activities selected above in terms of what the participant will experience from taking part in the research:**
Provide a summary of the focus of any research activities e.g. topics of the survey, interviews etc. and the format they will be undertaken e.g. face to face, online etc. If there are multiple methods, outline if participants are being asked to do one or all of the activities. Attach copies of surveys, interview or focus group schedules, questions and topics to be covered to the application. All attachments should be clearly labelled with appropriate headings and referred to within the body of the application.

Prior and during the University examination period, participants will I be asked to undertake a 10min mediation session using a smart phone app. Training on how to install and use the app will be given at an brief study introduction session offered online via Zoom. (
Before, during and after the University examination period, the PSS-10 and MBI-SS will be administered via smartphone (1 instance each of approximately 30minutes). Some demographic questions will also be provided.
Additionally, participants will be asked to take a daily survey (5pm) and take a heart rate variability measure using theirr smart phone camera and app (on wake up) (approximately 10minutes total daily). This information will be entered into an online questionnaire and linked with the anonymous participant ID number so that all of the data can be linked up later.

Information provided in **Question 3.16** should be incorporated into information provided to participants, either through a participant information sheet or other methods as described in **Question 3.11**. University templates for participant information sheets, consent forms and a drugs to be administered form are available at https://www.adelaide.edu.au/research-services/oreci/human/applications/.

**3.17 For research that involves the handling, storage, and/or disposal of human biospecimens, please detail below the protocols that will be followed to ensure *National Statement* requirements are met.**
See *National Statement Chapter 3.2*.

N/A

## SECTION 4: ETHICAL CONSIDERATIONS

In addition to the ethical considerations pertaining to all research participants, researchers should be aware of the specific issues that arise in terms of the design, conduct and ethical review of research involving various categories of participants as outlined in the *National Statement Section 4*.

**4.1 Describe the likely burdens of participation and any risks to participants when undertaking the research:**
Burdens include impacts on participants such as inconvenience e.g. filling in a form, participating in a street survey, or giving up time to participate in research and discomfort e.g. minor side-effects of medication, the discomforts related to measuring blood pressure, and anxiety induced by an interview. Risks can be emotional, social, legal, medical or physical and can include distress and harm. See *National Statement Chapter 2.1*.

The main burden of participation will be the time required to complete the study and the completion of the daily meditation and HRV measurements. Participants will be required to conduct 3x30mins surveys (prior, during and following examinations).
For a 6 week period they will be required to participate in daily meditation program using a smartphone application.
Throughout the study, participants will be required to take daily measurements of heart rate variability using their smartphone camera (on wake up) (5mins) and application and a daily survey (PSS-EMA) on their smartphone and 5pm each day (5mins).
Although burdensome, the potential benefits of learning strategies for stress management may be valuable to participants.

**4.2 Describe how the risks will be minimised or mitigated. Outline any relevant protocols for management of risks including distress protocols, occupational health and safety practices, first aid procedures etc.**
See *National Statement Chapter 1.7 and Chapter 2.1*.

To minimise the risks, all physiological measurements are non-invasive (PPG using smartphone camera) and survey based. In addition, the primary researchers email contact details will be provided and participants can cease participation at any time. In addition, should participants feel that their levels of stress are unmanageable they will be given the contact details for the Student Wellbeing Hub and the Lifeline Counselling service.

**4.3 Describe how researcher(s) will protect the privacy and confidentiality of participants.**
See *National Statement Chapter 1.6 and Chapter 2.1*

Researchers will protect the privacy and confidentiality of participants by applying de-identification codes at recruitment and abide by the UofA's and National Statement Chapter on the ethical conduct of human research. At no time will the data provided by participants be linked to any identifying information..

**4.4 Describe how the likely benefits of the research will justify the burdens and/or risks to participants:**

See *National Statement Chapter 1.6 and Chapter 2.1*

The data collected in this study will provide information on methods to prevent excess stress and burnout in psychology students during exams and maybe generalisable to other occupations where chronic stress and burnout are potential hazards associated with their work.

**4.5 Outline the protocol that will be followed in the event of any adverse events:**

It is a condition of approval that researchers **immediately** report to the HREC Secretariat any adverse events that might warrant review of ethical approval. See *National Statement Chapter 5.1 and 5.5.*

In the event of any breach of data, The University of Adelaide's Privacy Management Plan and Data Breach Response Plan must be followed.

Although the occurrence of adverse events is anticipated to be extremely low, should any event arise, the research team will immediately notify the HREC Secretariat in accordance with National Statement Chapter 5.1 and 5.5.

**4.6 Will participants receive any reimbursement of out of pocket expenses, or financial or other rewards as a result of participation? What is the amount or nature of the reimbursement/reward and the justification for this?**

See *National Statement Chapters 2.2.10 - 2.2.11; 3.1.10 and 3.1.22.*

No

**4.7 Does the research involve limited disclosure of the research aims? If YES, provide a justification.**

See *National Statement Chapter 2.3.*

Yes. The existence of a Sham Meditation control condition will not be disclosed to maintain blinding and the validity of the results.

**4.8 Describe any possible risks to the health or safety of the researcher(s) when undertaking the research?**

Where interviews are to be held in participants' homes as opposed to public places provide a rationale other than convenience for why this is necessary (and outline the personal safety protocol for the researchers involved). See the *Australian Code of Responsible Conduct in Research 1.2.*

There are no foreseeable risks to the health or safety of the researchers.

## SECTION 5: DATA – CONFIDENTIALITY, ANALYSIS, REPORTING, STORAGE AND FUTURE USE

**5.1 Select the option that reflects the type of data that will be accessed throughout the research:**

For some research, the type of data received or collected initially may be different to the type of data that is stored. For instance, interview data with names recorded is individually identifiable data. If names are *permanently* removed when the data is stored at the completion of the project, the data will then be considered non-identifiable. Personally identifiable information is any part of someone's personal details which can be used to identify them as an individual. This can include name, birth date, home address, email, phone number and student ID. See *National Statement Chapter 3.1 Element 4.*

| Type of data | Initially received/ collected | Stored (at completion) |
|---|---|---|
| **Non-identifiable:** data received or collected about participants that is received in a non-identifiable form. This includes data which has never had personal identifiers e.g. an anonymous survey, or from which identifiers have | ☒ | ☒ |

| | | |
|---|---|---|
| been permanently removed before you received it. **It is not possible for you to identify a specific individual.** | | |
| **Re-identifiable:** data from which personal identifiers have been removed and replaced by a code. The data is either received with a code already attached and personal identifiers have been removed or you remove identifiers and replace with code. **It remains possible for you or others to re-identify a specific individual by, for example, using the code or linking different data sets.** | ☒ | ☒ |
| **Individually Identifiable:** data where the identity of an individual could be reasonably ascertained. Examples of identifiers include the individual's name, image, date of birth or address, or in some cases their position in an organisation. | ☐ | ☐ |

### 5.2 Compliance with the *Guidelines under Section 95 and 95A of the Privacy Act 1988:*

| | YES | NO |
|---|---|---|
| **5.2.1** Is this research relevant to public health or public safety, or to the management, funding or monitoring of a health service?<br>This includes collecting, using or disclosing health information for the purposes of research or compiling statistics relevant to public health or public safety. | ☐ | ☒ |
| **5.2.2** Does the research involve collection, use or disclosure of health information held by an organisation **without** consent from the individual(s) the information relates to? | ☐ | ☒ |
| **5.2.3** Is the information you will be *accessing or collecting* individually identifiable? **i.e. the individual's identity can be reasonably ascertained.** Medical case note's would generally be considered individually identifiable. | ☐ | ☒ |

If you answer **YES** to all three questions in **5.2**, you will need to provide a proposal to the HREC as to why the public interest value of your research out-weighs the public interest in the protection of privacy. The proposal must address the appropriate sections of the G*uidelines under Section 95 and 95A of the Privacy Act 1988*. The guidelines are available at: https://nhmrc.gov.au/about-us/publications/guidelines-under-section-95-privacy-act-1988 and https://nhmrc.gov.au/about-us/publications/guidelines-approved-under-section-95a-privacy-act-1988.

In the questions below, outline how the privacy and confidentiality of participant data and samples will be protected throughout the different stages of the research, making reference to the type of data (non-identifiable, re-identifiable or individually identifiable) that will be accessed by the researcher(s).

### 5.3 How will the privacy and confidentiality of participant data, samples and information be protected during the collection and/or recruitment phase?

Outline the de-identification processes, separation of roles of those responsible for the management of data, and any other relevant practices. Outline where data will be stored during data collection phase and who will have access. See *National Statement Chapter 3.1 Element 4.*

Upon recruitment into the study each participant will be assigned a participant code which will be used to label data. This will be used to link the completion of the surveys across the three time points and to link the self-reported daily HRV data. Participants will control the transfer of raw HRV data, if applicable, to the researchers through the Welltory web portal.

The psychometric data will be entered into an excel file on a secure computer in de-identified form. This electronic data storage will be de-identified through the use of the participant code. Statistical analysis will be carried out using the statistical package R using custom analytical packages.

### 5.4 How will the privacy and confidentiality of participant data, samples and information be protected during the data analysis phase?

Outline the de-identification processes, use of pseudonyms, codes, or explicit consent, and any other relevant practices. Outline where data will be stored during data analysis and who will have access. See *National Statement Chapter 3.1 Element 4.*

Assoc. Professor Carolyn Semmler and Mr Peter Chu will be the primary investigators leading the data analysis phase and will be responsible for the management of all data protection, abiding by the University's guidelines.

**5.5 How will participant data, samples and information be analysed and who will undertake this analysis?**

The mean and standard deviation of the survey scores and HRV measurements will be used to identify within-participant trends and an Analysis of Variance (ANOVA) will be used to analyze the differences between the groups.

**5.6 What feedback of findings will be offered to participants e.g. access to transcripts of interviews, drafts or final reports? When will this occur? If no feedback will be offered, outline why.**

It is good practice to provide participants with the opportunity to review any transcripts, particularly if they will be named or there is the potential for them to be identifiable in the research findings.

None other than being able to access the final publication.

**5.7 How will the project outcomes be made publicly accessible at the end of the project and in what forms (e.g. journal article, book, conference paper, in the media, presentations)? If they will not be made publicly accessible, explain why.**

The project outcomes will be made available to publication as a journal article and possibly a conference presentation and as part of Mr Peter Chu's PhD thesis.

**5.8 How will researcher(s) protect the privacy and confidentiality of participant data, samples and information during the reporting of research results?**

Outline if participants will have the option of being identified or referred to by a pseudonym. Where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be clearly advised of this limitation in the information provided to participants. See *National Statement Chapter 3.1 Element 5, and Chapters 3.1.41 and 3.1.61.*

**5.9 Outline how the records, materials and data from the project will be stored at completion. Include details of the storage location, who will have access.**

Refer to Section 2 of the *Australian Code for the Responsible Conduct of Research*.

All source documents, and study documentation will be stored on a secure university cloud drive folder. The master decode sheet will be kept separate from the source documents.

As part of the University practice of research integrity and open data, all relevant deidentified datasets will be online archived for future use. Given we are recruiting from a small pool of potential participants with publicly available and potentially unique (i.e. identifying) combinations of key demographics will mean that we will withhold age, height and weight from any deposited dataset.

**5.10 Who will be the data custodian?**

All data collections should have an identified custodian to enable access by researchers or participants to the data while maintaining it in a protected form. The custodian of the data may be the individual researcher or agency who collected the information, or an intermediary that manages data coming from a number of sources.

**Please note for student projects the data custodian must be the Principal Supervisor ('Applicant').**

See *National Statement Chapter 3.1.55*.

The primary investigator, Assoc. Professor Carolyn Semmler (see DMP2023-00417)

**5.11 Outline the length of time that the records and materials will be retained by the University.**

Note that the minimum period for retention of research data is 5 years from the date of any publication and varies depending on the specific type of research. For more information refer to the University of Adelaide's Research Data and Primary Materials Policy and Section 2 of the *Australian Code for the Responsible Conduct of Research*.

All source documents, and study documentation will be kept by the Investigator for the appropriate retention period of five years after completion of the study and any resulting

publication. Data will also be permanently and openly available on the Open Science Framework..

**5.12 What type of consent will be obtained? Will consent be Specific, Extended, or Unspecified?**

Data collected as part of a research project ought to be collected and stored in such a way that it can be used in future research projects. Data collected as part of a research project can only be shared or used in future with the explicit consent of participants. The participant information sheet and consent forms must outline how data will be shared or used in future. You cannot share or use data in future if you do not have consent to do this. See *National Statement Chapter 3, particularly 'Sharing of Data and Information'.*

For definitions of types of consent see the *National Statement Chapter 2.2.14*.

'(b) 'extended': given for the use of data or tissue in future research projects that are:

(i) an extension of, or closely related to, the original project; **OR**

(ii) in the same general area of research (for example, genealogical, ethnographical, epidemiological, or chronic illness research);

**5.13 If Specific Consent is sought, justify why the data and information generated by this research should not be made available for future research:**

Where a researcher believes there are ethical reasons not to make research data or information accessible for future use, this must be justified. See *National Statement Chapter 3.1.50.*

N/A

**5.14 Describe what data will be used in future, how it will be used (i.e. for what purpose), who will have access and how participants will be informed. Outline how data will be shared.**

If future use or sharing of the data is intended, participants are to be fully informed of this in the Participant Information Sheet and Consent Form. For more information see *National Statement Chapters 2.2.14 - 2.2.18 and 3.1.45(i).*

The data may be used to from further analysis from the creation of the thesis for Mr Peter Chu's PhD dissertation.

## SECTION 6: CONFLICT OF INTEREST OR OTHER ETHICAL ISSUES

**6.1 Outline the source of any project funding:**

See *National Statement Chapter 5.2.8*

As part of the PhD research for Peter Chu

**6.2 Outline any 'conflict of interest' issues that may arise during the project:**

See *National Statement Chapter 5.2.11 and Chapter 5.4*

Peter Chu is found founder and director of Design Your Life PTY. LTD. which provides corporate meditation services. All data collection and analysis will be conducted by Peter Chu under the supervision of Assoc. Professor Semmler to ensure the integrity of the research and will be available through the Open Source Framework. All data will be owned and managed by the University of Adelaide and not Design Your Life PTY. LTD.

**6.3 Do the researchers expect to obtain any direct or indirect financial or other benefits from conducting this research?**

Benefits must be declared to the HREC and included in the information provided to participants. See *National Statement Chapter 5.4.*

| |
|---|
| No |

**6.4 Outline any other ethical or relevant issues not yet discussed in this application:**

| |
|---|
| N/A |

## SECTION 7: RESEARCHER(S)' QUALIFICATIONS AND EXPERIENCE

**7.1 Student Researcher(s):**

This section should be completed for all students listed in Question 1.6. If there will be direct contact with participants by the research student/s, outline their experience and training to conduct this research.

| | | | |
|---|---|---|---|
| **Student's name, title:** | Peter Chu | **School or Department:** | School of Psychology |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | peter.chu@adelaide.edu.au | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | BA (Security, Terrorism & Counterterrorism Studies), BPsych(Hons). Yoga Instructor | | |
| **Role in the research:** | Primary researcher (PhD student). | | |

| | | | |
|---|---|---|---|
| **Student's name, title:** | | **School or Department:** | |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

| | | | |
|---|---|---|---|
| **Student's name, title:** | | **School or Department:** | |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

**7.2 Other Researcher(s):**

This section should be completed for all researchers listed in Question 1.7.

| | | | |
|---|---|---|---|
| **Name, title and position:** | Assoc. Prof. Carolyn Semmler. | **School/Department or other institution:** | School of Psychology |
| **Email:** | Carolyn.semmler @adelaide.edu.au | **Phone:** | 08 8313 4628 |
| **Qualifications and research experience relevant to the project:** | BPsyc(Hons), PhD. | | |
| **Role in the research:** | Lead Researcher – ACEP Lab | | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | | **School/Department or other institution:** | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | | | |
| **Role in the research:** | | | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | | **School/Department or other institution:** | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | | **School/Department or other institution:** | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

## SECTION 8: DECLARATION BY THE RESEARCHER(S)

**8.1 Readability Review:**

Readability is the ease with which text can be read and understood. Applications are sometimes delayed when corrections due to issues with readability, especially to the participant documents (Information Sheets, Consent Forms, surveys etc.) are needed. Grammar, technical terms and language not tailored to the participant can impact on participants' understanding of the research and being able to give fully informed consent. A review for readability involves asking someone (other than the author) such as a peer outside the research team to review the application and participant documents for feedback on the ease to which the application and participant documents

were read and understood. For students, the Writing Centre can provide assistance with the expression of participant documents.

| | | |
|---|---|---|
| Has the application, including the participant documents, undergone a readability review? | Yes ☐ | No ☐ |

**8.2 Declaration by the Researcher(s):**

**I/we have read the *National Statement on Ethical Conduct in Human Research 2007 (Updated 2018)*** and the ***Australian Code for the Responsible Conduct of Research*.**

**I/we, the researcher(s) agree to**:

- conduct the project in accordance with our responsibilities under the *National Statement on Ethical Conduct in Human Research (2007)* and the *Australian Code for the Responsible Conduct of Research*
- start this research project only after obtaining final approval from the Human Research Ethics Committee (HREC)
- only carry out this research project where adequate funding and personnel is available to enable the project to be carried out according to good research practice and in an ethical manner
- notify the HREC in writing in the event of any adverse or unforeseen events; requesting amendments for approval prior to commencement; completion; discontinuation of the project or changes to research personnel
- provide an annual progress report to the HREC for the duration of the research project
- provide the HREC with a final report
- agree to participate in an audit if requested by the HREC.

**In addition, as the applicant, I**:

- accept responsibility for the conduct of this research project in accordance with the *National Statement on Ethical Conduct in Human Research 2007 (updated 2018)* and the *Australian Code for the Responsible Conduct of Research.*
- certify that all researchers and other personnel involved in this project are appropriately qualified and experienced or will undergo appropriate training and supervision to fulfil their role in this project
- will take responsibility for the confidential maintenance of the research materials as per the University's Responsible Conduct of Research Policy, the University's Records Policy, the University's Research Data and Primary Materials Policy and as required by legislation.

All persons named in **Section 1** are required to sign below:

| | | | | | |
|---|---|---|---|---|---|
| Applicant's signature: | | Name: | Assoc. Professor Carolyn Semmler | Date: | |
| Researcher's signature: | | Name: | Mr Peter Chu | Date: | |
| Researcher's signature: | | Name: | | Date: | |
| Researcher's signature: | | Name: | | Date: | |

| | | | | | |
|---|---|---|---|---|---|
| Researcher's signature: | | Name: | | Date: | |
| Researcher's signature: | | Name: | | Date: | |
| Researcher's signature: | | Name: | | Date: | |

## SECTION 9: CHECKLIST

**The following documents are attached to this application:**

All documents attached should be referred to in the main body of the application and clearly labelled using appropriate headings i.e. Attachment 1, Attachment 2 etc.

Documents should also be labelled with a version number and a date.

| Yes | No | N/A* | Item | Attachment Label (attachment 1 etc.) |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | Participant information including contacts for complaints: either as information sheet, verbal script or survey preamble | |
| ☐ | ☐ | ☐ | Standard Consent Form for a participant in a research project (written consent is required for the majority of projects) | |
| ☐ | ☐ | ☒ | Consent by a Third Party to Participation Form (required where participants are children under 18 years or a dependent adult) | |
| ☐ | ☐ | ☐ | Other recruitment documentation including advertisements, flyers, recruitment letters, emails of introduction, copy of Facebook event pages and social media event sites. | |
| ☐ | ☐ | ☒ | Procedure/protocol for interviews or focus groups including topics, questions or themes | |
| ☐ | ☐ | ☐ | Survey instrument/Questionnaire (include a printed copy of on-line survey) | |
| ☐ | ☐ | ☒ | Adverse events procedure | |
| ☐ | ☐ | ☒ | Evidence of approval/rejection by other HRECs, including comments and requested alterations to the application | |
| ☐ | ☐ | ☒ | Research with people outside Australia: Evidence of permissions, approvals from overseas authorities etc. | |
| ☐ | ☐ | ☒ | Administration of Drugs Form | |
| ☐ | ☐ | ☒ | Annual Report on Project Status (if extending project) | |

*Not applicable

**SECTION 10: HOW TO SUBMIT THIS APPLICATION**

1. Print the completed form and obtain signatures from all researchers.
2. Scan the signed form including all labelled attachments as **one pdf file** and email to: hrec@adelaide.edu.au. (Low Risk Applications in the School of Psychology should be sent to the chair of the review subcommittee).
3. Submission deadlines apply to applications requiring full HREC review. Applications for low risk review can be submitted at any time. Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information.

NB References to the *National Statement* throughout the application form are not meant to be exhaustive but rather they aim to provide a starting point for researchers to consider. Researchers should be familiar with the *National Statement* and other relevant guidelines.

References

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# Participant Information Sheet

**PROJECT TITLE: Meditation as a preventative measure for burnout in undergraduate psychology students during examinations.**

**HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2022-***

**PRINCIPAL INVESTIGATOR: Carolyn Semmler**

**STUDENT RESEARCHER: Peter Chu**

**STUDENT'S DEGREE: PhD**

Dear Participant,

You are invited to participate in the research project described below.

### What is the project about?

This study will aim to assess the effectiveness of focussed meditation to offset the increase of stress during examinations and reduce measures of burnout (survey and heart rate variability). It will use both pre-, during and post-, examination inventories (Percevied Stress Scale and Maslach Burnout Inventory) and ecological momentary assessment technqiues (daily questionnaire and heart rate variability). This study aims to fulfil a gap in the current literature which has used a variety of mindfulness interventions combined for treatment of burnout and focused predominatly on pre- and post- self-report surveys. Instead, this study will use an intervention of purely focussed mediation as a preventive measure and use both self-report and physiological measures administered daily throughout the study in addition to pre- and post- self-report surveys.

### Who is undertaking the project?

This project is being conducted by Peter Chu. This research will form the basis for the degree of Doctorate of Philosophy at the University of Adelaide under the supervision of Carolyn Semmler and Fiona Kerr.

### Why am I being invited to participate?

You are being invited as you are and undergraduate psychology student who plans to undertake examinations in the next examination period.

[

### What am I being invited to do?

You are being invited to take an initial baseline survey to measure stress and burnout levels online.

During and after the examination period, the same surveys will be provided

Prior and during the examination period, you'll be ask to undertake daily meditations session using a free smart phone app.

Additionally, you will be asked to take a daily heart rate variability measure using your smart phone camera and a free app and answer 4 questions about how stressed you have been in the last 24 hours.

### How much time will my involvement in the project take?

The pre-, during and post- surveys should take no longer than 30 minutes each and can be done online.

You'll be asked to do a 2 minute heart rate variability measure first thing each morning and answer a daily questionnaire of 4 questions in the afternoon/evening for the 15 day period.

You'll also be asked to do involve a short (4mins 20seconds to 7mins) mediation session for 15 days.

**Are there any risks associated with participating in this project?**

There are no foreseeable risks and all physiological measurements are non-invasive (using your smartphone camera) and all health information is self-recorded and provided by you (we will not be able to directly see your health data). You can choose how much information to share with the third-party application providers and can choose to cease participation if you are unhappy with their privacy policy / terms and conditions.

The primary reserachers can be contacted with issues via email at anytime and you can case participation at anytime and if you feel that your levels of stress are unmanagemable the Student Wellbing Hub and Lifeline Counselling service are both available.

**What are the potential benefits of the research project?**

Recent research has shown the effectiveness of mediation in reducing stress and burnout. You will receive mediation training and practice sessions that may assist you in reducing stress during your examinations and a way to measure the physiological effects of stress. In addition, you will be helping to research ways we can help to prevent burnout in students as well as other high risk occupations such as medical personal, emergency services workers and Australian Defence Force members.

**Can I withdraw from the project?**

Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any stage.

**What will happen to my information?**

Researchers will protect the privacy and confidentiality of participants by applying de-identification codes at recruitment and abide by the UofA's and National Statement Chapter on the ethical conduct of human research. The SONA Systems for undergraduate research processes will also be followed. Upon recruitment into the study each participant will be assigned a participant code which will be used to label paper data. The master decode of participant codes and identifiable participant information will be stored in a separate location from the de-identified records.

The psychometric data will be entered into an excel file on a secure university cloud storage system in de-identified form. These will be able to be accessed by the research team, only, including Assoc. Professor Semmler, Dr Kerr and Mr Chu. This electronic data storage will be de-identified through the use of the participant code. Statistical analysis will be carried out using the statistical package R using custom analytical packages. The data will be store and used using the Open Science Framework for future research that is an extension or closely related to this study in accordance with the National Statement Chapter 3, particularly 'Sharing of Data and Information'.

We do not require you to allow the third-party applications to access your personal health data other than the ability to access your smartphone camera during the collection of HRV data only.

The privacy policy for Welltory can be found here: https://welltory.com/privacy/

The privacy policy for Smiling Minds can be found here: https://www.smilingmind.com.au/privacy-and-terms

Your information will only be used as described in this participant information sheet and it will only be disclosed according to the consent provided, except as required by law.

**Who do I contact if I have questions about the project?**

The primary researcher can be contact via email at peter.chu@adelaide.edu.au

**What if I have a complaint or any concerns?**

The study has been approved by the Human Research Ethics Committee at the University of Adelaide (approval number H-2022-xxx). This research project will be conducted according to the NHMRC National Statement on Ethical Conduct in Human Research 2007 (Updated 2018). If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator. If you wish to speak with an

independent person regarding concerns or a complaint, the University's policy on research involving human participants, or your rights as a participant, please contact the Human Research Ethics Committee's Secretariat on:

Phone: +61 8 8313 6028

Email: hrec@adelaide.edu.au

Post: Level 3, Rundle Mall Plaza, 50 Rundle Mall, ADELAIDE SA 5000

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

**If I want to participate, what do I do?**

Indicate using the SONA System that you wish to participate.

Yours sincerely,

Peter Chu, PhD candidate.
Associate Professor Carolyn Semmler, PhD.




# Human Research Ethics Committee (HREC) – Consent Form

1. I have read the attached Information Sheet and agree to take part in the following research project:

| | |
|---|---|
| **Title:** | Meditation as a preventative measure for burnout in undergraduate psychology students during examinations. |
| **Ethics Approval Number:** | Researcher to insert this number (allocated once the project has been approved. |

2. I have had the project, so far as it affects me, and the potential risks and burdens fully explained to my satisfaction by the research worker. I have had the opportunity to ask any questions I may have about the project and my participation. My consent is given freely.

3. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

4. Although I understand the purpose of the research project is to improve the quality of health/medical care, it has also been explained that my involvement may not be of any benefit to me

5. I agree to participate in the activities outlined in the participant information sheet.

   [For projects with multiple activities, it can be useful to list them and if they are optional include checkboxes for participants to indicate the activities they agree to undertake].

6. I understand my participation is voluntary and that I am free to withdraw my information from the project at any time.

   I understand that if I decide not to take part or withdraws from the project, that this will not affect medical advice in the management of my health, now or in the future.

7. I have been informed that the information gained in the project may be published in a journal article and thesis.

8. I have been informed that in the published materials I will not be identified and any personal information that could identify me will not be divulged.

9. I consent for the use of my survey and HRV data by the same or other researchers in future research projects that are in the same general area of research (stress and burnout). I understand personal information that may identify me (e.g. name, address, date of birth) will be removed or changed before it is shared with other researchers:

   Yes ☐ No ☐

10. I understand my information will only be disclosed according to the consent provided, except where disclosure is required by law.

11. I am aware that I should keep a copy of this Consent Form, when completed, and the attached Information Sheet.

**Participant to complete:**

Name: _____Signature: _____ Date: _____



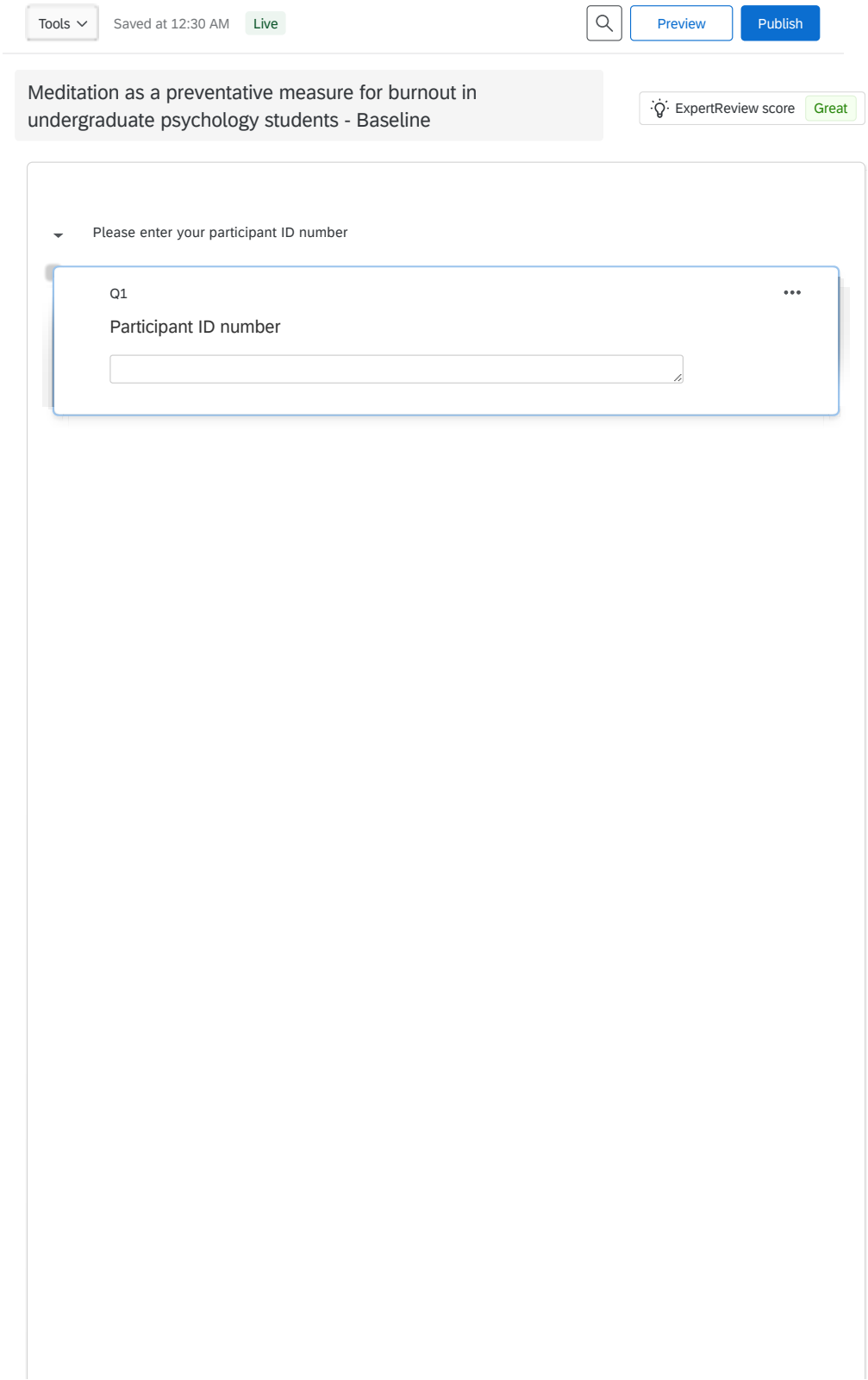

**School of Psychology** Research Participation System

Study Information

**PREVIEW MODE**
This shows how participants will see the study when they click on it.
Participants cannot sign up for this study because it has no timeslots (for dates in the future). Participants will not see the View Study Website link below until they actually sign up for the study. As this is a multi-part study, they will only see a link for the part currently available to them. A sample URL has been generated below based on the embedded SURVEY_CODE option.

| | |
|---|---|
| **Study Name** | Meditation as a preventative measure for burnout in undergraduate psychology students durin |
| **Study Type** | **Multi-Part Online Study**<br>This study is a multi-part online study on another website. To participate, sign up, and then you will be given access to the website to participate in the study. There are 4 parts.<br><br>Part 2 will become available 24 hours after you complete Part 1.<br>Part 3 will become available 24 hours after you complete Part 2.<br>Part 4 will become available 24 hours after you complete Part 3. |
| **Credits** | 1.5 Credits (Part 1)<br>0.5 Credits (Part 2)<br>0.5 Credits (Part 3)<br>0.5 Credits (Part 4)<br>(3 Credits total) |
| **Duration** | 185 minutes (Part 1)<br>15 minutes (Part 2)<br>15 minutes (Part 3)<br>10 minutes (Part 4) |
| **Abstract** | An online study looking at how effective a smartphone meditation app is and reducing stress increases and burnout during exams. |
| **Description** | Are there ways to reduce stress during exams and prevent burnout?<br>This study will look at how effective meditation is in reduce increases in stress during exams. It uses a meditation app combined with heart rate variability data collect using your smartphone camera and a daily 4-question survey to see what effect meditation has on stress and burnout levels during exams. |
| **Preparation** | Smart phone (iOS or Android) with a camera and flash. |
| **Website** | View Study Website - Part 1 \| View Study Website - Part 2 \| View Study Website - Part 3 \| View Study Website - Part 4 |
| **Researchers** | Peter Chu<br><br>Carolyn Semmler<br>Office: 507<br>8313 4628 |

(8:41 AM)


Tools
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Live
Preview
Publish
Meditation as a preventative measure for burnout in undergraduate psychology students - Baseline
ExpertReview score
Great
Please enter your participant ID number
Q1
Participant ID number

Q28

How do you describe yourself?

- Male
- Female
- Non-binary / third gender
- Prefer to self-describe
- Prefer not to say

Q29

How old are you?

- Under 18
- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65+ years old

Q29

Do you currently do any of the following mindfulness activities?

- Focussed meditation (focusing on your breath / a mantra or phrase etc).
- Mindful movement (i.e. Yoga)
- Other

Q30

If so, how often do you practice this mindfulness activity?

- More than once a day
- At least once a day
- 5-6 times a week
- 3-4 times a week
- 1-2 times a week
- 2-4 times a month
- 1-2 times a month
- Less than once a month

Import from library | Add new question

Add Block

Perceived Stress Scale - 10 item

Q1

In the last month, how often have you been upset because of something that happened unexpectedly?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q2

In the last month, how often have you felt that you were unable to control the important things in your life?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q3

In the last month, how often have you felt nervous and stressed?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q4

In the last month, how often have you felt confident about your ability to handle your personal problems?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Perceived Stress Scale - 10 item

Q1

In the last month, how often have you been upset because of something that happened unexpectedly?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q2

In the last month, how often have you felt that you were unable to control the important things in your life?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q3

In the last month, how often have you felt nervous and stressed?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q4

In the last month, how often have you felt confident about your ability to handle your personal problems?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q9

In the last month, how often have you been angered because of things that happened that were outside of your control?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q10

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Import from library | Add new question

Add Block

Maslach Burnout Inventory - Student Survey

EE1

I feel emotionally drained by my studies.

- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday

Q9

In the last month, how often have you been angered because of things that happened that were outside of your control?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q10

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Import from library | Add new question

Add Block

Maslach Burnout Inventory - Student Survey

EE1

I feel emotionally drained by my studies.

- Never
- A few times a year or less
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Q9

In the last month, how often have you been angered because of things that happened that were outside of your control?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q10

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Import from library | Add new question

Add Block

Maslach Burnout Inventory - Student Survey

EE1

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- Everyday

Q9

In the last month, how often have you been angered because of things that happened that were outside of your control?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q10

In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Import from library | Add new question

Add Block

Maslach Burnout Inventory - Student Survey

EE1

I feel emotionally drained by my studies.

- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday

AE3

In my opinion, I am a good student.

- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday

AE4

I feel stimulated when I achieve my study goals.

- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday

AE5

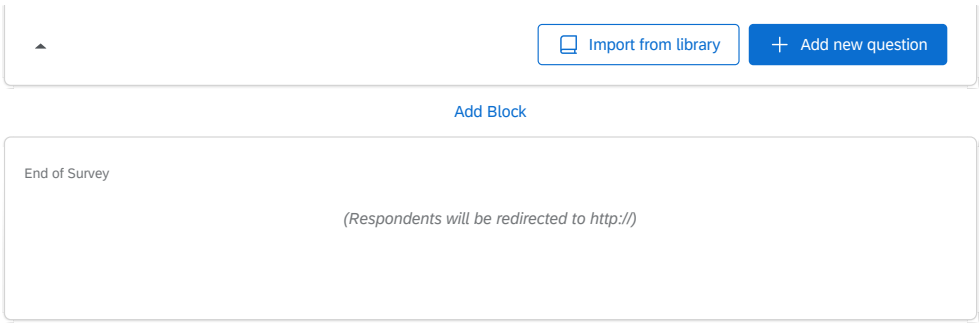
I have learned many interesting things during the course of my studies.

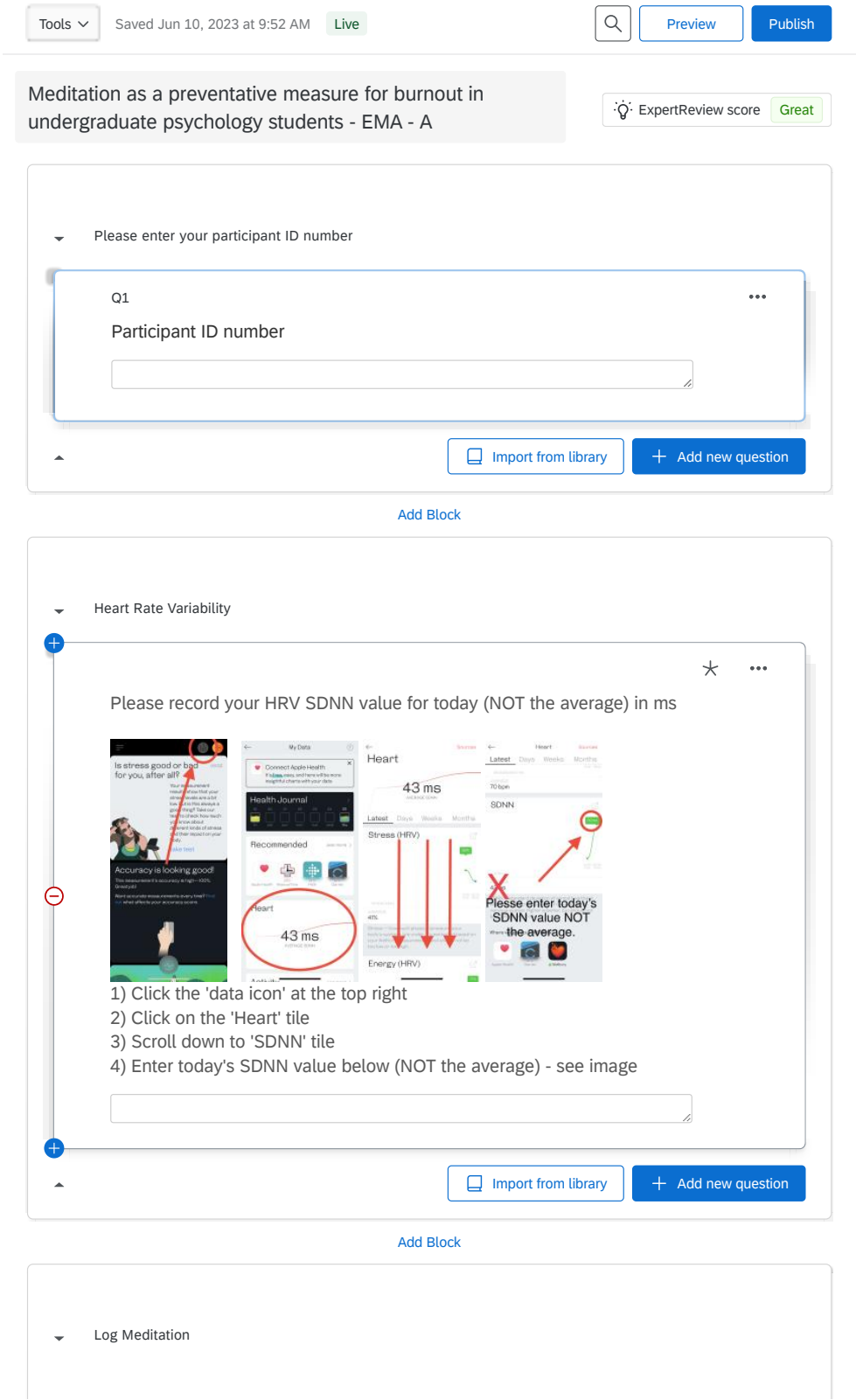
- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday

AE6

6. During class I feel confident that I am effective in getting things done.

- Never
- A few times a year or less
- Once a month or less
- A few times a month
- Once a week
- A few times a week
- Everyday


Import from library
Add new question
Add Block
End of Survey
(Respondents will be redirected to http://)


Tools
Saved Jun 10, 2023 at 9:52 AM
Live
Preview
Publish
Meditation as a preventative measure for burnout in undergraduate psychology students - EMA - A
ExpertReview score
Great
Please enter your participant ID number
Q1
Participant ID number
Import from library
Add new question
Add Block
Heart Rate Variability
Please record your HRV SDNN value for today (NOT the average) in ms
Is stress good or bad for you, after all?
Accuracy is looking good!
Health Journal
Recommended
Heart
43 ms
Stress (HRV)
Energy (HRV)
SDNN
Plesse enter today's SDNN value NOT the average.
1) Click the 'data icon' at the top right
2) Click on the 'Heart' tile
3) Scroll down to 'SDNN' tile
4) Enter today's SDNN value below (NOT the average) - see image
Import from library
Add new question
Add Block
Log Meditation

Q27

Which meditation did you do today?

Session 1 - Study

Import from library | Add new question

Add Block

Perceived Stress Scale - EMA

Q1

In the last 24 hours, I felt that I was unable to control the important things in my life.

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q2

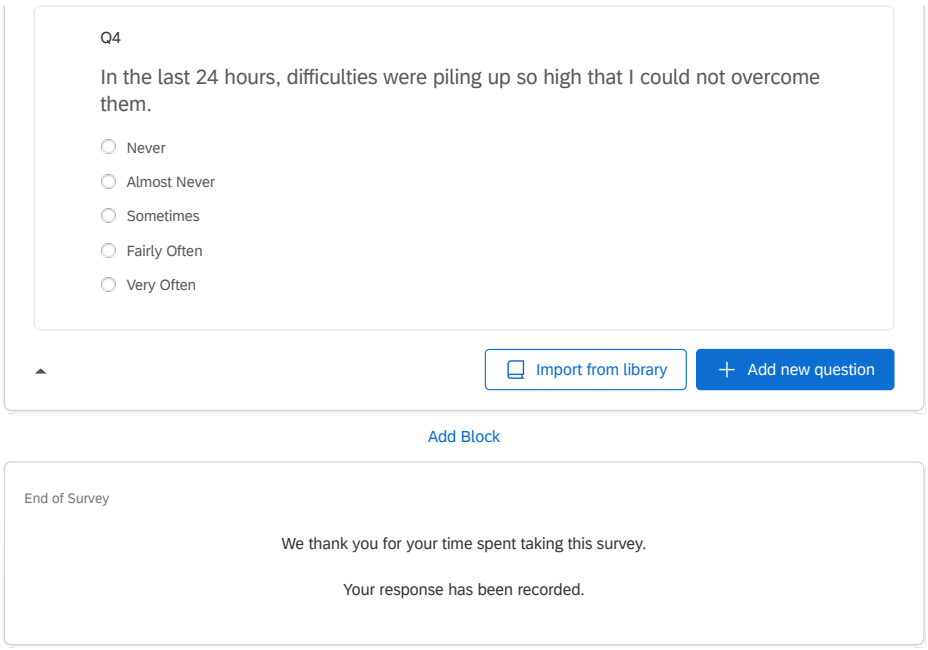
In the last 24 hours, I felt nervous and stressed.

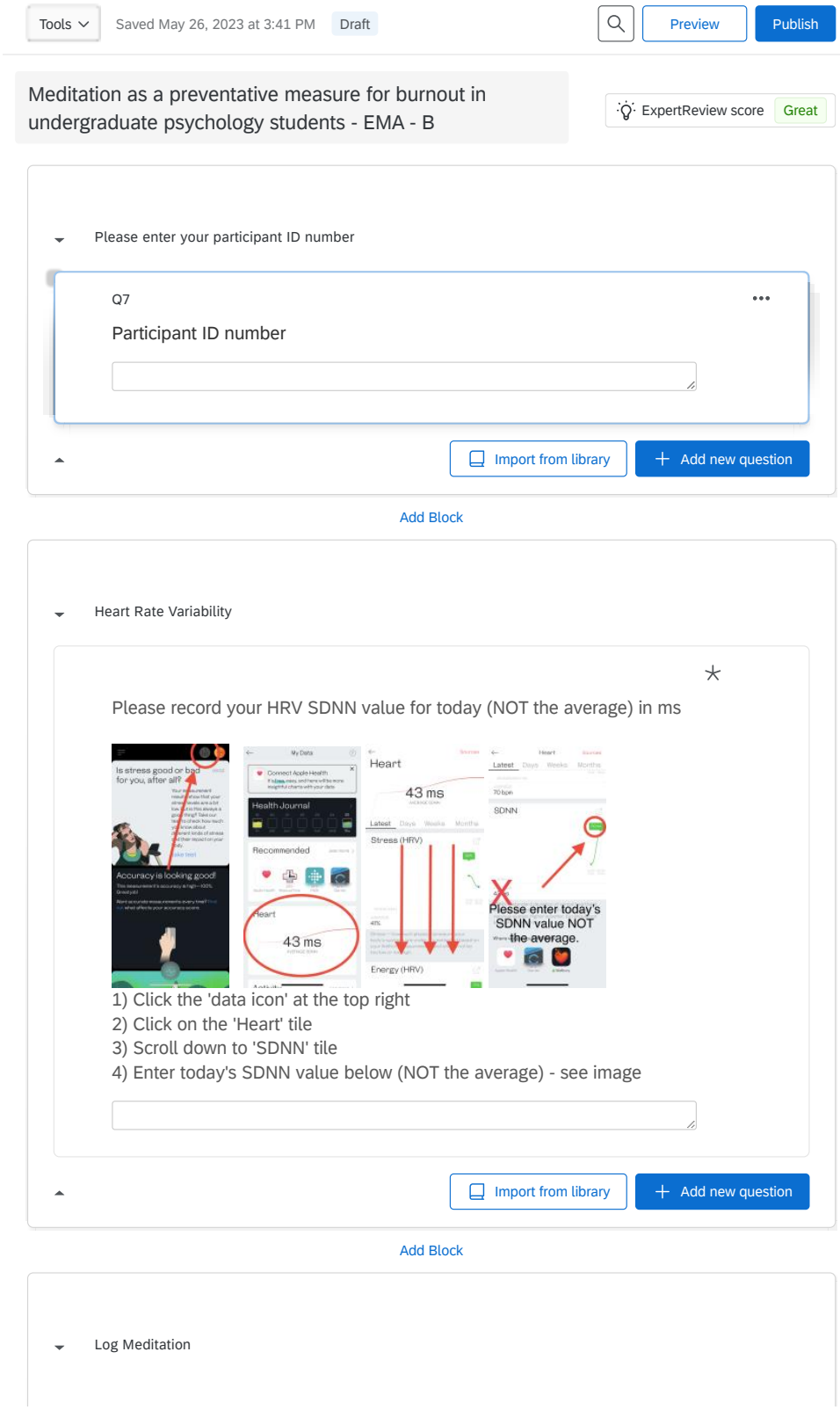
- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q3

In the last 24 hours, I felt I could not cope with all the things I had to do.

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often


Q4
In the last 24 hours, difficulties were piling up so high that I could not overcome them.
Never
Almost Never
Sometimes
Fairly Often
Very Often
Import from library
Add new question
Add Block
End of Survey
We thank you for your time spent taking this survey.
Your response has been recorded.


Tools
Saved May 26, 2023 at 3:41 PM
Draft
Preview
Publish
Meditation as a preventative measure for burnout in undergraduate psychology students - EMA - B
ExpertReview score
Great
Please enter your participant ID number
Q7
Participant ID number
Import from library
Add new question
Add Block
Heart Rate Variability
Please record your HRV SDNN value for today (NOT the average) in ms
Is stress good or bad for you, after all?
Accuracy is looking good!
Health Journal
Recommended
Heart
43 ms
Stress (HRV)
Energy (HRV)
SDNN
Plesse enter today's SDNN value NOT the average.
1) Click the 'data icon' at the top right
2) Click on the 'Heart' tile
3) Scroll down to 'SDNN' tile
4) Enter today's SDNN value below (NOT the average) - see image
Import from library
Add new question
Add Block
Log Meditation

Q27

Which meditation did you do today?

Session 1

Import from library | Add new question

Add Block

Perceived Stress Scale - EMA

Q1

In the last 24 hours, I felt that I was unable to control the important things in my life.

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q2

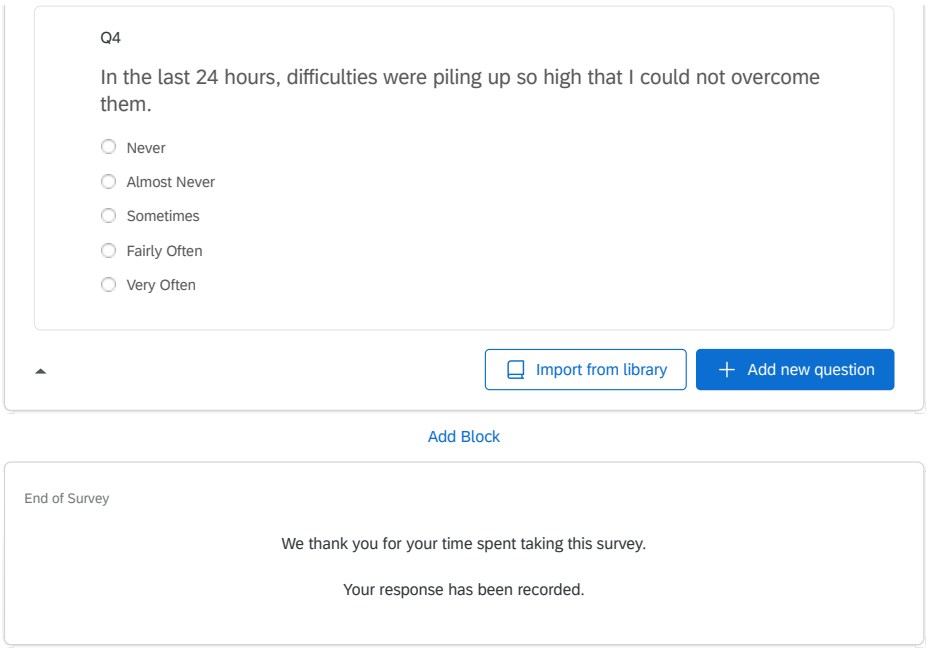
In the last 24 hours, I felt nervous and stressed.

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often

Q3

In the last 24 hours, I felt I could not cope with all the things I had to do.

- Never
- Almost Never
- Sometimes
- Fairly Often
- Very Often


Q4
In the last 24 hours, difficulties were piling up so high that I could not overcome them.
Never
Almost Never
Sometimes
Fairly Often
Very Often
Import from library
Add new question
Add Block
End of Survey
We thank you for your time spent taking this survey.
Your response has been recorded.

THE UNIVERSITY of ADELAIDE

Professor Paul Delfabbro – Chair of the low Human Research Ethics Subcommittee
School of Psychology
The University of Adelaide
Australia 5005

7th April 2024

Dear Professor Delfabbro,

I am writing to request an amendment to the previous ethics application, App 23/77.
Due to a lack of participant response during previous examination periods and a restriction with the SONA Research Participation System, we are requesting the following changes:

- The study will now use the mid-semester assignment period rather than the end of semester examination period.
- Accordingly, all references to 'exam' or 'examination' will be amended to 'assignment'.
- The study dates will change from 29 Oct 23 – 18 Nov 23 to 22 Apr 24 – 9 May 24.
- This date change will result in a corresponding reduction in participation time from approximately 3 hours and 35 minutes to 3 hours and 20 minutes.
- This new time commitment will result in 3.5 credit points in the SONA system.

Attached is an updated study schedule and breakdown of the participants' time commitment.

Thank you for your time and consideration,

Yours sincerely

Peter Chu BA(Security, Terrorism and Counterterrorism Studies), BPsych(Hons)
PhD Candidate
School of Psychology
The University of Adelaide

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The University of Adelaide SA 5005 AUSTRALIA
**Email:** peter.chu@adelaide.edu.au **www.adelaide.edu.au**
Australian University Provider Number PRV12105 CRICOS Provider Number 00123M

2024 <- MARCH MAY ->

## APRIL

| M | T | W | T | F | S | S |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 Research Methods Mid Semester Quiz | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| PSS-10 MBI-SS | PSS-EMA HRV | | | | | |
| Med R1S1 | Med R1S2 | Med R1S3 | Med R1S4 | Med R1S5 | Med R2S1 | Med R2S2 |
| 29 Psych IA Essay Due | 30 | 1 | 2 | 3 | 4 | 5 |
| PSS-EMA HRV | | | | | | |
| Med R2S3 | Med R2S4 | Med R2S5 | Med R3S1 | Med R3S2 | Med R3S3 | Med R3S4 |
| 6 | 7 | 8 Applied Paper Due | 9 | 10 | 11 | 12 |
| PSS-EMA HRV | | | PSS-10 MBI-SS | | | |
| Med R3S5 | Med R4S1 | MedR4S2 | Med R4S3 | | | |

Med R1S1 = Meditation Round 1 Session 1

Intervention Times
Smiling Minds - Study

| Session No. | Title | Time |
|---|---|---|
| S1 | Study | 06:59 |
| S2 | Grounding | 06:22 |
| S3 | Stress | 07:00 |
| S4 | Growth Mindset | 04:20 |
| S5 | Sleep | 07:00 |
| | Total per round | 0:31:41 |
| | Total for study | 1:55:24 |

Measurement Times

| | HRV Time | PSS-EMA Time | PSS-10 | MBI-SS |
|---|---|---|---|---|
| Time each | 0:02:00 | 0:02:00 | 0:05:00 | 0:05:00 |
| Number in study | 16 | 16 | 2 | 2 |
| Total for study | 0:32:00 | 0:32:00 | 0:10:00 | 0:10:00 |

Total survey 1:24:00
Total time for study 3:19:24

Appendix VIII. Mixed Model R Outputs

**PSS-EMA**

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: HRV ~ Group * Assignment_Stress + Group * Cumulative_Meditation + (1 | Participant)

Data: data

REML criterion at convergence: 1442.9

Scaled residuals:

| Min | 1Q | Median | 3Q | Max |
|---|---|---|---|---|
| -1.9449 | -0.4730 | -0.0535 | 0.3456 | 4.4418 |

Random effects:

| Groups | Name | Variance | Std.Dev. |
|---|---|---|---|
| Participant | (Intercept) | 754.8 | 27.47 |
| Residual | | 206.9 | 14.38 |

Number of obs: 172, groups: Participant, 21

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| (Intercept) | 52.17552 | 9.83491 | 22.46749 | 5.305 | 2.36e-05 | *** |
| Group1 | 16.59809 | 13.24488 | 20.43396 | 1.253 | 0.224 | |

Assignment_Stress 2.38877 5.33471 156.61268 0.448 0.655

Cumulative_Meditation 0.03537 0.68286 149.63448 0.052 0.959

Group1:Assignment_Stress -1.79107 7.00239 151.97464 -0.256 0.798

Group1:Cumulative_Meditation 0.43126 0.75960 149.36707 0.568 0.571

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

(Intr) Group1 Assg_S Cmlt_M G1:A_S

Group1 -0.743

Assgnmnt_St -0.361 0.268

Cmltv_Mdttn -0.259 0.192 0.205

Grp1:Assg_S 0.275 -0.299 -0.762 -0.156

Grp1:Cmlt_M 0.233 -0.234 -0.185 -0.899 0.186

**HRV**

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: HRV ~ Group * Assignment_Stress + Group * Cumulative_Meditation + (1 | Participant)

Data: data

REML criterion at convergence: 1442.9

Scaled residuals:

```
    Min      1Q  Median      3Q     Max
-1.9449 -0.4730 -0.0535  0.3456  4.4418

Random effects:
 Groups      Name        Variance Std.Dev.
 Participant (Intercept) 754.8    27.47
 Residual                206.9    14.38
Number of obs: 172, groups:  Participant, 21

Fixed effects:
                            Estimate Std. Error       df t value Pr(>|t|)
(Intercept)                 52.17552    9.83491  22.46749   5.305 2.36e-05 ***
Group1                      16.59809   13.24488  20.43396   1.253    0.224
Assignment_Stress            2.38877    5.33471 156.61268   0.448    0.655
Cumulative_Meditation        0.03537    0.68286 149.63448   0.052    0.959
Group1:Assignment_Stress    -1.79107    7.00239 151.97464  -0.256    0.798
Group1:Cumulative_Meditation  0.43126    0.75960 149.36707   0.568    0.571
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects: next will be the pre- post- results for pss-10. Are oyou
ready/
            (Intr) Group1 Assg_S Cmlt_M G1:A_S
Group1      -0.743
Assgnmnt_St -0.361  0.268
```

Cmltv_Mdttn -0.259  0.192  0.205

Grp1:Assg_S  0.275 -0.299 -0.762 -0.156

Grp1:Cmlt_M  0.233 -0.234 -0.185 -0.899  0.186 Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: HRV ~ Group * Assignment_Stress + Group * Cumulative_Meditation
+ (1 | Participant)

Data: data

REML criterion at convergence: 1442.9

Scaled residuals:

Min 1Q Median 3Q Max

-1.9449 -0.4730 -0.0535  0.3456  4.4418

Random effects:

| Groups | Name | Variance | Std.Dev. |
|---|---|---|---|
| Participant | (Intercept) | 754.8 | 27.47 |
| Residual | | 206.9 | 14.38 |

Number of obs: 172, groups:  Participant, 21

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| (Intercept) | 52.17552 | 9.83491 | 22.46749 | 5.305 | 2.36e-05 | *** |
| Group1 | 16.59809 | 13.24488 | 20.43396 | 1.253 | 0.224 | |
| Assignment_Stress | 2.38877 | 5.33471 | 156.61268 | 0.448 | 0.655 | |
| Cumulative_Meditation | 0.03537 | 0.68286 | 149.63448 | 0.052 | 0.959 | |

Group1:Assignment_Stress -1.79107 7.00239 151.97464 -0.256 0.798

Group1:Cumulative_Meditation 0.43126 0.75960 149.36707 0.568 0.571

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

(Intr) Group1 Assg_S Cmlt_M G1:A_S

Group1 -0.743

Assgnmnt_St -0.361 0.268

Cmltv_Mdttn -0.259 0.192 0.205

Grp1:Assg_S 0.275 -0.299 -0.762 -0.156

Grp1:Cmlt_M 0.233 -0.234 -0.185 -0.899 0.186

**PSS-10 (Pre-post)**

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: PSS-10 ~ Group * Time * Total meditations + Number of Assignments + (1 | Participant ID)

Data: Data

REML criterion at convergence: 139.9

Scaled residuals:

Min 1Q Median 3Q Max

-1.86826 -0.32060 0.02171 0.28697 1.47353

Random effects:

| Groups | Name | Variance | Std.Dev. |
|---|---|---|---|
| Participant ID | (Intercept) | 32.164 | 5.671 |
| Residual | | 4.841 | 2.200 |

Number of obs: 28, groups: Participant ID, 14

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| (Intercept) | 7.57325 | 6.14607 | 9.53601 | 1.232 | 0.2474 | |
| Group1 | 11.39280 | 7.63515 | 10.20974 | 1.492 | 0.1659 | |
| TimePre-test | -0.23319 | 2.08959 | 10.00000 | -0.112 | 0.9134 | |
| Total meditations | 0.59203 | 0.40028 | 10.05172 | 1.479 | 0.1698 | |
| Number of Assignments | 1.38787 | 1.04937 | 9.00000 | 1.323 | 0.2186 | |
| Group1:TimePre-test | -1.04128 | 3.83333 | 10.00000 | -0.272 | 0.7914 | |
| Group1:Total meditations | -1.44995 | 0.70648 | 10.23013 | -2.052 | 0.0666 | . |
| TimePre-test:Total meditations | 0.41155 | 0.18811 | 10.00000 | 2.188 | 0.0535 | . |
| Group1:TimePre-test:Total meditations | -0.08458 | 0.35750 | 10.00000 | -0.237 | 0.8178 | |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

| | (Intr) | Group1 | TmPr-t | Tmdt | NoAs | G1:TP- | G1:Tm | TP-:m |
|---|---|---|---|---|---|---|---|---|
| Group1 | -0.498 | | | | | | | |
| TimePre-tst | -0.170 | 0.137 | | | | | | |

Ttlmdttns -0.834  0.509  0.207

NoAssgnmn -0.747  0.191  0.000  0.395

Grp1:TmPr-t  0.093 -0.251 -0.545 -0.113  0.000

Grp1:Tmdt  0.414 -0.879 -0.117 -0.536 -0.146  0.222

TmPr-t:Tm  0.150 -0.121 -0.882 -0.235  0.000  0.481  0.133

G1:TP-:Tm -0.079  0.220  0.464  0.124  0.000 -0.877 -0.253 -0.526

> # Fit the mixed-effects model for MBI-SS EE scores

> model_ee <- lmer(MBI-SS EE ~ Group * Time * Total meditations +

+ Number of Assignments +

+ (1 | Participant ID), data = Data)

>

**MBI-SS**

> summary(model_ee)

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: MBI-SS EE ~ Group * Time * Total meditations + Number of Assignments + (1 | Participant ID)

Data: Data

REML criterion at convergence: 139.3

Scaled residuals:

Min 1Q Median 3Q Max

-1.09504 -0.40684  0.05823  0.44748  1.44679

Random effects:

| Groups | Name | Variance | Std.Dev. |
|---|---|---|---|
| Participant ID | (Intercept) | 21.053 | 4.588 |
| Residual | | 6.329 | 2.516 |

Number of obs: 28, groups: Participant ID, 14

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| (Intercept) | 4.1296 | 5.2071 | 10.0002 | 0.793 | 0.4461 | |
| Group1 | 17.4807 | 6.5614 | 11.2429 | 2.664 | 0.0217 | * |
| TimePre-test | -0.7822 | 2.3894 | 10.0000 | -0.327 | 0.7502 | |
| Total meditations | 0.6356 | 0.3429 | 10.9539 | 1.854 | 0.0909 | . |
| Number of Assignments | 0.8763 | 0.8781 | 9.0000 | 0.998 | 0.3444 | |
| Group1:TimePre-test | 2.0328 | 4.3833 | 10.0000 | 0.464 | 0.6528 | |
| Group1:Total meditations | -1.4249 | 0.6074 | 11.2800 | -2.346 | 0.0382 | * |
| TimePre-test:Total meditations | 0.3757 | 0.2151 | 10.0000 | 1.747 | 0.1113 | |
| Group1:TimePre-test:Total meditations | -0.4569 | 0.4088 | 10.0000 | -1.118 | 0.2899 | |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

| | (Intr) | Group1 | TmPr-t | Tmdt | NoAs | G1:TP- | G1:Tm | TP-:m |
|---|---|---|---|---|---|---|---|---|
| Group1 | -0.499 | | | | | | | |
| TimePre-tst | -0.229 | 0.182 | | | | | | |
| Ttlmdttns | -0.834 | 0.508 | 0.277 | | | | | |

```
NoAssgnmn -0.738  0.186  0.000  0.386

Grp1:TmPr-t  0.125 -0.334 -0.545 -0.151  0.000

Grp1:Tmdt  0.415 -0.879 -0.156 -0.535 -0.142  0.295

TmPr-t:Tm  0.202 -0.161 -0.882 -0.314  0.000  0.481  0.177

G1:TP-:Tm -0.107  0.293  0.464  0.165  0.000 -0.877 -0.337 -0.526


> model_cy <- lmer(MBI-SS CY ~ Group * Time * Total meditations +

+                  Number of Assignments +

+                  (1 | Participant ID), data = Data)

>

> # Check the summary of the model

> summary(model_cy)

Linear mixed model fit by REML. t-tests use Satterthwaite's method
['lmerModLmerTest']

Formula: MBI-SS CY ~ Group * Time * Total meditations + Number of Assignments
+     (1 | Participant ID)

   Data: Data


REML criterion at convergence: 150.6


Scaled residuals:

    Min      1Q  Median      3Q     Max

-1.07940 -0.31806 -0.02489  0.35388  1.40175


Random effects:

 Groups        Name        Variance Std.Dev.
```

Participant ID (Intercept) 32.59 5.708

Residual 12.78 3.575

Number of obs: 28, groups: Participant ID, 14

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) |
|---|---|---|---|---|---|
| (Intercept) | 6.44141 | 6.65013 | 10.25388 | 0.969 | 0.355 |
| Group1 | 5.97482 | 8.44157 | 11.79624 | 0.708 | 0.493 |
| TimePre-test | 0.33114 | 3.39555 | 10.00000 | 0.098 | 0.924 |
| Total meditations | 0.12480 | 0.44041 | 11.44021 | 0.283 | 0.782 |
| Number of Assignments | 0.08122 | 1.11402 | 9.00000 | 0.073 | 0.943 |
| Group1:TimePre-test | -0.17601 | 6.22909 | 10.00000 | -0.028 | 0.978 |
| Group1:Total meditations | -0.70526 | 0.78158 | 11.84186 | -0.902 | 0.385 |
| TimePre-test:Total meditations | 0.16009 | 0.30567 | 10.00000 | 0.524 | 0.612 |
| Group1:TimePre-test:Total meditations | -0.25794 | 0.58093 | 10.00000 | -0.444 | 0.666 |

Correlation of Fixed Effects:

| | (Intr) | Group1 | TmPr-t | Tmdt | NoAs | G1:TP- | G1:Tm | TP-:m |
|---|---|---|---|---|---|---|---|---|
| Group1 | -0.499 | | | | | | | |
| TimePre-tst | -0.255 | 0.201 | | | | | | |
| Ttlmdttns | -0.834 | 0.507 | 0.306 | | | | | |
| NoAssgnmn | -0.733 | 0.183 | 0.000 | 0.381 | | | | |
| Grp1:TmPr-t | 0.139 | -0.369 | -0.545 | -0.167 | 0.000 | | | |
| Grp1:Tmdt | 0.415 | -0.879 | -0.173 | -0.535 | -0.140 | 0.326 | | |
| TmPr-t:Tm | 0.225 | -0.177 | -0.882 | -0.347 | 0.000 | 0.481 | 0.196 | |

```
G1:TP-:Tm -0.119  0.324  0.464  0.183  0.000 -0.877 -0.372 -0.526


> model_pa <- lmer(MBI-SS PA ~ Group * Time * Total meditations +

+                  Number of Assignments +

+                  (1 | Participant ID), data = Data)

>

> # Check the summary of the model

> summary(model_pa)

Linear mixed model fit by REML. t-tests use Satterthwaite's method
['lmerModLmerTest']

Formula: MBI-SS PA ~ Group * Time * Total meditations + Number of Assignments
+     (1 | Participant ID)

   Data: Data


REML criterion at convergence: 139.6


Scaled residuals:

    Min      1Q  Median      3Q     Max

-1.41134 -0.46065 -0.01776  0.47834  1.17924


Random effects:

 Groups         Name        Variance Std.Dev.

 Participant ID (Intercept) 26.315   5.13

 Residual                   5.522   2.35

Number of obs: 28, groups:  Participant ID, 14
```

Fixed effects:

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| (Intercept) | 32.3837 | 5.6644 | 9.7272 | 5.717 | 0.000215 | *** |
| Group1 | -7.7802 | 7.0791 | 10.6379 | -1.099 | 0.296001 | |
| TimePre-test | -2.7741 | 2.2319 | 10.0000 | -1.243 | 0.242242 | |
| Total meditations | -0.3222 | 0.3706 | 10.4249 | -0.869 | 0.404259 | |
| Number of Assignments | -0.6298 | 0.9622 | 9.0000 | -0.655 | 0.529136 | |
| Group1:TimePre-test | 1.4066 | 4.0944 | 10.0000 | 0.344 | 0.738306 | |
| Group1:Total meditations | 0.9407 | 0.6551 | 10.6654 | 1.436 | 0.179730 | |
| TimePre-test:Total meditations | -0.1557 | 0.2009 | 10.0000 | -0.775 | 0.456299 | |
| Group1:TimePre-test:Total meditations | 0.1414 | 0.3818 | 10.0000 | 0.370 | 0.718910 | |

---

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:

| | (Intr) | Group1 | TmPr-t | Tmdt | NoAs | G1:TP- | G1:Tm | TP-:m |
|---|---|---|---|---|---|---|---|---|
| Group1 | -0.499 | | | | | | | |
| TimePre-tst | -0.197 | 0.158 | | | | | | |
| Ttlmdttns | -0.834 | 0.509 | 0.239 | | | | | |
| NoAssgnmn | -0.743 | 0.189 | 0.000 | 0.391 | | | | |
| Grp1:TmPr-t | 0.107 | -0.289 | -0.545 | -0.130 | 0.000 | | | |
| Grp1:Tmdt | 0.414 | -0.879 | -0.135 | -0.536 | -0.144 | 0.256 | | |
| TmPr-t:Tm | 0.174 | -0.139 | -0.882 | -0.271 | 0.000 | 0.481 | 0.153 | |
| G1:TP-:Tm | -0.091 | 0.254 | 0.464 | 0.143 | 0.000 | -0.877 | -0.291 | -0.526 |

# Appendix IX. Study 3 - Ethics Amendment

THE UNIVERSITY of ADELAIDE

Professor Paul Delfabbro – Chair of the low-risk Human Research Ethics Subcommittee
School of Psychology
The University of Adelaide
Australia 5005

15th August 2024

Dear Professor Delfabbro,

I am writing to request an amendment to the previous ethics application, App 23/77.
After the study was run during the semester 1, 2024, we would like to build on the study and conduct it again during semester 2, 2024.

I. The study dates will change from now include the semester 2 assignment period, 17 Sep 24 to 8 Oct 24.
II. In order to explore the mechanisms behind the relationship between meditation and stress and burnout, the study will seek to include self-report measures of rumination and worry.
    - *Ruminative Responses Scale (RRS)*- The RRS is a 22 item self-report questionnaire using a four-point Likert Scale ranging from "1 – almost never" to "4 – almost always" and has been shown to have high internal validity α = .90 (1, 2).
    - *Penn State Worry Questionnaire (PSWQ)* – The PSWQ is a 16-item self-report questionnaire designed to measure the generality, excessiveness and uncontrollable dimensions of worry. It shows good internal consistency (α = .91) and, in tertiary student samples, correlates positively with measures of psychological constructs associated with pervasive worry such as perfectionism and generalised anxiety disorder (3).
    - Short Attention Network Test (ANT) – The Short ANT is an abbreviated version of the original ANT. It's is a computer delivered test designed to test the networks of attention outlined by Posner (30). The ANT tests the efficacy of the alerting network using response time (RT) to a warning signal, the orienting network is tested uses RT with accompanying cues to where the target will occur and the executive network is tested using a central stimulus surrounded by incongruent, congruent and neutral flankers(49). The test consists of 1 block of 12 practice trail sequences with feedback and 1 block of 120 trial sequences with no feedback. The 120 trial sequences are made up of 5 repetitions with 3 cue conditions, 2 flanker conditions, 2 target positions and 2 target directions. The Short ANT will be delivered online using the Inquisit Web software (48).
    -
III. This time commitment (approximately 3 hours and 50 minutes) will result in 4 credit points in the SONA system.

Attached is an updated study schedule and breakdown of the participants' time commitment.

**School of Psychology**
The University of Adelaide SA 5005 AUSTRALIA
**Email:** peter.chu@adelaide.edu.au **www.adelaide.edu.au**
Australian University Provider Number PRV12105 CRICOS Provider Number 00123M

Thank you for your time and consideration,

Yours sincerely

Peter Chu BA(Security, Terrorism and Counterterrorism Studies), BPysch(Hons)
PhD Candidate
School of Psychology
The University of Adelaide

References

1. Luminet O. Measurement of Depressive Rumination and Associated Constructs. Chichester, UK: John Wiley & Sons Ltd; 2003. p. 185-215.
2. Nolen-Hoeksema S, Parker LE, Larson J. Ruminative Coping With Depressed Mood Following Loss. Journal of personality and social psychology. 1994;67(1):92-104.
3. Meyer TJ, Miller ML, Metzger RL, Borkovec TD. Development and validation of the penn state worry questionnaire. Behaviour research and therapy. 1990;28(6):487-95.

Appendix X. Study 3 – R Script

```
# 1. Packages
install.packages(c("dplyr", "vegan", "lmPerm"))   # run once if not installed
library(dplyr)
library(vegan)
library(lmPerm)


# 2. Clean dataset
df <- X20241014_Baseline_comparisons %>%
  # drop rows without Participant ID
  filter(!is.na(`Participant ID`) & `Participant ID` != "")


# Make grouping variable
df$MindfulnessGroup <- df$`Current Mindfulness? Y/N`


# 3. Ensure numeric baseline outcomes
df <- df %>%
  mutate(
    `Pre-intervention PSS-10 Score`    = as.numeric(`Pre-intervention PSS-10
Score`),
    `Pre-intervention MBI-SS EE Score` = as.numeric(`Pre-intervention MBI-SS
EE Score`),
    `Pre-intervention MBI-SS DP Score` = as.numeric(`Pre-intervention MBI-SS
DP Score`),
```

```
    `Pre-intervention MBI-SS PA Score` = as.numeric(`Pre-intervention MBI-SS
PA Score`),
    `Pre-intervention PSWQ Score`      = as.numeric(`Pre-intervention PSWQ
Score`),
    `Pre-intervention RSS Score`       = as.numeric(`Pre-intervention RSS Score`)
  )

# 4. Multivariate PERMANOVA
df_adonis <- df %>%
  select(MindfulnessGroup,
         `Pre-intervention PSS-10 Score`,
         `Pre-intervention MBI-SS EE Score`,
         `Pre-intervention MBI-SS DP Score`,
         `Pre-intervention MBI-SS PA Score`,
         `Pre-intervention PSWQ Score`,
         `Pre-intervention RSS Score`)

adonis_result <- adonis2(df_adonis[, -1] ~ MindfulnessGroup,
                         data = df_adonis,
                         permutations = 999,
                         method = "euclidean")

cat("\n--- PERMANOVA (multivariate) ---\n")
print(adonis_result)
```

```
# 5. Univariate permutation ANOVAs
cat("\n--- Univariate permutation ANOVAs ---\n")

aov_pss <- aovp(`Pre-intervention PSS-10 Score` ~ MindfulnessGroup,
                data = df, perm = "Prob")
cat("\nPSS-10:\n"); print(summary(aov_pss))

aov_ee <- aovp(`Pre-intervention MBI-SS EE Score` ~ MindfulnessGroup,
               data = df, perm = "Prob")
cat("\nMBI-SS EE:\n"); print(summary(aov_ee))

aov_dp <- aovp(`Pre-intervention MBI-SS DP Score` ~ MindfulnessGroup,
               data = df, perm = "Prob")
cat("\nMBI-SS DP:\n"); print(summary(aov_dp))

aov_pa <- aovp(`Pre-intervention MBI-SS PA Score` ~ MindfulnessGroup,
               data = df, perm = "Prob")
cat("\nMBI-SS PA:\n"); print(summary(aov_pa))

aov_pswq <- aovp(`Pre-intervention PSWQ Score` ~ MindfulnessGroup,
                 data = df, perm = "Prob")
cat("\nPSWQ:\n"); print(summary(aov_pswq))

aov_rrs <- aovp(`Pre-intervention RSS Score` ~ MindfulnessGroup,
                data = df, perm = "Prob")
```

```
cat("\nRRS:\n"); print(summary(aov_rrs))
```

Appendix XI. Study 3 – RStudio Ouputs

```
>
> outcomes <- df_clean[, c("Pre-intervention PSS-10 Score",
+                          "Pre-intervention MBI-SS EE Score",
+                          "Pre-intervention MBI-SS DP Score",
+                          "Pre-intervention MBI-SS PA Score",
+                          "Pre-intervention PSWQ Score",
+                          "Pre-intervention RSS Score")]
>
> adonis_result <- adonis2(outcomes ~ MindfulnessGroup,
+                          data = df_clean,
+                          permutations = 999,
+                          method = "euclidean")
'nperm' >= set of all permutations: complete enumeration.
Set of permutations < 'minperm'. Generating entire set.
>
> print(adonis_result)
Permutation test for adonis under reduced model
Permutation: free
Number of permutations: 23

adonis2(formula = outcomes ~ MindfulnessGroup, data = df_clean,
permutations = 999, method = "euclidean")
            Df SumOfSqs      R2      F Pr(>F)
Model     1    59.83 0.10562 0.2362      1
```

```
Residual  2   506.67 0.89438
Total     3   566.50 1.00000
> library(lmPerm)
>
> aov_pss <- aovp(`Pre-intervention PSS-10 Score` ~ MindfulnessGroup, data = df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_pss)
Component 1 :
                  Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1   10.083    10.083   51        1
Residuals          2   48.667    24.333

>
> aov_ee <- aovp(`Pre-intervention MBI-SS EE Score` ~ MindfulnessGroup, data = df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_ee)
Component 1 :
                  Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1   1.3333    1.3333   51        1
Residuals          2   8.6667    4.3333

>
```

```
> aov_dp <- aovp(`Pre-intervention MBI-SS DP Score` ~ MindfulnessGroup,
data = df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_dp)
Component 1 :
                  Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1        0         0   51        1
Residuals          2       50        25


>
> aov_pa <- aovp(`Pre-intervention MBI-SS PA Score` ~ MindfulnessGroup,
data = df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_pa)
Component 1 :
                  Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1    1.333     1.333   51        1
Residuals          2  120.667    60.333


>
> aov_pswq <- aovp(`Pre-intervention PSWQ Score` ~ MindfulnessGroup, data
= df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_pswq)
Component 1 :
```

```
                    Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1        3         3   51   0.6863
Residuals          2       14         7

>
> aov_rrs <- aovp(`Pre-intervention RSS Score` ~ MindfulnessGroup, data =
df_clean, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> summary(aov_rrs)
Component 1 :
                    Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1    44.083    44.083   51   0.7255
Residuals          2  264.667   132.333

> # Check missingness
> colSums(is.na(df[, c("Pre-intervention PSS-10 Score",
+                      "Pre-intervention MBI-SS EE Score",
+                      "Pre-intervention MBI-SS DP Score",
+                      "Pre-intervention MBI-SS PA Score",
+                      "Pre-intervention PSWQ Score",
+                      "Pre-intervention RSS Score")]))
  Pre-intervention PSS-10 Score Pre-intervention MBI-SS EE Score Pre-
intervention MBI-SS DP Score Pre-intervention MBI-SS PA Score      Pre-intervention
PSWQ Score
```

```
                    0                    0                    0
0                   0
    Pre-intervention RSS Score
                    0
> str(df[, c("Pre-intervention PSS-10 Score",
+           "Pre-intervention MBI-SS EE Score",
+           "Pre-intervention MBI-SS DP Score",
+           "Pre-intervention MBI-SS PA Score",
+           "Pre-intervention PSWQ Score",
+           "Pre-intervention RSS Score")])
tibble [15 × 6] (S3: tbl_df/tbl/data.frame)
 $ Pre-intervention PSS-10 Score   : num [1:15] 22 27 22 28 25 24 21 19 23
25 ...
 $ Pre-intervention MBI-SS EE Score: num [1:15] 10 26 18 24 20 13 19 22 20
23 ...
 $ Pre-intervention MBI-SS DP Score: num [1:15] 9 15 0 9 5 7 12 10 18 15 ...
 $ Pre-intervention MBI-SS PA Score: num [1:15] 28 13 24 20 21 17 16 28 26
23 ...
 $ Pre-intervention PSWQ Score     : num [1:15] 34 40 38 36 37 41 34 35 34
35 ...
 $ Pre-intervention RSS Score      : num [1:15] 47 71 52 0 72 46 60 48 57 67 ...
> # Combine grouping + outcomes into one frame
> df_adonis <- df %>%
+   select(MindfulnessGroup,
+          `Pre-intervention PSS-10 Score`,
```

```
+         `Pre-intervention MBI-SS EE Score`,
+         `Pre-intervention MBI-SS DP Score`,
+         `Pre-intervention MBI-SS PA Score`,
+         `Pre-intervention PSWQ Score`,
+         `Pre-intervention RSS Score`)
>
> # Run PERMANOVA
> adonis_result <- adonis2(df_adonis[, -1] ~ MindfulnessGroup,
+                          data = df_adonis,
+                          permutations = 999,
+                          method = "euclidean")
>
> print(adonis_result)
Permutation test for adonis under reduced model
Permutation: free
Number of permutations: 999

adonis2(formula = df_adonis[, -1] ~ MindfulnessGroup, data = df_adonis,
permutations = 999, method = "euclidean")
          Df SumOfSqs      R2      F Pr(>F)
Model     1    240.4 0.03997 0.5412  0.643
Residual 13   5773.9 0.96003
Total    14   6014.3 1.00000
> # ----------------------------------------------------
> # 1. Packages
```

```
> # ------------------------------------------------------
> install.packages(c("dplyr", "vegan", "lmPerm"))   # run once if not installed
Error in install.packages : Updating loaded packages
> library(dplyr)
> library(vegan)
> library(lmPerm)
>
> # ------------------------------------------------------
> # 2. Clean dataset
> # ------------------------------------------------------
> # Start with your original dataframe
> df <- X20241014_Baseline_comparisons %>%
+     # drop rows without Participant ID
+     filter(!is.na(`Participant ID`) & `Participant ID` != "")
>
> # Make grouping variable
> df$MindfulnessGroup <- df$`Current Mindfulness? Y/N`
>
> # ------------------------------------------------------
> # 3. Ensure numeric baseline outcomes
> # ------------------------------------------------------
> df <- df %>%
+     mutate(
+         `Pre-intervention PSS-10 Score`    = as.numeric(`Pre-intervention PSS-
10 Score`),
```

```
+         `Pre-intervention MBI-SS EE Score` = as.numeric(`Pre-intervention
MBI-SS EE Score`),
+         `Pre-intervention MBI-SS DP Score` = as.numeric(`Pre-intervention
MBI-SS DP Score`),
+         `Pre-intervention MBI-SS PA Score` = as.numeric(`Pre-intervention
MBI-SS PA Score`),
+         `Pre-intervention PSWQ Score`      = as.numeric(`Pre-intervention
PSWQ Score`),
+         `Pre-intervention RSS Score`       = as.numeric(`Pre-intervention RSS
Score`)
+     )
>
> # ----------------------------------------------------------
> # 4. Multivariate PERMANOVA
> # ----------------------------------------------------------
> df_adonis <- df %>%
+     select(MindfulnessGroup,
+            `Pre-intervention PSS-10 Score`,
+            `Pre-intervention MBI-SS EE Score`,
+            `Pre-intervention MBI-SS DP Score`,
+            `Pre-intervention MBI-SS PA Score`,
+            `Pre-intervention PSWQ Score`,
+            `Pre-intervention RSS Score`)
>
> adonis_result <- adonis2(df_adonis[, -1] ~ MindfulnessGroup,
```

```
+                     data = df_adonis,
+                     permutations = 999,
+                     method = "euclidean")
>
> cat("\n--- PERMANOVA (multivariate) ---\n")


--- PERMANOVA (multivariate) ---
> print(adonis_result)
Permutation test for adonis under reduced model
Permutation: free
Number of permutations: 999

adonis2(formula = df_adonis[, -1] ~ MindfulnessGroup, data = df_adonis,
permutations = 999, method = "euclidean")
          Df SumOfSqs      R2      F Pr(>F)
Model     1    240.4 0.03997 0.5412  0.703
Residual 13   5773.9 0.96003
Total    14   6014.3 1.00000
>
> # ----------------------------------------------------------
> # 5. Univariate permutation ANOVAs
> # ----------------------------------------------------------
> cat("\n--- Univariate permutation ANOVAs ---\n")


--- Univariate permutation ANOVAs ---
```

```
>
> aov_pss <- aovp(`Pre-intervention PSS-10 Score` ~ MindfulnessGroup,
+                 data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nPSS-10:\n"); print(summary(aov_pss))


PSS-10:
Component 1 :
                Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1    1.633    1.6333   51   0.7255
Residuals         13  103.300    7.9462


>
> aov_ee <- aovp(`Pre-intervention MBI-SS EE Score` ~ MindfulnessGroup,
+                 data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nMBI-SS EE:\n"); print(summary(aov_ee))


MBI-SS EE:
Component 1 :
                Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1   168.03   168.033 2137  0.04492 *
Residuals         13   499.30    38.408
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
>
> aov_dp <- aovp(`Pre-intervention MBI-SS DP Score` ~ MindfulnessGroup,
+               data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nMBI-SS DP:\n"); print(summary(aov_dp))

MBI-SS DP:
Component 1 :
                Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1     58.8    58.800  277   0.2671
Residuals         13    543.6    41.815

>
> aov_pa <- aovp(`Pre-intervention MBI-SS PA Score` ~ MindfulnessGroup,
+               data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nMBI-SS PA:\n"); print(summary(aov_pa))

MBI-SS PA:
Component 1 :
                Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1     0.03     0.033   51        1
Residuals         13   460.90    35.454
```

```
>
> aov_pswq <- aovp(`Pre-intervention PSWQ Score` ~ MindfulnessGroup,
+                  data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nPSWQ:\n"); print(summary(aov_pswq))


PSWQ:
Component 1 :
                 Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1    3.333    3.3333   96   0.5104
Residuals         13   60.400    4.6462


>
> aov_rrs <- aovp(`Pre-intervention RSS Score` ~ MindfulnessGroup,
+                  data = df, perm = "Prob")
[1] "Settings:  unique SS : numeric variables centered"
> cat("\nRRS:\n"); print(summary(aov_rrs))


RRS:
Component 1 :
                 Df R Sum Sq R Mean Sq Iter Pr(Prob)
MindfulnessGroup1  1      8.5     8.533   51   0.7647
Residuals         13   4106.4   315.877
```

Coding created with the assistance of Chat GPT (OpenAI, 2025)

Appendix XII. Study 4 - Meditation and burnout – exploring the attentional control pathway: a registered report

**Abstract**

Mindfulness practices are the most reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout. However, the research into this relationship has been largely atheoretical with very few studies detailing how and why meditation should be effective. One proposed mechanism responsible for the benefits of meditation is via an increase in attentional control resulting in a better ability to shift attention away from negative thoughts and emotions and inhibit being drawn back toward them resulting in a reduction in rumination. This is important as rumination has been implicated in prolonging stress and burnout. Participants will be recruited via snowball sampling via email and text message and be directed toward an online study site. They will be asked to conduct a meditation habits survey, the Attentional Network Test, the Rumination Response scale, the Perceived Stress Scale – 10 item and the Burnout Assessment Tool. We propose a model for the role of rumination and use structural equation modelling to ascertain the relationship between meditation habits, attention control, rumination, perceived stress and burnout. Confirmation of this pathway will allow for further research and intervention development targeting the increase in attentional control and the reduction in rumination for the prevention and treatment of prolonged stress and burnout.

**Introduction**

Burnout is characterised by physical fatigue, emotional exhaustion and cognitive weariness and is often due to high workload and stressful conditions (Naczenski et al., 2017; Shirom & Melamed, 2006). Mindfulness practices are the most

reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout, however, the research into this relationship has been largely atheoretical with very few studies detailing much about how and why meditation should be effective (Chu et al., 2024; Hölzel et al., 2011; Sedlmeier et al., 2012).

Mindfulness is an umbrella term encompassing being present in the moment (Van Dam et al., 2018). It is not a unitary construct and includes many different practices in many different contexts (Kabat-Zinn, 1990). Conversely, meditation denotes a specific set of practices where one is mindful during a specific moment and comprises of two broad types (Lutz et al., 2015). Focused meditation involves practicing the deliberate focusing of attention on a particular element such as the breath, sensation, sound, mental image, word, phrase, or object (Davidson & Kaszniak, 2015; Lutz et al., 2015). Open meditation, on the other hand, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015).

Two factors that are thought to mediate the relationship between meditation and psychological well-being are worry and rumination. These are two common forms of repetitive negative thinking (RNT) and together, these have also been termed perseverative cognition (PC) (McCarrick et al., 2021). While the research regarding the overlap between rumination and worry is inconsistent, Watkins, Moulds and Mackintosh propose that rumination and worry involve the same repetitive thought process but about different content (Watkins et al., 2005). Worry tends to be future focused and is associated with anxiety, whist rumination tends to be past focused and is associated with depression (McCarrick et al., 2021; Watkins et al., 2005).

Rumination involves repeatedly thinking about information from the past that is negative and is comprised of two components; reflective pondering and brooding (Nolen-Hoeksema et al., 2008; Treynor et al., 2003). One systematic review found that rumination mediated the relationship between mindful-based interventions and stress, anxiety, depression and global psychopathological symptoms (Gu et al., 2016). Specifically, when compared to relaxation therapy, mindfulness meditation's ability to reduce distress was found to be mediated by reductions in rumination (Hsu et al., 2015; Jain et al., 2007; Willis & Burnett, 2016). Further evidence for the importance of rumination comes from studies that have found that those who ruminate tend to have higher levels of perceived stress and increased levels of burnout (Bianchi & Schonfeld, 2016; Košir et al., 2015; Liu et al., 2021). The Response Style theory proposes that rumination, in particular brooding, promotes and prolongs distress by interfering with problem solving and preventing instrumental behaviour so individuals become fixated on their feelings and problems without acting to improve their mood (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008). Rumination can also prevent the use of distracting activities which would otherwise reduce their distress (Nolen-Hoeksema, 1991). Lastly rumination can result in a depressed mood which further focuses an individual on negative thoughts and emotions resulting in greater distress (Nolen-Hoeksema, 1991). Hence, reducing rumination may free resources required for problem solving and instrumental behaviour whilst also allowing for distracting activities which reduce distress and burnout symptoms.

Worry also involves repetitive negative thoughts which are instead focused on the future and used to anticipate and avoid danger (Capobianco et al., 2018). One environmental risk factor for burnout is a perception of a lack of control and uncertainty (Bährer-Kohler, 2013). It has been found those who have less tolerance for uncertainty,

tend to worry more and, additionally, people often use worry as a way regain a sense of control (Freeston et al., 1994). The Reflexive Adaptation Process (RAP) proposes that worry prolongs stress by focusing attention toward threat-related stimuli depleting the cognitive resources required for the flexible control needed to return cognition to its original threat-free state (Roussis & Wells, 2008). Thus worry lack of control in the workplace can lead to increased worry resulting in prolonged stress and burnout.

When considered together as perseverative cognition, worry and rumination are thought to contribute to a prolonged stress response (Brosschot et al., 2006). The preservative cognition hypothesis proposes that preservative cognition results in a state of moderate, chronic levels of stress including chronic activation of the immune, hypothalamic pituitary adrenal and cardiovascular systems (Brosschot et al., 2006). As burnout is defined as the presence of chronic stress, it proposed that worry and rumination (PC) lead to burnout. Additionally, in line with the Conservation of Resources theory, it is thought that resources are allocated to negative thoughts and emotions, such as with rumination and worry, rather than relevant tasks leading to poor job performance and burnout (Hobfoll & Freedy, 1993; Liu et al., 2021).

One way to reduce PC through an increase in attentional control. Attentional control comprises of two aspects, the ability to maintain attention and the ability to return after being distracted (MacDonald & Olsen, 2020). These distractions can be from the environment, from self-generated information or from previously learned behaviour (von Bastian et al., 2020). Posner and Peterson proposed a model of attention comprising three networks, alerting, orienting and executive control (Posner & Petersen, 1990). The initial capture and sustainment of attention is conducted by the alerting system while the orienting system anticipates the direction of a specific stimuli (Posner & Petersen, 1990). However, it is the last system that is the most relevant to

examining the effects of meditation, the executive control network. This is now thought to be responsible for refreshing information, switching between stimuli (attentional juggling/attention shifting), and refraining from shifting or updating attention to another stimulus (inhibition) (Miyake et al., 2000).

However, much of the literature examining the relationship between attentional control and rumination is cross-correlational and some propose that rumination causes deficits in attentional control while others suggest that a third-variable, such as mood, accounts for the relationship (Pepper, 2017). The resource depletion account proposes that when someone is ruminating it uses attentional resources and depletes them for future attention shifting toward positive thoughts or emotions (Whitmer & Gotlib, 2013). Neuroimaging studies have also found that those who have high levels of brooding showed high activation of the right dorsolateral prefrontal cortex. This part of the brain is thought to allow people to disengage from negative thoughts to limit rumination (Vanderhasselt et al., 2011). The attentional control theory of anxiety (ACT), proposes that worry disrupts the balance between the "bottom-up" (stimulus-driven) attentional system and the "top-down" (goal-directed) attentional system resulting in the exhaustion of cognitive capacity leading to reduced cognitive efficiency and performance (Eysenck et al., 2007; Fox et al., 2015). This suggests that those who worry and ruminate end up needing to recruit more attentional control and exhaust their capacity.

Others believe that it is a deficit in attentional control that causes worry and rumination as reduced attentional control leads to a decreased ability to block or disengage from negative, non-task oriented thoughts (Joormann et al., 2007). The impaired disengagement hypothesis proposes that those who have an impaired ability to exert attentional control are unable to disengage from negative thoughts and feelings

are more likely to endure ongoing rumination (Daches et al., 2010; DeJong et al., 2019). In one study, a fear conditioning procedure was used to induce deficits in attentional control and this was associated with greater worry and difficulties controlling negative intrusive thoughts (Fox et al., 2015). It is likely that both pathways are present resulting in a vicious cycle (32)(Koster et al., 2011).

On the other hand, improvements in attentional control correlate with improvements in the ability to suppress worry-related intrusive thoughts (Fox et al., 2015). This could be by replenishing attentional resources lots due to worry and rumination or by removing any deficit in the first place. This concept of attention and attentional control features heavily in the meditation and mindfulness literature. Lutz et al viewed attentional control as the result of training of meditation skills (Lutz et al., 2008). Accordingly, Holzel et al., identified attention regulation as a major component of their mindful meditation theory and surmised that the main aspect of focused meditation, the ability to focus attention on an element and return to this when distracted, improves attentional control. This relationship has been supported by various studies showing improvements in cognitive tests measuring executive attention (Hölzel et al., 2011; Lutz et al., 2015). They also use supporting neurological findings suggesting that meditation produces enduring brain function changes. Attentional control, with neuroimaging studies have found that experienced meditators demonstrate greater activation in the anterior cingulate cortex (ACC) (Hölzel et al., 2011; Slagter et al., 2007). In Shapiro et al.'s model, attention is identified as a fundamental component of mindfulness and that meditation results in the improvement of sustained attention, attention shifting and inhibition (Shapiro et al., 2006). Additionally, the Liverpool Mindfulness Model, proposes that during meditation one is required to sustain attention on an object using the alerting network, return from mind wandering using the

executive attention network and return attention back to the original task using the orienting network (Malinowski, 2013). In a randomised controlled trial, those who did meditation showed improvements in cognitive tests of attention switching, orienting and executive attention (Vieth & Von Stockhausen, 2022). Thus, as focused meditation encourages the practice of sustaining attention and returning from distractions, it is thought to strengthen the attentional networks responsible for these tasks.

These improvements in attentional networks are proposed to be behind the reduction in worry and rumination associated with meditation. In focused meditation, attention is focused on a neutral object, such as breathing, which results in the continual distraction from ruminative thoughts back to the neutral object (Wolkin, 2015). It is also thought that once an individual becomes more experienced with meditation, their attentional focus is broadened and thoughts are non-judgementally accepted and let go of rather than being ruminated upon (Wolkin, 2015). The Attentional Scope Model of Rumination proposes that a narrowed focus of attention can lead to a predisposition to ruminate by promoting a persistent, narrow focus on negative thoughts while a broader attentional scope increases the likelihood of the thoughts shifting away and reduce the chances of them becoming repetitive (Whitmer & Gotlib, 2013)

While studies have examined meditation, and more broadly mindfulness, as a treatment for stress and burnout, little has been done to explore the mechanisms behind this relationship. This study proposes that mindfulness, and focused meditation specifically, will be associated with greater attentional control, which will be associated with reduced brooding rumination and worry and less perceived stress and symptoms of burnout.

### Study question

Does increased attentional control and reduced rumination and worry explain the effectiveness of meditation in reducing perceived stress and symptoms of burnout?

### Keywords

Meditation; Mindfulness; Prevention and Control; Stress, Psychological;

## Materials and methods

### Study Design

This study will be an online observational study using self-report scales and a self-administered behavioural test with no blinding or randomisation. As of the data of submission of this research plan for preregistration, the data have not yet been collected.

### Participants

Participants will be recruited via snowball sampling using e-mail and text-messages to provide a link to the study hosted on Inquisit Web (Millisecond Software). Once on the study site, they will be provided with a participant information sheet and informed consent page. Participants will be required to be over the age of 18 years and be proficient in English. Recruiting will commence in January, 2024.

### Measures

#### Meditation habits questionnaire

To assess the meditation habits of participants, they will be asked a series of question about the type of practice they do, how effective they find it, how often they practice and for what duration. The questionnaire is outlined in the appendices.

#### Attention Network Test (ANT)

As meditation is thought to affect the alerting, orienting and executive attention networks, the ANT will be used. The ANT is a computer delivered test designed to test

the networks of attention outlined by Posner (Posner & Petersen, 1990). The ANT tests the efficacy of the alerting network using response time (RT) to a warning signal, the orienting network is tested uses RT with accompanying cues to where the target will occur and the executive network is tested using a central stimulus surrounded by incongruent, congruent and neutral flankers(Fan et al., 2002). The test consists of 4 cue conditions (no cue, centre cue, double cue and spatial cue), 3 flanker conditions (neutral, congruent and incongruent), 1 practice block and 3 experimental blocks with 96 trials(Fan et al., 2002). The ANT will be delivered online using the Inquisit Web software (Millisecond Software).

**Ruminative Responses Scale (RRS)**

The RRS is a 22 item self-report questionnaire using a four-point Likert Scale ranging from "1 – almost never" to "4 – almost always" and has been shown to have high internal validity $\alpha = .90$ (Luminet, 2003; Nolen-Hoeksema et al., 1994).

**Penn State Worry Questionnaire (PSWQ)**

The PSWQ is a 16-item self-report questionnaire designed to measure the generality, excessiveness and uncontrollable dimensions of worry. It shows good internal consistency ($\alpha = .91$) and, in tertiary student samples, correlates positively with measures of psychological constructs associated with pervasive worry such as perfectionism and generalised anxiety disorder (Meyer et al., 1990).

**Perceived Stress Scale – 10 item (PSS-10)**

The PSS-10 contains 10 questions regarding thoughts and feelings to measure perceived stress. Using a Likert Scale ranging from "0 - never" to "5 - very often", it asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (Cohen, 2012; Cohen et al., 1983). Four of the questions are reversed scored. A review of its validity found that it

had internal consistency ($\alpha > .70$) in all 12 studies used and satisfactory test-retest reliability (Lee, 2012). It has been shown to have strong validity in student populations (Smith et al., 2014).

**Burnout Assessment Tool – Work Related Version (BAT)**

The BAT is made up of the BAT-C (Core) and BAT-S (Secondary). The BAT-C has 23 questions and four core dimensions; exhaustion, mental distance, emotional impairment and cognitive impairment. The exhaustion component uses 8 questions to assess both mental and physical exhaustion. The mental distance component uses 5 questions to measure if a participant is psychologically distancing themselves from work. The emotional impairment component uses 5 questions to measure if emotional impairment is present during intense emotional reactions. Lastly, the cognitive impairment component uses 5 questions to measure memory issues, concentration deficits and reduced cognitive performance. The BAT-S has 10 questions and includes two secondary dimension; psychological complaints and psychosomatic complaints. All the items use a 5-point Likert scale (Schaufeli, 2019; Schaufeli et al., 2020). The internal consistency for the BAT-C was found to be good as a whole and for each subscale. ($\alpha_{total} = .95$; $\alpha_{exhaustion} = .92$; $\alpha_{mental\ distance} = .91$; $\alpha_{cognitive\ impairment} = .92$; $\alpha_{emotional\ impairment} = .90$) For the BAT-S ($\alpha_{total} = .90$; $\alpha_{psychological\ complaints} = .81$; $\alpha_{psychosomatic\ complaints} = .85$) (Leiter & Schaufeli, 1996; Schaufeli et al., 2020).($\alpha_{total} = .95$; $\alpha_{exhaustion} = .92$; $\alpha_{mental\ distance} = .91$; $\alpha_{cognitive\ impairment} = .92$; $\alpha_{emotional\ impairment} = .90$) For the BAT-S ($\alpha_{total} = .90$; $\alpha_{psychological\ complaints} = .81$; $\alpha_{psychosomatic\ complaints} = .85$) (Leiter & Schaufeli, 1996; Schaufeli et al., 2020).

**Data analysis**

The meditation habits questionnaire results will be used to obtain an understanding of the number of participants who practice mindfulness techniques, the

types they practice, and the average reported time spent doing focused meditation per week. These measures may be correlated with scores on the PSS-10, the RRS and the ANT-R.

The results from the ANT-R will be examined for each of the attention networks. The alerting effect will be calculated using the difference between the mean RT for correct responses in the no cue condition and the mean RT for correct responses in the double cue condition. The orienting effects will be calculated using the difference between the mean RT for correct responses in the centre cue condition and the mean RT for correct responses in the spatial cue condition. The conflict effect (executive control) will be calculated using the mean RT for correct responses in the incongruent condition and the mean RT for correct responses in the congruent condition.

A meta-analysis of meditation studies and attentional control found meditation led to greater alerting effects ($\kappa = 77$, $g = 0.158$, $SE = 0.050$, $z = 3.14$, $p = .002$) and executive control ($\kappa = 155$, $g = 0.203$, $SE = 0.031$, $z = 6.54$, $p < .001$) but not orienting effect ($\kappa = 21$, $g = -0.086$, $SE = 0.074$, $z = -1.16$, $p = .248$)(Sumantry & Stewart, 2021). This study did not specifically look at time spent meditating but did find in a moderator analysis that the time spent significantly moderated the effect of meditation on alerting effect (Sumantry & Stewart, 2021).

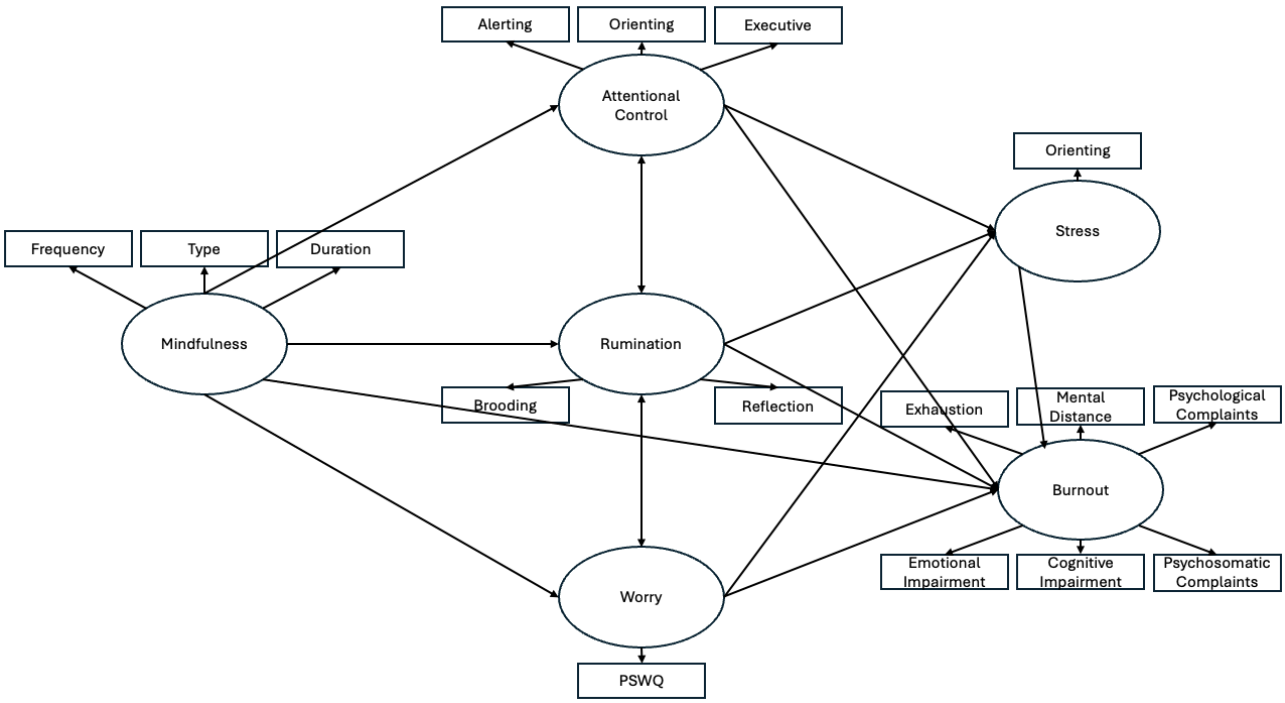
A study examining attention networks and brooding rumination found that executive control, and not alerting effect and orienting effect, were correlated with brooding measures in the RRS *r = -.29, p < 0.05 (DeJong et al., 2019)*.

Structural equation modelling analysis will be conducted using R Studio to analyse the relationship between the amount of average reported time spend doing meditation, the scores for alerting effects, orienting effects and conflict effects on the ANT, the brooding rumination score and the PSS-10 and MBI-GS scores. The predicted

relationships are shown in Figure 1(RStudio, 2020). It is predicted the indirect pathway through the mediators of attention control and rumination will be significant with the indirect path through conflict (executive function) and rumination having the greatest effect. The direct pathway is still predicted to be significant with increased meditation time correlating with reduced PSS-10 and MBI-GS scores as the attentional control/rumination pathway is thought to be one of several pathways between meditation and stress and burnout.

Figure 1

*Proposed attentional control pathway*



# Appendix XIII. Study 4 – Ethics Approval

THE UNIVERSITY of ADELAIDE

**Human Research Ethics Committee (HREC)**

**2019 Application for ethics approval**

| Office use only | | | | | | |
|---|---|---|---|---|---|---|
| | Received: | | | | | |
| | RM No. | | | | | |
| | Ethics Approval No: | | | | | |
| | HREC | EXEC | A/P | HSc | Psych | ORECI |

## LEVEL OF ETHICAL REVIEW:

Indicate the level of ethical review that is being sought for this application:

| | |
|---|---|
| X ☐ | **Full HREC review**<br>Applies to all research involving more than 'low risk research' as defined in the National Statement on Ethical Conduct in Human Research 2007 (updated 2018) |
| ☒ | **Low risk review**<br>Applies to 'low risk research' as defined in the National Statement on Ethical Conduct in Human Research 2007 (updated 2018) (referred to hereafter as *National Statement)*. Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information. |

## SECTION 1: PROJECT AND RESEARCHERS' DETAILS

**1.1 Project title:**

Meditation and Burnout – exploring the attentional control pathway

**1.2 Provide a 1-2 sentence plain language summary of the project:**

This summary should be in plain language and suitable for release to the public.

Mindfulness practices are the most reported intervention for preventing burnout and have been found to offer improvement in stress levels and reduction of burnout, however, the research into this relationship has been largely atheoretical with very few studies saying much about how and why meditation should be effective (Chu, 2024; Hölzel et al., 2011; Sedlmeier et al., 2012). This study aims to investigate the possible rumination pathway in which meditation improves attentional control, leading to reduce rumination which results in a reduction in perceived stress and improved measures of burnout.

**1.3 Project timeframe:**

| | | | |
|---|---|---|---|
| **Proposed commencement date of activities that require human ethics approval**: | Feb 2024 | **Estimated completion date of the project:** | Jun 2025 |

Research must not commence without the prior written approval of the HREC. Retrospective approval cannot be provided.

**1.4 If this application is to extend a currently approved project, provide the HREC approval number:**

| | |
|---|---|
| **HREC approval number:** | NA |

An Annual Report on Project Status Form should also be completed.

**1.5 Applicant:**

The applicant may also be referred to as the principal investigator. If the project is to be undertaken by a research student, the student's primary or other supervisor at The University of Adelaide is the Applicant.

| | | | |
|---|---|---|---|
| **Applicant's title and name:** | Prof. Carolyn Semmler | **EMPLID**: | a1154192 |

| | | | |
|---|---|---|---|
| **School or Department:** | School of Psychology | | |
| **Email:** | carolyn.semmler@adelaide.edu.au | **Phone:** | 8313 4628 |
| **Qualifications and research experience relevant to the project:** | BPsych(Hons), PhD.Prof Semmler has extensive human research experimentation experience leading national and international research teams in past 20 years. Lead Researcher – Applied Cognition and Experimental Psychology (ACEP) group. | | |
| **Role in the research:** | Primary supervisor | | |

### 1.6 Student projects:

If the project is to be undertaken by a research student as part of their studies, please indicate below. **Section 7** must also be completed.

| | | | | | |
|---|---|---|---|---|---|
| **Name:** | Peter Chu | **Student ID:** | A1104736 | **Program Level:** | PhD |
| **Name:** | | **Student ID:** | | **Program Level:** | |
| **Name:** | | **Student ID:** | | **Program Level:** | |

### 1.7 Other researchers:

List all researchers (other than the Applicant and students) in the table below and if applicable their University of Adelaide EMPLID. Include all co-supervisors and researchers internal and external to The University of Adelaide. **Section 7** must also be completed.

| Names: | EMPLID: |
|---|---|
| Fiona Kerr | a1006048 |
| | |
| | |
| | |
| | |
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| | |

### 1.8 Has or will this project be submitted for approval to other HRECs?

Include the HREC's name, current status of the application (i.e. submitted, approved, deferred or rejected) and attach this documentation. The University of Adelaide accepts ethics approval granted by some other HRECs and may not require a separate ethics application. Researchers are encouraged to consult with information about Notification of ethical review and approval from other institutions to see if this applies.

☐ Yes – the project *will* be submitted for approval to:
☐ Yes – the project *has been* submitted for approval to:
☒ No

### 1.9 Has or will this project be submitted for approval to any departments or institutions?

E.g. Department of Education, prisons, government institutions, or businesses. Attach authorising correspondence and/or approval documentation to the application.

☐ Yes – the project *will* be submitted for approval to:
☐ Yes – the project *has been* submitted for approval to:
☒ No

**SECTION 2: NATURE OF THE PROJECT**

**2.1 Aims of the project:**

Discuss in standard English the main research aims/hypotheses to be investigated.

The aim is to explore the relationships between meditation habits, attentional control, rumination, perceived stress and burnout and answer the research question; Does increased attentional control and reduced rumination explain the effectiveness of meditation in reducing perceived stress and symptoms of burnout? It is hypothesised that those with higher use of focused meditation practice will exhibit higher levels of attentional control, lower levels of rumination, lower levels of perceived stress and lower levels of burnout.

**2.2 Rationale of the project:**

Explain in standard English the rationale for the project i.e. how the research will fill any gaps or contribute new knowledge to the field.

This study aims to examine the mindfulness habits of participants in more detail including what types of mindful activities they do and if they find them effective. Additionally, this study aims to add to the literature by proposing and testing a attentional control pathway between focused meditation, in particular, and burnout. Whilst rumination, worry and attentional control have been examined as pathways toward depression, anxiety and post-traumatic stress disorder, it has not been examined as a pathway to burnout.

**2.3 Background to the project:**

Briefly discuss any previous research of relevance and cite no more than 4 key references.

Current studies have found an increase in the prevalence of burnout across the world (Back, Steinhauser, Kamal, & Jackson, 2016). Mindfulness practices are the most reported intervention for burnout and have been found to offer statistically significant results in improving stress levels and reducing burnout, however, the research into this relationship has been largely atheoretical with very few studies saying much about how and why meditation should be effective (Chu, 2024; Hölzel et al., 2011; Sedlmeier et al., 2012).

Mindfulness is an umbrella term that encompasses being present the moment or situation (Van Dam et al., 2018). It is not a unitary construct and includes many different practices in many different contexts (Kabat-Zinn, 1990). Conversely, meditation denotes a specific set of practices where one is mindful during a specific activity and comprises of two broad types(Lutz, Jha, Dunne, & Saron, 2015). Focused meditation involves practicing the deliberate directing and focusing of attention on a particular element the breath, sensation, sound, mental image, word, phrase, or object (Davidson & Kaszniak, 2015; Lutz et al., 2015). Open meditation, on the other hand, involves releasing focus and letting thoughts and feelings go while being aware of them (Davidson & Kaszniak, 2015).

One proposed mechanism responsible for the benefits of meditation is via improved attentional control. This concept of attention and attentional control features heavily in the meditation and mindfulness literature. Lutz et al viewed attention as the result of trainable skills with meditation being specifically designed to train them (Lutz, Slagter, Dunne, & Davidson, 2008).

While meditation has been found to improve attentional control, deficits of attentional control have been linked to rumination(Daches, Mor, Winquist, & Gilboa-Schechtman, 2010; DeJong,

Fox, & Stein, 2019). Thus it is proposed that an increase in attentional control could result in better ability to shift attention away from negative thoughts and emotions and inhibit being drawn back toward them resulting in a reduction in rumination.

Those who ruminate tend to have high levels of perceived stress and increased levels of burnout(Bianchi & Schonfeld, 2016; Košir, Tement, Licardo, & Habe, 2015; Liu et al., 2021). The response style theory proposes that rumination promotes and prolongs distress by interfering with problem solving and preventing instrumental behaviour so individuals become fixated on their feelings and problems without taking action (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination also can prevent the use of distracting activities which would otherwise reduce their distress (Nolen-Hoeksema, 1991).

While studies have examined meditation, and more broadly mindfulness, as a treatment for stress and burnout, little has been done to explore the mechanisms behind this relationship. This study proposes that mindfulness, and focused meditation specifically, is associated with greater attentional control, reduced rumination and in less perceived stress and symptoms of burnout.

**2.4 Have there been any preliminary studies? If YES, provide the project title and HREC approval number(s):**

**2.5 Research methodology:**

Describe how the study will be undertaken and explain what interactions will occur between researchers and participants. Include a description of the research methodology and how this will achieve the research aims. For example, you could include a justification of why the sample size/sampling method will yield valid and reliable results. Where appropriate, please refer back to the aims described in 2.1 when describing the methodological approach.

## Study Design

This study will be an online observational study using self-report scales and a self-administered behavioural test with no blinding or randomisation.

## Measures

*Meditation habits questionnaire* - To assess the meditation habits of participants, they will be asked a series of question about the type of practice they do, how effective they find it, how often they practice and for what duration. The questionnaire is outlined in the appendices.

*Attentional Network Task (ANT) - revised* - As meditation is thought to affect the alerting, orienting and executive attention networks, the ANT will be used. The ANT is a computer delivered test designed to test the networks of attention outlined by Posner (Posner & Petersen, 1990). The ANT tests the efficacy of the alerting network using response time (RT) to a warning signal, the orienting network is tested uses RT with accompanying cues to where the target will occur and the executive network is tested by the use of a central stimuli surrounded by incongruent, congruent and neutral flankers(Fan, McCandliss, Sommer, Raz, & Posner, 2002). The test consists of 4 cue conditions (no cue, centre cue, double cue and spatial cue), 3 flanker conditions (neutral, congruent and incongruent), 1 practice block and 3 experimental blocks with 96 trials(Fan et al., 2002). The ANT will be delivered online using the Inquisit Web software (Software).

*Rumination Responses Scale (RRS)*- The RRS is a 22 item self-report questionnaire using a four-point Likert Scale ranging from “1 – almost never” to “4 – almost always” and has been shown to have high internal validity α = .90 (Luminet, 2003; Nolen-Hoeksema, Parker, & Larson, 1994).

*Perceived Stress Scale – 10 item (PSS-10)* - The PSS-10 contains 10 questions regarding thoughts and feelings to measures perceived stress. Using a Likert Scale of from “0 - never” to “5 - very often”, it asks participants to indicate how overwhelmed they have been during the last month with high scores representing higher perceived stress levels (Cohen, 2012; Cohen, Kamarck, & Mermelstein, 1983). Four of the questions are reversed scored. A review of its validity found that it had greater than the minimum measures of internal consistence (α > .70) in all 12 studies used and satisfactory test-retest reliability (Lee, 2012). It has been shown to have strong validity in student populations (Smith, Rosenberg, & Timothy Haight, 2014).

*Penn State Worry Questionnaire (PSWQ)* – The PSWQ is a 16-item self-report questionnaire designed to measure the generality, excessiveness and uncontrollable dimensions of worry. It shows good internal consistency (α = .91) and, in tertiary student samples, correlates positively with measures of psychological constructs associated with pervasive worry such as perfectionism and generalised anxiety disorder (Meyer, Miller, Metzger, & Borkovec, 1990).

*Burnout Assessment Tool – Work Related Version (BAT)*. The BAT is made up of the BAT-C (Core) and BAT-S (Secondary). The BAT-C has 23 questions and four core dimensions; exhaustion, mental distance, emotional impairment and cognitive impairment. The exhaustion component uses 8 questions to assess both mental and physical exhaustion. The mental distance component uses 5 questions to measure if a participant is psychologically distancing themselves from work. The emotional impairment component uses 5 questions to measure if emotional impairment is present during intense emotional reactions. Lastly, the cognitive impairment component uses 5 questions to measure memory issues, concentration deficits and reduced cognitive performance. The BAT-S has 10 questions and includes two secondary dimension; psychological complaints and psychosomatic complaints. All the items use a 5-point

Likert scale (W. B. Schaufeli, De Witte, H. & Desart, S., 2019; W. B. Schaufeli, Desart, & De Witte, 2020). The internal consistency for the BAT-C was found to be good as a whole and for each subscale. ($\alpha_{total}$ = .95; $\alpha_{exhaustion}$ = .92; $\alpha_{mental\ distance}$ = .91; $\alpha_{cognitive\ impairment}$ = .92; $\alpha_{emotional\ impairment}$ = .90) For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; W. B. Schaufeli et al., 2020).($\alpha_{total}$ = .95; $\alpha_{exhaustion}$ = .92; $\alpha_{mental\ distance}$ = .91; $\alpha_{cognitive\ impairment}$ = .92; $\alpha_{emotional\ impairment}$ = .90) For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; W. B. Schaufeli et al., 2020).

**2.6 Location(s) of the research:**

Include details of all sites where the project will be undertaken and locations of participants.

University of Adelaide and via online website (Inquisit Web/Qualtrics).

**2.7 If research is to be conducted with or about participants living outside Australia outline any local legislation, regulations, permissions or customs that need to be addressed before the research can commence. Outline the steps taken to ensure that this has been adequately considered and addressed.**

See *National Statement Chapter 4.8.* Attach authorising correspondence and/or approval documentation to the application. If you are travelling to a region classified as level 3 or 4 according to the Department of Foreign Affairs and Trade, travel approval may be required. See The University of Adelaide's travel safety information in the HSW Policy and Handbook.

NA

## SECTION 3: PARTICIPANTS AND RECRUITMENT

**3.1 Who will be the participants in this project?**

Participants also includes data about people or human tissue samples.

**Participants will be members of the public over the age of 18 with normal vision and English language and students in the Psychology first year participation pool and through passive recruitment only.(Software)**

**3.2 Does the planned or anticipated recruitment of participants target, focus on, or include as a group, any of the following population groups? Select as many as relevant.**

This question is to capture the planned or foreseeable recruitment of participants from these population groups, rather than their incidental inclusion. Select as many groups as applicable to the research.

| Participant group | | Participant group | |
|---|---|---|---|
| Aboriginal and Torres Strait Islander people | ☐ | People who may be involved in illegal activities | ☐ |
| Children and young people | ☐ | People with a cognitive impairment, an intellectual disability or a mental illness | ☐ |
| Defence Force personnel | ☐ | Primary or secondary school students | ☐ |
| People highly dependent on medical care who may be unable to give consent | ☐ | University students | x ☒ |
| People in dependent or unequal relationships | ☐ | Women who are pregnant and the human fetus | ☐ |
| People in other countries | ☐ | None of these participant groups | ☐ |

**3.3 What is the number of participants?**

**3.4 What is the age range of participants?**

Likert scale (W. B. Schaufeli, De Witte, H. & Desart, S., 2019; W. B. Schaufeli, Desart, & De Witte, 2020). The internal consistency for the BAT-C was found to be good as a whole and for each subscale. ($\alpha_{total}$ = .95; $\alpha_{exhaustion}$ = .92; $\alpha_{mental\ distance}$ = .91; $\alpha_{cognitive\ impairment}$ = .92; $\alpha_{emotional\ impairment}$ = .90) For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; W. B. Schaufeli et al., 2020).($\alpha_{total}$ = .95; $\alpha_{exhaustion}$ = .92; $\alpha_{mental\ distance}$ = .91; $\alpha_{cognitive\ impairment}$ = .92; $\alpha_{emotional\ impairment}$ = .90) For the BAT-S ($\alpha_{total}$ = .90; $\alpha_{psychological\ complaints}$ = .81; $\alpha_{psychosomatic\ complaints}$ = .85) (Leiter & Schaufeli, 1996; W. B. Schaufeli et al., 2020).

**2.6 Location(s) of the research:**

Include details of all sites where the project will be undertaken and locations of participants.

University of Adelaide and via online website (Inquisit Web/Qualtrics).

**2.7 If research is to be conducted with or about participants living outside Australia outline any local legislation, regulations, permissions or customs that need to be addressed before the research can commence. Outline the steps taken to ensure that this has been adequately considered and addressed.**

See *National Statement Chapter 4.8.* Attach authorising correspondence and/or approval documentation to the application. If you are travelling to a region classified as level 3 or 4 according to the Department of Foreign Affairs and Trade, travel approval may be required. See The University of Adelaide's travel safety information in the HSW Policy and Handbook.

NA

## SECTION 3: PARTICIPANTS AND RECRUITMENT

**3.1 Who will be the participants in this project?**

Participants also includes data about people or human tissue samples.

**Participants will be members of the public over the age of 18 with normal vision and English language and students in the Psychology first year participation pool and through passive recruitment only.(Software)**

**3.2 Does the planned or anticipated recruitment of participants target, focus on, or include as a group, any of the following population groups? Select as many as relevant.**

This question is to capture the planned or foreseeable recruitment of participants from these population groups, rather than their incidental inclusion. Select as many groups as applicable to the research.

| Participant group | | Participant group | |
|---|---|---|---|
| Aboriginal and Torres Strait Islander people | ☐ | People who may be involved in illegal activities | ☐ |
| Children and young people | ☐ | People with a cognitive impairment, an intellectual disability or a mental illness | ☐ |
| Defence Force personnel | ☐ | Primary or secondary school students | ☐ |
| People highly dependent on medical care who may be unable to give consent | ☐ | University students | x ☒ |
| People in dependent or unequal relationships | ☐ | Women who are pregnant and the human fetus | ☐ |
| People in other countries | ☐ | None of these participant groups | ☐ |

**3.3 What is the number of participants?**

**3.4 What is the age range of participants?**

See *National Statement Chapter 2.2 and Chapter 3.1 Element 3.* Templates for consent forms should be modified to suit the nature of the project.

Consent will be obtained following recruitment via the online questionnaire and the provision of the participation information sheet.

**3.13 For participants not fluent in English or who have difficulty understanding English, what arrangements will be made to ensure comprehension of the research information?**

No participants who fall into this category will be accepted as per the exclusion criteria as the surveys are provided in English.

**3.14 Will the researcher(s) be taking photographs or recordings of participants using audio tape, film/video, or other electronic medium? If so, how will these be used?**

This information should be provided to participants in the participant information sheet and the consent form.

No.

**3.15 In reference to Question 2.5, indicate all research activities in the study and where applicable outline the approximate time commitment required of participants.**

Consult the definitions of research methods for guidance on selecting the method(s) applicable to the project:

| Research method/activity | | Participant time | Research method/activity | | Participant time |
|---|---|---|---|---|---|
| **Action research** | ☐ | | **Interventional** | ☐ | |
| **Biospecimen analysis** | ☐ | | **Interview** | ☐ | |
| **Body organs, tissues or fluids** | ☐ | | **Observational** | ☐ | |
| **Clinical Trial** | ☐ | | **Phlebotomy (Blood sampling)** | ☐ | |
| **Data linkage** | ☐ | | **Survey** | ☒ | 45 minutes |
| **Drugs or isotopes** If this is selected, a Drugs to be Administered Form is to be completed. | | | **Textual analysis** (including medical records, academic records, personal documents) | | |
| **Epidemiological** | ☐ | | **Use of data sets** | ☐ | |
| **Ethnographic** | ☐ | | **Other** | ☐ | |
| **Focus group** | ☐ | | | | |

**3.16 Provide a description of each of the activities selected above in terms of what the participant will experience from taking part in the research:**

Provide a summary of the focus of any research activities e.g. topics of the survey, interviews etc. and the format they will be undertaken e.g. face to face, online etc. If there are multiple methods, outline if participants are being asked to do one or all of the activities. Attach copies of surveys, interview or focus group schedules, questions and topics to be covered to the application. All attachments should be clearly labelled with appropriate headings and referred to within the body of the application.

Participants will be directed to a study website hosting by Inquisit Web.
Participants will be asked to:
fill out some demographic questions. – 2 minutes,
fill out a meditation habits survey - 3 minutes,
complete the Attention Network Task (ANT) – 20 minutes,
Complete the Rumination Responses Scale (RRS) – 1 minute,
Complete the Penn State Worry questionnaire (PSWQ) - 1 minute
complete the Perceived Stress Scale (PSS-10) – 2 minutes, and
complete the Burnout Assessment Tool (BAT) – 10-15 minutes.
The total participation time will be approximately 45 minutes.

Information provided in **Question 3.16** should be incorporated into information provided to participants, either through a participant information sheet or other methods as described in **Question 3.11**. University templates for participant information sheets, consent forms and a drugs to be administered form are available at https://www.adelaide.edu.au/research-services/oreci/human/applications/.

**3.17 For research that involves the handling, storage, and/or disposal of human biospecimens, please detail below the protocols that will be followed to ensure *National Statement* requirements are met.**

See *National Statement Chapter 3.2.*

N/A

## SECTION 4: ETHICAL CONSIDERATIONS

In addition to the ethical considerations pertaining to all research participants, researchers should be aware of the specific issues that arise in terms of the design, conduct and ethical review of research involving various categories of participants as outlined in the *National Statement Section 4.*

**4.1 Describe the likely burdens of participation and any risks to participants when undertaking the research:**

Burdens include impacts on participants such as inconvenience e.g. filling in a form, participating in a street survey, or giving up time to participate in research and discomfort e.g. minor side-effects of medication, the discomforts related to measuring blood pressure, and anxiety induced by an interview. Risks can be emotional, social, legal, medical or physical and can include distress and harm. See *National Statement Chapter 2.1*.

The main burden of participation will be the time required to complete the study which is approximately 45 minutes.

**4.2 Describe how the risks will be minimised or mitigated. Outline any relevant protocols for management of risks including distress protocols, occupational health and safety practices, first aid procedures etc.**

See *National Statement Chapter 1.7 and Chapter 2.1.*

The primary researcher's email contact details will be provided and participants can cease participation at any time. In addition, should participants feel that their levels of stress are unmanageable they will be given the contact details for the Student Counselling Services 08 8313 5663 and the Lifeline Counselling service 131114.

**4.3 Describe how researcher(s) will protect the privacy and confidentiality of participants.**

See *National Statement Chapter 1.6 and Chapter 2.1*

Researchers will protect the privacy and confidentiality of participants by not requiring any personally identifying information for the study and will abide by the NHMRC Code of Responsible Research and National Statement Chapter on the ethical conduct of human research. At no time will the data provided by participants be linked to any identifying information.

**4.4 Describe how the likely benefits of the research will justify the burdens and/or risks to participants:**

See *National Statement Chapter 1.6 and Chapter 2.1*

The data collected in this study will provide information on a possible pathway between meditation and the prevention and treatment of burnout while requiring participants to provide less than an hour of their time for an online survey.

**4.5 Outline the protocol that will be followed in the event of any adverse events:**

It is a condition of approval that researchers **immediately** report to the HREC Secretariat any adverse events that might warrant review of ethical approval. See *National Statement Chapter 5.1 and 5.5.*

In the event of any breach of data, The University of Adelaide's Privacy Management Plan and Data Breach Response Plan must be followed.

Although the occurrence of adverse events is anticipated to be extremely low, should any event arise, the research team will immediately notify the HREC Secretariat in accordance with National Statement Chapter 5.1 and 5.5.

**4.6 Will participants receive any reimbursement of out of pocket expenses, or financial or other rewards as a result of participation? What is the amount or nature of the reimbursement/reward and the justification for this?**

See *National Statement Chapters 2.2.10 - 2.2.11; 3.1.10 and 3.1.22.*

Those recruited through SONA and will receive .5 credits per hour or as otherwise instructed by the program coordinator. Members of the general public recruited through Prolific will be reimbursed through the Prolific system.

**4.7 Does the research involve limited disclosure of the research aims? If YES, provide a justification.**

See *National Statement Chapter 2.3.*

No.

**4.8 Describe any possible risks to the health or safety of the researcher(s) when undertaking the research?**

Where interviews are to be held in participants' homes as opposed to public places provide a rationale other than convenience for why this is necessary (and outline the personal safety protocol for the researchers involved). See the *Australian Code of Responsible Conduct in Research 1.2.*

There are no foreseeable risks to the health or safety of the researchers.

## SECTION 5: DATA – CONFIDENTIALITY, ANALYSIS, REPORTING, STORAGE AND FUTURE USE

**5.1 Select the option that reflects the type of data that will be accessed throughout the research:**

For some research, the type of data received or collected initially may be different to the type of data that is stored. For instance, interview data with names recorded is individually identifiable data. If names are *permanently* removed when the data is stored at the completion of the project, the data will then be considered non-identifiable. Personally identifiable information is any part of someone's personal details which can be used to identify them as an individual. This can include name, birth date, home address, email, phone number and student ID. See *National Statement Chapter 3.1 Element 4.*

| Type of data | Initially received/ collected | Stored (at completion) |
|---|---|---|
| **Non-identifiable:** data received or collected about participants that is received in a non-identifiable form. This includes data which has never had personal identifiers e.g. an anonymous survey, or from which identifiers have been permanently removed before you received it. **It is not possible for you to identify a specific individual.** | ☒ | x |
| **Re-identifiable:** data from which personal identifiers have been removed and replaced by a code. The data is either received with a code already attached and personal identifiers have been removed or you remove identifiers and replace with code. **It remains possible for you or others to re-identify a specific individual by, for example, using the code or linking different data sets.** | ☐ | ☐ |
| **Individually Identifiable:** data where the identity of an individual could be reasonably ascertained. Examples of identifiers include the individual's name, image, date of birth or address, or in some cases their position in an organisation. | ☐ | ☐ |

**5.2 Compliance with the *Guidelines under Section 95 and 95A of the Privacy Act 1988:***

| | YES | NO |
|---|---|---|

| | | |
|---|---|---|
| **5.2.1** Is this research relevant to public health or public safety, or to the management, funding or monitoring of a health service?<br>This includes collecting, using or disclosing health information for the purposes of research or compiling statistics relevant to public health or public safety. | ☐ | x |
| **5.2.2** Does the research involve collection, use or disclosure of health information held by an organisation **without** consent from the individual(s) the information relates to? | ☐ | x |
| **5.2.3** Is the information you will be *accessing or collecting* individually identifiable? **i.e. the individual's identity can be reasonably ascertained.**<br>Medical case note's would generally be considered individually identifiable. | ☐ | x |

If you answer **YES** to all three questions in **5.2**, you will need to provide a proposal to the HREC as to why the public interest value of your research out-weighs the public interest in the protection of privacy. The proposal must address the appropriate sections of the G*uidelines under Section 95 and 95A of the Privacy Act 1988*. The guidelines are available at: https://nhmrc.gov.au/about-us/publications/guidelines-under-section-95-privacy-act-1988 and https://nhmrc.gov.au/about-us/publications/guidelines-approved-under-section-95a-privacy-act-1988.

In the questions below, outline how the privacy and confidentiality of participant data and samples will be protected throughout the different stages of the research, making reference to the type of data (non-identifiable, re-identifiable or individually identifiable) that will be accessed by the researcher(s).

**5.3 How will the privacy and confidentiality of participant data, samples and information be protected during the collection and/or recruitment phase?**

Outline the de-identification processes, separation of roles of those responsible for the management of data, and any other relevant practices. Outline where data will be stored during data collection phase and who will have access. See *National Statement Chapter 3.1 Element 4*.

Researchers will protect the privacy and confidentiality of participants by not requiring any personally identifying information for the study. All data will be stored and analysed on approved university cloud based storage (UofA MS OneDrive).

**5.4 How will the privacy and confidentiality of participant data, samples and information be protected during the data analysis phase?**

Outline the de-identification processes, use of pseudonyms, codes, or explicit consent, and any other relevant practices. Outline where data will be stored during data analysis and who will have access. See *National Statement Chapter 3.1 Element 4*.

Professor Carolyn Semmler and Mr Peter Chu will be the primary investigators leading the data analysis phase and will be responsible for the management of all data protection, abiding by the University's guidelines. Data will be managed in accordance with Data Management Plan DMP2023-01076

**5.5 How will participant data, samples and information be analysed and who will undertake this analysis?**

The data analysis will be conducted by Mr. Chu under the supervision of Professor Semmler.

The meditation habits questionnaire results will be used to obtain an understanding of the number of participants who practice mindfulness techniques, the types they practice and the average reported time spent doing focused meditation per week.

The results from the ANT-R will be examined for each of the attention networks. The alerting effect will be calculated using the difference between the mean RT for correct responses in the no cue condition and the mean RT for correct responses in the double cue condition. The orienting effects will be calculated using the difference between the mean RT for correct responses in the centre cue condition and the mean RT for correct responses in the spatial cue condition. The conflict effect (executive control) will be calculated using the mean RT for correct responses in the in congruent condition and the mean RT for correct responses in the congruent condition.

Structural equation modelling analysis will be conducted using R Studio to analyse the relationship between the amount of average reported time spend doing meditation, the scores for alerting effects, orienting effects and conflict effects on the ANT, the brooding rumination score, worry on the PSWQ and the PSS-10 and BAT (W. B. Schaufeli, De Witte, H. & Desart, S., 2019) facets scores. (Team, 2020).

**5.6 What feedback of findings will be offered to participants e.g. access to transcripts of interviews, drafts or final reports? When will this occur? If no feedback will be offered, outline why.**

It is good practice to provide participants with the opportunity to review any transcripts, particularly if they will be named or there is the potential for them to be identifiable in the research findings.

Generally none other than being able to access the final publication. However, participants will be able to email the research team and receive general feedback, on request.

**5.7 How will the project outcomes be made publicly accessible at the end of the project and in what forms (e.g. journal article, book, conference paper, in the media, presentations)? If they will not be made publicly accessible, explain why.**

The project outcomes will be made available on the Open Science Framework and via publication as a journal article (likely open access) and possibly a conference presentation and as part of Mr Peter Chu's PhD thesis.

**5.8 How will researcher(s) protect the privacy and confidentiality of participant data, samples and information during the reporting of research results?**

Outline if participants will have the option of being identified or referred to by a pseudonym. Where the sample size is very small, it may be impossible to guarantee anonymity/confidentiality of participant identity. Participants involved in such projects need to be clearly advised of this limitation in the information provided to participants. See *National Statement Chapter 3.1 Element 5, and Chapters 3.1.41 and 3.1.61.*

**5.9 Outline how the records, materials and data from the project will be stored at completion. Include details of the storage location, who will have access.**

Refer to Section 2 of the Australian Code for the Responsible Conduct of Research.

All source documents, and study documentation will be stored on a secure university cloud drive folder. As part of the University practice of research integrity and open data, all relevant deidentified datasets will be online archived for future use.

**5.10 Who will be the data custodian?**

All data collections should have an identified custodian to enable access by researchers or participants to the data while maintaining it in a protected form. The custodian of the data may be the individual researcher or agency who collected the information, or an intermediary that manages data coming from a number of sources.

**Please note for student projects the data custodian must be the Principal Supervisor ('Applicant').**

See *National Statement Chapter 3.1.55.*

The primary investigator, Professor Carolyn Semmler (see DMP2023-01076)

**5.11 Outline the length of time that the records and materials will be retained by the University.**

Note that the minimum period for retention of research data is 5 years from the date of any publication and varies depending on the specific type of research. For more information refer to the University of Adelaide's Research Data and Primary Materials Policy and Section 2 of the Australian Code for the Responsible Conduct of Research.

All source documents, and study documentation will be kept by the Investigator for the appropriate retention period of five years after completion of the study and any resulting publication. Data will also be permanently and openly available on the Open Science Framework..

**5.12 What type of consent will be obtained? Will consent be Specific, Extended, or Unspecified?**

Data collected as part of a research project ought to be collected and stored in such a way that it can be used in future research projects. Data collected as part of a research project can only be shared or used in future with the explicit consent of participants. The participant information sheet and consent forms must outline how data will be shared or used in future. You cannot share or use data in future if you do not have consent to do this. See *National Statement Chapter 3, particularly 'Sharing of Data and Information'.*

For definitions of types of consent see the *National Statement Chapter 2.2.14.*

'(b) 'extended': given for the use of data or tissue in future research projects that are:

(i) an extension of, or closely related to, the original project; **OR**

(ii) in the same general area of research (for example, genealogical, ethnographical, epidemiological, or chronic illness research);

**5.13 If Specific Consent is sought, justify why the data and information generated by this research should not be made available for future research:**

Where a researcher believes there are ethical reasons not to make research data or information accessible for future use, this must be justified. See *National Statement Chapter 3.1.50.*

N/A

**5.14 Describe what data will be used in future, how it will be used (i.e. for what purpose), who will have access and how participants will be informed. Outline how data will be shared.**

If future use or sharing of the data is intended, participants are to be fully informed of this in the Participant Information Sheet and Consent Form. For more information see *National Statement Chapters 2.2.14 - 2.2.18 and 3.1.45(i).*

The data may be used to from further analysis from the creation of the thesis for Mr Peter Chu's PhD dissertation.

## SECTION 6: CONFLICT OF INTEREST OR OTHER ETHICAL ISSUES

**6.1 Outline the source of any project funding:**

See *National Statement Chapter 5.2.8*

None

**6.2 Outline any 'conflict of interest' issues that may arise during the project:**

See *National Statement Chapter 5.2.11 and Chapter 5.4*

None

**6.3 Do the researchers expect to obtain any direct or indirect financial or other benefits from conducting this research?**

Benefits must be declared to the HREC and included in the information provided to participants. See *National Statement Chapter 5.4.*

No

**6.4 Outline any other ethical or relevant issues not yet discussed in this application:**

N/A

## SECTION 7: RESEARCHER(S)' QUALIFICATIONS AND EXPERIENCE

### 7.1 Student Researcher(s):

This section should be completed for all students listed in Question 1.6. If there will be direct contact with participants by the research student/s, outline their experience and training to conduct this research.

| | | | |
|---|---|---|---|
| **Student's name, title:** | Peter Chu | **School or Department:** | School of Psychology |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | peter.chu@adelaide.edu.au | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | BA (Security, Terrorism & Counterterrorism Studies), BPsych(Hons). Yoga Instructor | | |
| **Role in the research:** | Primary researcher (PhD student). | | |

| | | | |
|---|---|---|---|
| **Student's name, title:** | | **School or Department:** | |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

| | | | |
|---|---|---|---|
| **Student's name, title:** | | **School or Department:** | |
| **Program Level:** PhD, Masters by Research/Coursework, Bachelor, Honours etc. | | Select option If other please describe | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

### 7.2 Other Researcher(s):

This section should be completed for all researchers listed in Question 1.7.

| | | | |
|---|---|---|---|
| **Name, title and position:** | | | |
| **Email:** | | | |
| **Qualifications and research experience relevant to the project:** | | | |

| | |
|---|---|
| **Role in the research:** | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | Dr Fiona Kerr | **School/Department or other institution:** | The Neurotech Institute |
| **Email:** | fiona@theneurotechinstitute.com | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | PhD | | |
| **Role in the research:** | Adjunct Senior Fellow / CEO and founder of The Neurotech Institute | | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | | **School/Department or other institution:** | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

| | | | |
|---|---|---|---|
| **Name, title and position:** | | **School/Department or other institution:** | |
| **Email:** | | **Phone:** | |
| **Qualifications and research experience relevant to the project:** | (No more than 100 words) | | |
| **Role in the research:** | | | |

## SECTION 8: DECLARATION BY THE RESEARCHER(S)

### 8.1 Readability Review:

Readability is the ease with which text can be read and understood. Applications are sometimes delayed when corrections due to issues with readability, especially to the participant documents (Information Sheets, Consent Forms, surveys etc.) are needed. Grammar, technical terms and language not tailored to the participant can impact on participants' understanding of the research and being able to give fully informed consent. A review for readability involves asking someone (other than the author) such as a peer outside the research team to review the application and participant documents for feedback on the ease to which the application and participant documents were read and understood. For students, the Writing Centre can provide assistance with the expression of participant documents.

| | | |
|---|---|---|
| Has the application, including the participant documents, undergone a readability review? | Yes ☒ | ☐ |

### 8.2 Declaration by the Researcher(s):

THE UNIVERSITY of ADELAIDE

**I/we have read the National Statement on Ethical Conduct in Human Research 2007 (Updated 2018)** and the **Australian Code for the Responsible Conduct of Research.**

**I/we, the researcher(s) agree to**:

- conduct the project in accordance with our responsibilities under the *National Statement on Ethical Conduct in Human Research (2007)* and the *Australian Code for the Responsible Conduct of Research*
- start this research project only after obtaining final approval from the Human Research Ethics Committee (HREC)
- only carry out this research project where adequate funding and personnel is available to enable the project to be carried out according to good research practice and in an ethical manner
- notify the HREC in writing in the event of any adverse or unforeseen events; requesting amendments for approval prior to commencement; completion; discontinuation of the project or changes to research personnel
- provide an annual progress report to the HREC for the duration of the research project
- provide the HREC with a final report
- agree to participate in an audit if requested by the HREC.

**In addition, as the applicant, I**:

- accept responsibility for the conduct of this research project in accordance with the *National Statement on Ethical Conduct in Human Research 2007 (updated 2018)* and the *Australian Code for the Responsible Conduct of Research.*
- certify that all researchers and other personnel involved in this project are appropriately qualified and experienced or will undergo appropriate training and supervision to fulfil their role in this project
- will take responsibility for the confidential maintenance of the research materials as per the University's Responsible Conduct of Research Policy, the University's Records Policy, the University's Research Data and Primary Materials Policy and as required by legislation.

All persons named in **Section 1** are required to sign below:

| | | | | | |
|---|---|---|---|---|---|
| Applicant's signature: | | Name: | Professor Carolyn Semmler | Date: | **12/11/2024** |
| Researcher's signature: | | Name: | Mr Peter Chu | Date: | 20/02/2024 |
| Researcher's signature: | | Name: | Dr Fiona Kerr | Date: | 01/02/2023 |
| Researcher's signature: | | Name: | | Date: | |
| Researcher's signature: | | Name: | | Date: | |
| Researcher's signature: | | Name: | | Date: | |

| Researcher's signature: | | Name: | | Date: | |
|---|---|---|---|---|---|

## SECTION 9: CHECKLIST

**The following documents are attached to this application:**

All documents attached should be referred to in the main body of the application and clearly labelled using appropriate headings i.e. Attachment 1, Attachment 2 etc.

Documents should also be labelled with a version number and a date.

| Yes | No | N/A | Item | Attachment Label (attachment 1 etc.) |
|---|---|---|---|---|
| ☒ | ☐ | ☐ | Participant information including contacts for complaints: either as information sheet, verbal script or survey preamble | |
| ☐ | ☐ | ☐ | Standard Consent Form for a participant in a research project (written consent is required for the majority of projects) | |
| ☐ | ☐ | ☒ | Consent by a Third Party to Participation Form (required where participants are children under 18 years or a dependent adult) | |
| ☒ | ☐ | ☐ | Other recruitment documentation including advertisements, flyers, recruitment letters, emails of introduction, copy of Facebook event pages and social media event sites. | **Participant recruitment email / text message** |
| ☐ | ☐ | ☒ | Procedure/protocol for interviews or focus groups including topics, questions or themes | |
| ☐ | ☐ | ☐ | Survey instrument/Questionnaire (include a printed copy of on-line survey) | |
| ☐ | ☐ | ☒ | Adverse events procedure | |
| ☐ | ☐ | ☒ | Evidence of approval/rejection by other HRECs, including comments and requested alterations to the application | |
| ☐ | ☐ | ☒ | Research with people outside Australia: Evidence of permissions, approvals from overseas authorities etc. | |
| ☐ | ☐ | ☒ | Administration of Drugs Form | |
| ☐ | ☐ | ☒ | Annual Report on Project Status (if extending project) | |

*Not applicable

**T**

## SECTION 10: HOW TO SUBMIT THIS APPLICATION

1. Print the completed form and obtain signatures from all researchers.

2. Scan the signed form including all labelled attachments as **one pdf file** and email to: hrec@adelaide.edu.au. (Low Risk Applications in the School of Psychology should be sent to the chair of the review subcommittee).
3. Submission deadlines apply to applications requiring full HREC review. Applications for low risk review can be submitted at any time. Research timetables should allow for the possibility that a project submitted as a low risk application may be deemed to involve more than low risk, or to raise other issues, therefore requiring full review. Researchers may be requested to provide additional information.

NB References to the *National Statement* throughout the application form are not meant to be exhaustive but rather they aim to provide a starting point for researchers to consider. Researchers should be familiar with the *National Statement* and other relevant guidelines.

References

Back, A. L., Steinhauser, K. E., Kamal, A. H., & Jackson, V. A. (2016). Building Resilience for Palliative Care Clinicians: An Approach to Burnout Prevention Based on Individual Skills and Workplace Factors. *Journal of Pain and Symptom Management, 52*(2), 284-291. doi:10.1016/j.jpainsymman.2016.02.002

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# Participant Information Sheet

**PROJECT TITLE: Meditation and Burnout – exploring the attentional control pathway.**

**HUMAN RESEARCH ETHICS COMMITTEE APPROVAL NUMBER: H-2022-*****

**PRINCIPAL INVESTIGATOR: Carolyn Semmler**

**STUDENT RESEARCHER: Peter Chu**

**STUDENT'S DEGREE: PhD**

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Dear Participant,

You are invited to participate in the research project described below.

### What is the project about?

This study will aim to gather information regarding meditation habits, attentional control, rumination tendencies, worry, perceived stress levels and burnout levels in order to test the relationship between these constructs and a runmination pathway between meditation and stress and burnout.

### Who is undertaking the project?

This project is being conducted by Peter Chu. This research will form the basis for the degree of Doctorate of Philosophy at the University of Adelaide under the supervision of Carolyn Semmler and Fiona Kerr.

### Why am I being invited to participate?

You are being invited as you are as a volunteer to help support this research.

### What am I being invited to do?

You are being invited to take part in the online study include surveys regarding medtation, rumination, perceived stress and burnout as well as a attentional control task.

### How much time will my involvement in the project take?

There will be a one-off survey taking approximately 45 minutes.

### Are there any risks associated with participating in this project?

There are no foreseeable risks and all physiological measurements are non-invasive and all information is self-recorded and provided by you.

The primary reserachers can be contacted with issues via email at anytime and you can case participation at anytime and if you feel that your levels of stress are unmanagemable Student Counselling Support (08 8313 5663), The University Crisis Line (out of hours) (1300 167 654), and Lifeline Counselling service (13 11 14) are available.




**What are the potential benefits of the research project?**

Recent research has shown the effectiveness of meditation in reducing stress and burnout. This research intends to build on this research by testing a rumination path between meditation and stress and burnout with a view to better understand the mechanisms involved for future interventions. In addition, you will be helping to research ways we can help to prevent burnout in students as well as other high risk occupations such as medical personal, emergency services workers and Australian Defence Force members.

**Can I withdraw from the project?**

Participation in this project is completely voluntary. If you agree to participate, you can withdraw from the study at any stage.

**What will happen to my information?**

Researchers will protect the privacy and confidentiality of participants by applying de-identification codes at recruitment and abide by the UofA's and National Statement Chapter on the ethical conduct of human research.

No personal identifying details are required. The psychometric data will be entered into an excel file on a secure university cloud storage system in de-identified form. These will be able to be accessed by the research team, only, including Assoc. Professor Semmler, Dr Kerr and Mr Chu. Statistical analysis will be carried out using the statistical package R using custom analytical packages. The data will be store and used using the Open Science Framework for future research that is an extension or closely related to this study in accordance with the National Statement Chapter 3, particularly 'Sharing of Data and Information'.

Your information will only be used as described in this participant information sheet and it will only be disclosed according to the consent provided, except as required by law.

**Who do I contact if I have questions about the project?**

The primary researcher can be contact via email at peter.chu@adelaide.edu.au

**What if I have a complaint or any concerns?**

If you have questions or problems associated with the practical aspects of your participation in the project, or wish to raise a concern or complaint about the project, then you should consult the Principal Investigator

For any questions about the ethical conduct of research, please contact Dr Paul Delfabbro, Chair of the low Human Research Ethics Subcommittee in the School of Psychology (paul.delfabbro@adelaide.edu.au).

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

**If I want to participate, what do I do?**

If you would like to participate, please acknowledge this information sheet and proceed with the online study.

Yours sincerely,

Peter Chu, PhD candidate.
Associate Professor Carolyn Semmler, PhD.

CRICOS 00123M

Appendix XIV. Study 4 - R Script

```
# Packages
library(dplyr)
library(tidyr)
library(purrr)
library(lavaan)
# Qualtrics: renames (match your sheet)
colnames(qual_raw)[34] <- "Frequency"
colnames(qual_raw)[35] <- "Duration"
colnames(qual_raw)[32] <- "Type_raw"

# Response mappings
pss_map <- c("Never"=0, "Almost Never"=1, "Sometimes"=2, "Fairly Often"=3, "Very Often"=4)
bat_map <- c("Never"=1, "Rarely"=2, "Sometimes"=3, "Often"=4, "Always"=5)
rrs_map <- c("Almost Never"=1, "Sometimes"=2, "Often"=3, "Almost Always"=4)
pswq_map <- c(
  "Not at all typical of me"=1, "Rarely typical of me"=2, "Somewhat typical of me"=3,
  "Often typical of me"=4, "Very typical of me"=5
)

# Column index sets
pss_idx <- 36:45
```

```
pss_rev <- c(38, 39, 41, 42)


bat_idx <- 46:68

bat_ex <- 46:53

bat_md <- 54:58

bat_ci <- 59:63

bat_ei <- 64:68


# Secondary

bat_pd  <- 69:72  # psych distress

bat_psc <- 73:76  # psychosomatic

bat_secondary <- 69:76  # (optional composite, not used in SEM)


rrs_idx <- 77:98

pswq_idx <- 99:114

pswq_rev <- c(99, 101, 104, 105, 107)


# Qualtrics scoring

qual_scored <- qual_raw %>%

  mutate(

    Frequency = as.numeric(Frequency),

    Duration  = as.numeric(Duration),

    Type_clean = case_when(

      is.na(Type_raw) ~ NA_character_,

      grepl("No", Type_raw, ignore.case = TRUE) ~ "None",
```

```
            grepl("Focused", Type_raw, ignore.case = TRUE) &
              !grepl("Mindful movement|Other", Type_raw, ignore.case = TRUE) ~
"Focused",
            grepl("Mindful movement", Type_raw, ignore.case = TRUE) &
              !grepl("Focused|Other", Type_raw, ignore.case = TRUE) ~ "Movement",
            grepl("Other", Type_raw, ignore.case = TRUE) &
              !grepl("Focused|Mindful movement", Type_raw, ignore.case = TRUE) ~
"Other",
            TRUE ~ "Mixed"
          )
        ) %>%
        mutate(across(all_of(pss_idx),  ~
as.numeric(recode(as.character(.x), !!!pss_map,  .default = NA_real_)))) %>%
        mutate(across(all_of(pswq_idx), ~
as.numeric(recode(as.character(.x), !!!pswq_map, .default = NA_real_)))) %>%
        mutate(across(all_of(bat_idx),  ~
as.numeric(recode(as.character(.x), !!!bat_map,  .default = NA_real_)))) %>%
        mutate(across(all_of(bat_secondary), ~
as.numeric(recode(as.character(.x), !!!bat_map, .default = NA_real_)))) %>%
        mutate(across(all_of(rrs_idx), ~
as.numeric(recode(as.character(.x), !!!rrs_map, .default = NA_real_)))) %>%
        mutate(across(all_of(pss_rev),  ~ 4 - .x)) %>%
        mutate(across(all_of(pswq_rev), ~ 6 - .x)) %>%
        mutate(
          brooding   = rowSums(across(all_of(rrs_idx[1:5])),  na.rm = TRUE),
```

```
  reflection = rowSums(across(all_of(rrs_idx[6:10])), na.rm = TRUE)
 ) %>%
 rowwise() %>%
 mutate(
  PSS_total = sum(c_across(all_of(pss_idx)), na.rm = TRUE),

  # BAT subscales (kept; secondary is split and BOTH parts are available)
  BAT_total          = mean(c_across(all_of(bat_idx)), na.rm = TRUE),
  BAT_exhaustion     = mean(c_across(all_of(bat_ex)),  na.rm = TRUE),
  BAT_mental_dist    = mean(c_across(all_of(bat_md)),  na.rm = TRUE),
  BAT_cognitive_imp  = mean(c_across(all_of(bat_ci)),  na.rm = TRUE),
  BAT_emotional_imp  = mean(c_across(all_of(bat_ei)),  na.rm = TRUE),
  BAT_psych_distress = mean(c_across(all_of(bat_pd)),  na.rm = TRUE),
  BAT_psychosomatic  = mean(c_across(all_of(bat_psc)), na.rm = TRUE),

  # Optional secondary composite — computed but NOT used in the model
  BAT_secondary      = mean(c_across(all_of(bat_secondary)), na.rm =
TRUE),

  # Totals
  RRS_total  = sum(c_across(all_of(rrs_idx)),  na.rm = TRUE),
  PSWQ_total = sum(c_across(all_of(pswq_idx)), na.rm = TRUE)
 ) %>%
 ungroup()
```

```
# ANT scoring (fixed; uses numeric flanker = 1/2/3)
# 1. Filter out junk rows (cueCondition 0, flankerCondition 0)
ant_means <- ant_raw %>%
  filter(cueCondition %in% c("NoCue", "DoubleCue", "CenterCue",
"SpatialCue"),
         flankerCondition %in% c(1, 2, 3)) %>%
  mutate(
    latency = as.numeric(latency),
    correct = as.numeric(correct)
  ) %>%
  group_by(subject, cueCondition, flankerCondition) %>%
  summarise(mean_rt = mean(latency, na.rm = TRUE), .groups = "drop")

# 2. Existing scoring code
# Alerting: NoCue - DoubleCue
alerting_scores <- ant_means %>%
  group_by(subject, cueCondition) %>%
  summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
  pivot_wider(names_from = cueCondition, values_from = mean_rt) %>%
  mutate(alerting = NoCue - DoubleCue) %>%
  select(subject, alerting)

# Orienting: CenterCue - SpatialCue
orienting_scores <- ant_means %>%
  group_by(subject, cueCondition) %>%
```

```
  summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
  pivot_wider(names_from = cueCondition, values_from = mean_rt) %>%
  mutate(orienting = CenterCue - SpatialCue) %>%
  select(subject, orienting)

# Conflict: Incongruent (3) - Congruent (1)
conflict_scores <- ant_means %>%
  group_by(subject, flankerCondition) %>%
  summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
  pivot_wider(names_from = flankerCondition, values_from = mean_rt) %>%
  mutate(conflict = `3` - `1`) %>%
  select(subject, conflict)
# Merge ANT scores
ant_scores <- reduce(list(alerting_scores, orienting_scores, conflict_scores),
                     full_join, by = "subject")
# Merge Qualtrics + ANT
qual_scored <- qual_scored %>%
  mutate(ResponseID = as.character(.data[[colnames(qual_raw)[9]]]))
combined_data <- left_join(
  qual_scored,
  ant_scores %>% mutate(subject = as.character(subject)),
  by = c("ResponseID" = "subject")
)

# Z-scores for SEM predictors
```

```
combined_data <- combined_data %>%
  mutate(
    alerting_z  = scale(alerting)[,1],
    orienting_z = scale(orienting)[,1],
    conflict_z  = scale(conflict)[,1],
    Frequency_z = scale(Frequency)[,1],
    Duration_z  = scale(Duration)[,1]
  )

# Dummies for Type_clean
combined_data <- combined_data %>%
  mutate(
    Type_Focused  = ifelse(Type_clean == "Focused", 1, 0),
    Type_Movement = ifelse(Type_clean == "Movement", 1, 0),
    Type_Other    = ifelse(Type_clean == "Other",    1, 0),
    Type_Mixed    = ifelse(Type_clean == "Mixed",    1, 0)
    # "None" is the reference
  )

# THEORY MODEL (UNCHANGED / PREREG)
full_model <- '
  # Measurement
  Mindfulness       =~ Frequency_z + Duration_z + Type_Focused +
Type_Movement + Type_Other + Type_Mixed
  AttentionalControl =~ alerting_z + orienting_z + conflict_z
```

```
          Rumination        =~ brooding + reflection
          Stress            =~ PSS_total
          Burnout           =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+
                            BAT_emotional_imp + BAT_psych_distress +
BAT_psychosomatic

          # Structural (as preregistered)
          AttentionalControl ~ Mindfulness
          Rumination        ~ Mindfulness + AttentionalControl + PSWQ_total
          Stress            ~ AttentionalControl + Rumination
          Burnout           ~ Stress + Rumination + PSWQ_total + Mindfulness
          PSWQ_total        ~ Mindfulness
        '
        # Fit
        fit_full <- sem(full_model, data = combined_data, missing = "ML", estimator =
"MLR")
         summary(fit_full, fit.measures = TRUE, standardized = TRUE, rsquare =
TRUE)
        #Remove type_movement (weakest)



        # --- STEP A (fixed names + remove Type_Movement)
        model_obs_no_movement <- '
          # Measurement (names aligned with your dataset)
```

```
        AttentionalControl =~ alerting_z + orienting_z + conflict_z
        Rumination         =~ brooding + reflection
        Stress             =~ PSS_total
        Burnout            =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+
                              BAT_emotional_imp + BAT_psych_distress +
BAT_psychosomatic


        # Structural (Mindfulness proxies as observed predictors; Type_Movement
removed)
        AttentionalControl ~ Frequency_z + Duration_z + Type_Focused +
Type_Other + Type_Mixed
        Rumination         ~ Frequency_z + Duration_z + Type_Focused + Type_Other
+ Type_Mixed +
                             AttentionalControl + PSWQ_total
        Stress             ~ AttentionalControl + Rumination
        Burnout            ~ Stress + Rumination + PSWQ_total +
                             Frequency_z + Duration_z + Type_Focused + Type_Other +
Type_Mixed
        PSWQ_total         ~ Frequency_z + Duration_z + Type_Focused + Type_Other
+ Type_Mixed
    '


    # --- STEP B: Fit the updated model
    fit_obs_no_movement <- sem(
```

```
  model_obs_no_movement,
  data      = combined_data,
  missing   = "ML",
  estimator = "MLR",
  fixed.x   = FALSE,
  std.lv    = TRUE
)

# Quick fit check
fitMeasures(fit_obs_no_movement, c("cfi","tli","rmsea","srmr"))

# --- STEP C: Recompute the weak table
pe2 <- parameterEstimates(fit_obs_no_movement, standardized = TRUE)

mind_vars2 <-
c("Frequency_z","Duration_z","Type_Focused","Type_Other","Type_Mixed")

struct2 <- pe2 %>%
  filter(
    op == "~",
    lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
    rhs %in% mind_vars2
  ) %>%
  select(lhs, rhs, std = std.all, p = pvalue)
```

```
weak_table2 <- struct2 %>%
  group_by(rhs) %>%
  summarise(
    max_abs_std = max(abs(std), na.rm = TRUE),
    any_sig     = any(p < .05, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  arrange(max_abs_std)

# Show results
weak_table2
struct2 %>% arrange(lhs, desc(abs(std)))

#Remove type_other (next weakest)

# --- STEP D: Remove Type_Other as well
model_obs_no_move_other <- '
  # Measurement (unchanged)
  AttentionalControl =~ alerting_z + orienting_z + conflict_z
  Rumination         =~ brooding + reflection
  Stress             =~ PSS_total
  Burnout            =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+
```

```
                    BAT_emotional_imp + BAT_psych_distress +
BAT_psychosomatic

    # Structural (Mindfulness proxies as observed predictors; Type_Movement &
Type_Other removed)
    AttentionalControl ~ Frequency_z + Duration_z + Type_Focused +
Type_Mixed
    Rumination        ~ Frequency_z + Duration_z + Type_Focused + Type_Mixed
+
                    AttentionalControl + PSWQ_total
    Stress            ~ AttentionalControl + Rumination
    Burnout           ~ Stress + Rumination + PSWQ_total +
                    Frequency_z + Duration_z + Type_Focused + Type_Mixed
    PSWQ_total        ~ Frequency_z + Duration_z + Type_Focused +
Type_Mixed
  '

  fit_obs_no_move_other <- sem(
    model_obs_no_move_other,
    data      = combined_data,
    missing   = "ML",
    estimator = "MLR",
    fixed.x   = FALSE,
    std.lv    = TRUE
  )
```

```
# Quick fit snapshot
fitMeasures(fit_obs_no_move_other, c("cfi","tli","rmsea","srmr"))

# --- Updated weak-table after dropping Type_Other
pe3 <- parameterEstimates(fit_obs_no_move_other, standardized = TRUE)

mind_vars3 <- c("Frequency_z","Duration_z","Type_Focused","Type_Mixed")

struct3 <- pe3 %>%
  dplyr::filter(
    op == "~",
    lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
    rhs %in% mind_vars3
  ) %>%
  dplyr::select(lhs, rhs, std = std.all, p = pvalue)

weak_table3 <- struct3 %>%
  dplyr::group_by(rhs) %>%
  dplyr::summarise(
    max_abs_std = max(abs(std), na.rm = TRUE),
    any_sig     = any(p < .05, na.rm = TRUE),
    .groups = "drop"
  ) %>%
```

```
  dplyr::arrange(max_abs_std)


weak_table3
struct3 %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))
```

#Next remove type_focused (frequency was actual next weakest but due to theory remove all ‘type’ first).

```
# --- STEP E (Types only): Remove Type_Focused as well ------------------------
model_obs_types_only_drop_focused <- '
 # Measurement (unchanged)
 AttentionalControl =~ alerting_z + orienting_z + conflict_z
 Rumination        =~ brooding + reflection
 Stress            =~ PSS_total
 Burnout           =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
                      BAT_emotional_imp + BAT_psych_distress +
BAT_psychosomatic

 # Structural (Mindfulness proxies as observed predictors; Type_Movement,
Type_Other, Type_Focused removed)
 AttentionalControl ~ Frequency_z + Duration_z + Type_Mixed
 Rumination        ~ Frequency_z + Duration_z + Type_Mixed +
                     AttentionalControl + PSWQ_total
```

```
  Stress           ~ AttentionalControl + Rumination
  Burnout          ~ Stress + Rumination + PSWQ_total +
                     Frequency_z + Duration_z + Type_Mixed
  PSWQ_total       ~ Frequency_z + Duration_z + Type_Mixed
'

fit_obs_types_only_drop_focused <- sem(
  model_obs_types_only_drop_focused,
  data      = combined_data,
  missing   = "ML",
  estimator = "MLR",
  fixed.x   = FALSE,
  std.lv    = TRUE
)

# Quick fit snapshot
fitMeasures(fit_obs_types_only_drop_focused, c("cfi","tli","rmsea","srmr"))

# --- Updated weak table (mindfulness proxies that remain)
pe_next <- parameterEstimates(fit_obs_types_only_drop_focused, standardized
= TRUE)

mind_vars_next <- c("Frequency_z","Duration_z","Type_Mixed")

struct_next <- pe_next %>%
```

```
  dplyr::filter(
   op == "~",
   lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
   rhs %in% mind_vars_next
  ) %>%
  dplyr::select(lhs, rhs, std = std.all, p = pvalue)

weak_table_next <- struct_next %>%
  dplyr::group_by(rhs) %>%
  dplyr::summarise(
   max_abs_std = max(abs(std), na.rm = TRUE),
   any_sig     = any(p < .05, na.rm = TRUE),
   .groups = "drop"
  ) %>%
  dplyr::arrange(max_abs_std)

weak_table_next
struct_next %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))

#Remove type_mixed

# --- STEP F (Types only): Remove Type_Mixed as well -
model_obs_types_only_drop_mixed <- '
  # Measurement (unchanged)
```

```
    AttentionalControl =~ alerting_z + orienting_z + conflict_z
    Rumination         =~ brooding + reflection
    Stress             =~ PSS_total
    Burnout            =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+
                          BAT_emotional_imp + BAT_psych_distress +
BAT_psychosomatic

    # Structural (Mindfulness proxies as observed predictors; all Type vars
removed)
    AttentionalControl ~ Frequency_z + Duration_z
    Rumination         ~ Frequency_z + Duration_z +
                         AttentionalControl + PSWQ_total
    Stress             ~ AttentionalControl + Rumination
    Burnout            ~ Stress + Rumination + PSWQ_total +
                         Frequency_z + Duration_z
    PSWQ_total         ~ Frequency_z + Duration_z
  '

  fit_obs_types_only_drop_mixed <- sem(
    model_obs_types_only_drop_mixed,
    data      = combined_data,
    missing   = "ML",
    estimator = "MLR",
    fixed.x   = FALSE,
```

```
  std.lv    = TRUE
)

# Quick fit snapshot
fitMeasures(fit_obs_types_only_drop_mixed, c("cfi","tli","rmsea","srmr"))

# --- Updated weak table (mindfulness proxies that remain)
pe_next2 <- parameterEstimates(fit_obs_types_only_drop_mixed, standardized
= TRUE)

mind_vars_next2 <- c("Frequency_z","Duration_z")

struct_next2 <- pe_next2 %>%
  dplyr::filter(
    op == "~",
    lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
    rhs %in% mind_vars_next2
  ) %>%
  dplyr::select(lhs, rhs, std = std.all, p = pvalue)

weak_table_next2 <- struct_next2 %>%
  dplyr::group_by(rhs) %>%
  dplyr::summarise(
    max_abs_std = max(abs(std), na.rm = TRUE),
```

```
    any_sig     = any(p < .05, na.rm = TRUE),
    .groups = "drop"
  ) %>%
  dplyr::arrange(max_abs_std)


weak_table_next2
struct_next2 %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))
#Mindfulness minutes per week only participants
# 1) Practitioners-only data
practice_data <- combined_data %>%
  filter(!is.na(Frequency) & Frequency > 0) %>%  # keep only practitioners
  mutate(
    minutes_week = ifelse(
      is.finite(Frequency) & is.finite(Duration),
      pmax(Frequency, 0) * pmax(Duration, 0),
      NA_real_
    ),
    minutes_z = as.numeric(scale(minutes_week))
    # If minutes are very skewed, consider:
    # minutes_log = log1p(pmax(minutes_week, 0))
    # minutes_z   = as.numeric(scale(minutes_log))
  )
# Quick check
# summary(practice_data$minutes_week); sum(is.na(practice_data$minutes_z))
# 2) Prereg structural model with minutes_z in place of "Mindfulness"
```

```
#    (AttentionalControl, Rumination, Stress, Burnout as in prereg)
#    + labeled paths and indirect/total effects
model_prereg_minutes <- '
  # Measurement (same as prereg)
  AttentionalControl =~ alerting_z + orienting_z + conflict_z
  Rumination         =~ brooding + reflection
  Stress             =~ 1*PSS_total
  Burnout            =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+ BAT_emotional_imp
  # Structural (Mindfulness -> minutes_z)
  # minutes -> AttentionalControl
  AttentionalControl ~ a1*minutes_z
  # minutes -> Rumination (direct) + via AttentionalControl; PSWQ as prereg
covariate
  Rumination ~ b1*minutes_z + b2*AttentionalControl + b3*PSWQ_total

  # Stress ~ AttentionalControl + Rumination (as prereg)
  Stress ~ c1*AttentionalControl + c2*Rumination
  # Burnout ~ Stress + Rumination + PSWQ_total + minutes (direct, per prereg)
  Burnout ~ d1*Stress + d2*Rumination + d3*PSWQ_total + d4*minutes_z
  # PSWQ_total ~ minutes (as prereg)
  PSWQ_total ~ e1*minutes_z

  # Indirect and total effects of minutes_z
  # Minutes -> AttentionalControl -> Rumination
```

```
        ind_min_AC_to_Rum := a1*b2

        # Minutes -> Rumination (direct + via AC)
        dir_min_to_Rum    := b1
        tot_min_to_Rum    := dir_min_to_Rum + ind_min_AC_to_Rum

        # Minutes -> Stress:
        #   via AC only (minutes->AC->Stress)
        ind_min_AC_to_Stress := a1*c1
        #   via Rum only (minutes->Rum->Stress)
        ind_min_Rum_to_Stress := (b1 + a1*b2)*c2
        #   total to Stress
        tot_min_to_Stress := ind_min_AC_to_Stress + ind_min_Rum_to_Stress

        # Minutes -> Burnout:
        #   via Stress (minutes->...->Stress->Burnout)
        ind_min_to_Burn_via_Stress := tot_min_to_Stress * d1
        #   via Rumination directly to Burnout
        ind_min_to_Burn_via_Rum    := (b1 + a1*b2) * d2
        #   plus direct path to Burnout
        dir_min_to_Burn            := d4
        #   total to Burnout
        tot_min_to_Burn            := ind_min_to_Burn_via_Stress +
ind_min_to_Burn_via_Rum + dir_min_to_Burn
        '
```

```
fit_prereg_minutes <- sem(
  model_prereg_minutes,
  data      = practice_data,
  missing   = "ML",
  estimator = "MLR",
  std.lv    = TRUE,
  fixed.x   = FALSE   # keeps cases with missing minutes_z under FIML
)

# Full results
summary(fit_prereg_minutes, fit.measures = TRUE, standardized = TRUE,
rsquare = TRUE)

#Distributions and outlier analysis
# 1) Practitioners-only data
practice_data <- combined_data %>%
  filter(!is.na(Frequency) & Frequency > 0) %>%  # keep only practitioners
  mutate(
    minutes_week = ifelse(is.finite(Frequency) & is.finite(Duration),
                          pmax(Frequency, 0) * pmax(Duration, 0), NA_real_),
    minutes_z = as.numeric(scale(minutes_week))
    # If minutes are very skewed, consider:
    # minutes_log = log1p(pmax(minutes_week, 0)),
    # minutes_z   = as.numeric(scale(minutes_log))
```

```
)


# Quick check
# summary(practice_data$minutes_week); sum(is.na(practice_data$minutes_z))
# 2) Prereg structural model with minutes_z in place of "Mindfulness"
#    (AttentionalControl, Rumination, Stress, Burnout as in prereg)
#    + labeled paths and indirect/total effects
# ------------------------------------------------------------
model_prereg_minutes <- '
  # Measurement (same as prereg)
  AttentionalControl =~ alerting_z + orienting_z + conflict_z
  Rumination         =~ brooding + reflection
  Stress             =~ 1*PSS_total
  Burnout            =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp
+ BAT_emotional_imp


  # Structural (Mindfulness → minutes_z)
  AttentionalControl ~ a1*minutes_z
  Rumination ~ b1*minutes_z + b2*AttentionalControl + b3*PSWQ_total
  Stress ~ c1*AttentionalControl + c2*Rumination
  Burnout ~ d1*Stress + d2*Rumination + d3*PSWQ_total + d4*minutes_z
  PSWQ_total ~ e1*minutes_z


  # Indirect and total effects
  ind_min_AC_to_Rum := a1*b2
```

```
  dir_min_to_Rum    := b1
  tot_min_to_Rum    := dir_min_to_Rum + ind_min_AC_to_Rum

  ind_min_AC_to_Stress := a1*c1
  ind_min_Rum_to_Stress := (b1 + a1*b2)*c2
  tot_min_to_Stress := ind_min_AC_to_Stress + ind_min_Rum_to_Stress

  ind_min_to_Burn_via_Stress := tot_min_to_Stress * d1
  ind_min_to_Burn_via_Rum    := (b1 + a1*b2) * d2
  dir_min_to_Burn            := d4
  tot_min_to_Burn            := ind_min_to_Burn_via_Stress +
ind_min_to_Burn_via_Rum + dir_min_to_Burn
'

fit_prereg_minutes <- sem(
  model_prereg_minutes,
  data      = practice_data,
  missing   = "ML",
  estimator = "MLR",
  std.lv    = TRUE,
  fixed.x   = FALSE
)

# Full results
```

```
summary(fit_prereg_minutes, fit.measures = TRUE, standardized = TRUE,
rsquare = TRUE)


#Windsorise data and redo sem


#
==========================================================

# Phase 3: winsorize only |z| > 3 back to ±2 SD, then re-run SEM

# - Creates practice_data_winsor3to2

# - Re-fits model_prereg_minutes on both original & winsorized

# - Compares fit measures & selected paths

#
==========================================================


library(dplyr)

library(tidyr)

library(lavaan)

library(readr)

library(tibble)

library(purrr)


stopifnot(exists("practice_data"))

stopifnot(exists("model_prereg_minutes"))


# Observed variables in Phase 3
```

```
obs_vars_phase3 <- c(
  "alerting_z","orienting_z","conflict_z",      # ANT indicators
  "brooding","reflection",                      # Rumination indicators
  "PSS_total",                                  # Stress indicator
  "BAT_exhaustion","BAT_mental_dist",
  "BAT_cognitive_imp","BAT_emotional_imp",      # Burnout indicators
  "PSWQ_total",                                 # Covariate
  "minutes_z"                                   # Mindfulness predictor
)
obs_vars_phase3 <- intersect(obs_vars_phase3, names(practice_data))

# Winsorize function: ONLY values with |z|>3
# are moved back to mean ± 2*SD (keeping sign)
winsorize_3to2sd <- function(x) {
  if (!is.numeric(x)) return(x)
  m <- mean(x, na.rm = TRUE)
  s <- sd(x, na.rm = TRUE)
  if (!is.finite(m) || !is.finite(s) || s == 0) return(x)
  z <- (x - m) / s
  # Compute the two caps at ±2 SD around mean
  lower_cap <- m - 2*s
  upper_cap <- m + 2*s
  # Only replace if |z| > 3
  x[is.finite(z) & z >  3] <- upper_cap
  x[is.finite(z) & z < -3] <- lower_cap
```

```
  x
}
# Create winsorized copy (3SD -> 2SD for extremes)
practice_data_winsor3to2 <- practice_data %>%
  mutate(across(all_of(obs_vars_phase3), winsorize_3to2sd))

# How many values were changed per variable?
winsor_changes <- map_dfr(obs_vars_phase3, function(v){
  orig <- practice_data[[v]]
  win  <- practice_data_winsor3to2[[v]]
  tibble(
    Variable = v,
    N_changed = sum(is.finite(orig) & is.finite(win) & !is.na(orig) & !is.na(win)
& orig != win)
  )
}) %>% arrange(desc(N_changed))

print(winsor_changes)
#write_csv(winsor_changes, "phase3_winsor_changes_3to2sd.csv")

# Fit SEM: original vs winsorized
fit_phase3_orig <- sem(
  model_prereg_minutes,
  data      = practice_data,
  missing   = "ML",
```

```
  estimator = "MLR",
  std.lv    = TRUE,
  fixed.x   = FALSE
)

fit_phase3_win <- sem(
  model_prereg_minutes,
  data      = practice_data_winsor3to2,
  missing   = "ML",
  estimator = "MLR",
  std.lv    = TRUE,
  fixed.x   = FALSE
)
# Compare key fit indices
fit_names <- c("cfi","tli","rmsea","srmr","chisq","df","pvalue","bic","aic")
fit_cmp <- tibble(
  metric = toupper(fit_names),
  Original = as.numeric(fitMeasures(fit_phase3_orig, fit_names)),
  Winsor_3to2 = as.numeric(fitMeasures(fit_phase3_win, fit_names))
)
print(fit_cmp)
#write_csv(fit_cmp, "phase3_fit_compare_original_vs_winsor3to2.csv")

# Compare selected structural paths (standardized)
paths_of_interest <- tribble(
```

```
  ~lhs,              ~op, ~rhs,            ~label,
  "Rumination",      "~", "PSWQ_total",    "b3",
  "Rumination",      "~", "AttentionalControl", "b2",
  "Rumination",      "~", "minutes_z",     "b1",
  "Stress",          "~", "AttentionalControl", "c1",
  "Stress",          "~", "Rumination",    "c2",
  "Burnout",         "~", "Stress",        "d1",
  "Burnout",         "~", "Rumination",    "d2",
  "Burnout",         "~", "PSWQ_total",    "d3",
  "Burnout",         "~", "minutes_z",     "d4",
  "PSWQ_total",      "~", "minutes_z",     "e1"
)

get_std <- function(fit, lhs, op, rhs){
  pe <- parameterEstimates(fit, standardized = TRUE)
  row <- pe[pe$lhs==lhs & pe$op==op & pe$rhs==rhs, ]
  if (nrow(row)) return(row$std.all[1]) else return(NA_real_)
}

path_cmp <- paths_of_interest %>%
  rowwise() %>%
  mutate(
    Std_Orig = get_std(fit_phase3_orig, lhs, op, rhs),
    Std_Win  = get_std(fit_phase3_win,  lhs, op, rhs)
  ) %>% ungroup()
```

```
print(path_cmp, n = nrow(path_cmp))
#write_csv(path_cmp, "phase3_path_compare_original_vs_winsor3to2.csv")
# 90% CI for RMSEA
fitMeasures(fit_phase3_win, c("rmsea.ci.lower","rmsea.ci.upper"))

# R² for each endogenous latent variable
inspect(fit_phase3_win, "r2")

#Phase 4 Focused meditation only
# 1. Keep only focused-only meditators
practice_data_focused <- practice_data %>%
  filter(Type_raw == "Focused meditation (focusing on your breath / a mantra or phrase etc).")
# 2. Winsorize (|z| > 3 moved back to ±2SD)
obs_vars_phase4 <- c(
  "alerting_z","orienting_z","conflict_z",      # ANT indicators
  "brooding","reflection",                      # Rumination indicators
  "PSS_total",                                  # Stress
  "BAT_exhaustion","BAT_mental_dist",
  "BAT_cognitive_imp","BAT_emotional_imp",      # Burnout indicators
  "PSWQ_total",                                 # Worry
  "minutes_z"                                   # Mindfulness predictor
)
obs_vars_phase4 <- intersect(obs_vars_phase4, names(practice_data_focused))
```

```
winsorize_3to2sd <- function(x) {
  if (!is.numeric(x)) return(x)
  m <- mean(x, na.rm = TRUE)
  s <- sd(x, na.rm = TRUE)
  if (!is.finite(m) || !is.finite(s) || s == 0) return(x)
  z <- (x - m) / s
  lower_cap <- m - 2*s
  upper_cap <- m + 2*s
  x[is.finite(z) & z >  3] <- upper_cap
  x[is.finite(z) & z < -3] <- lower_cap
  x
}

practice_data_focused_win <- practice_data_focused %>%
  mutate(across(all_of(obs_vars_phase4), winsorize_3to2sd))

# 3. Fit SEM on winsorised focused meditators only
fit_phase4_win <- sem(
  model_prereg_minutes,
  data      = practice_data_focused_win,
  missing   = "ML",
  estimator = "MLR",
  std.lv    = TRUE,
  fixed.x   = FALSE
```

```
)
# 4. Fit indices
fitMeasures(fit_phase4_win,
c("chisq","df","pvalue","cfi","tli","rmsea","srmr","aic","bic",
                    "rmsea.ci.lower","rmsea.ci.upper"))
# 5. Path estimates (standardized)
parameterEstimates(fit_phase4_win, standardized = TRUE) %>%
  filter(op == "~") %>%
  select(lhs, op, rhs, est, se, z, pvalue, std.all)

# 6. R² for endogenous variables
inspect(fit_phase4_win, "r2")

# SEM Assumption Checks for Phase 3 and Phase 4

library(ggplot2)
library(lmtest)
library(gvlma)
# Function to run all assumption checks on observed DVs
check_sem_assumptions <- function(fit, data, phase_label, dvs, pdf_file) {
  cat("\n============================\n")
  cat("Assumption checks for", phase_label, "\n")
  cat("============================\n")

  # Open PDF device for plots
```

```
pdf(pdf_file, width = 7, height = 5)

for (dv in dvs) {
 cat("\n---- Dependent Variable:", dv, "----\n")

 # Pick predictors
 predictors <- c("minutes_z", "PSWQ_total", "brooding", "reflection")
 predictors <- intersect(predictors, colnames(data))
 if (length(predictors) == 0) next

 # Build linear model
 f <- as.formula(paste(dv, "~", paste(predictors, collapse = " + ")))
 lm_model <- lm(f, data = data)

 # Residuals + fitted
 df_plot <- data.frame(
  Fitted = fitted(lm_model),
  Residuals = resid(lm_model)
 )

 # 1. Scatterplots DV vs predictors
 for (pred in predictors) {
  p_scatter <- ggplot(data, aes_string(x = pred, y = dv)) +
   geom_point(alpha = 0.6) +
   geom_smooth(method = "lm", se = FALSE, color = "blue") +
```

```
    theme_minimal() +
    labs(title = paste("Scatterplot:", dv, "vs", pred, "-", phase_label))
  print(p_scatter)
}

# 2. Residuals vs Fitted
p_resid <- ggplot(df_plot, aes(x = Fitted, y = Residuals)) +
  geom_point(alpha = 0.6) +
  geom_hline(yintercept = 0, linetype = "dashed", color = "red") +
  theme_minimal() +
  labs(title = paste("Residuals vs Fitted:", dv, "-", phase_label))
print(p_resid)

# 3. Histogram of residuals
p_hist <- ggplot(df_plot, aes(x = Residuals)) +
  geom_histogram(color = "white", fill = "skyblue", bins = 20) +
  theme_minimal() +
  labs(title = paste("Histogram of Residuals:", dv, "-", phase_label))
print(p_hist)

# 4. QQ plot of residuals
qqnorm(resid(lm_model), main = paste("QQ Plot of Residuals:", dv, "-",
phase_label))
qqline(resid(lm_model), col = "red")
```

```
  # 5. Durbin-Watson Test
  cat("\nDurbin-Watson Test:\n")
  print(dwtest(lm_model))

  # 6. Breusch-Pagan Test
  cat("\nBreusch-Pagan Test:\n")
  print(bptest(lm_model))

  # 7. GVLMA global test
  cat("\nGVLMA Results:\n")
  print(gvlma(lm_model))
 }

 dev.off()
 cat("\nPlots saved to:", pdf_file, "\n")
}
# Run for Phase 3 (all practitioners, winsorized data)
phase3_dvs <- c("PSS_total", "brooding", "reflection",
                "BAT_exhaustion", "BAT_mental_dist",
                "BAT_cognitive_imp", "BAT_emotional_imp")

check_sem_assumptions(
 fit_phase3_win,
 practice_data_winsor3to2,
 "Phase 3 (All Mindfulness Practitioners)",
```

```
  phase3_dvs,
  "phase3_sem_assumptions.pdf"
)
# Run for Phase 4 (focused-only meditators, winsorized)
phase4_dvs <- phase3_dvs

check_sem_assumptions(
  fit_phase4_win,
  practice_data_focused_win,
  "Phase 4 (Focused Meditation Only)",
  phase4_dvs,
  "phase4_sem_assumptions.pdf"
```

Appendix XV. Study 4 - RStudio Outputs

```
> # --------------------------
> # Packages
> # --------------------------
> # install.packages("semPlot") # optional
> library(dplyr)
> library(tidyr)
> library(purrr)
> library(lavaan)
>
> # --------------------------
> # Expect these objects to exist:
> #   qual_raw  <- <your Qualtrics dataframe>
> #   ant_raw   <- <your ANT dataframe>
> # --------------------------
>
> # --------------------------
> # Qualtrics: renames (match your sheet)
> # --------------------------
> colnames(qual_raw)[34] <- "Frequency"
> colnames(qual_raw)[35] <- "Duration"
> colnames(qual_raw)[32] <- "Type_raw"
>
> # --------------------------
> # Response mappings
> # --------------------------
> pss_map <- c("Never"=0, "Almost Never"=1, "Sometimes"=2, "Fairly Often"=3,
"Very Often"=4)
> bat_map <- c("Never"=1, "Rarely"=2, "Sometimes"=3, "Often"=4, "Always"=5)
> rrs_map <- c("Almost Never"=1, "Sometimes"=2, "Often"=3, "Almost Always"=4)
> pswq_map <- c(
+    "Not at all typical of me"=1, "Rarely typical of me"=2, "Somewhat typical of
me"=3,
+    "Often typical of me"=4, "Very typical of me"=5
+ )
>
> # --------------------------
> # Column index sets (per your sheet)
> # --------------------------
> pss_idx <- 36:45
> pss_rev <- c(38, 39, 41, 42)
>
> bat_idx <- 46:68
> bat_ex <- 46:53
> bat_md <- 54:58
> bat_ci <- 59:63
```

```
> bat_ei <- 64:68
>
> # Secondary—now split into the two parts you asked for
> bat_pd  <- 69:72  # psych distress
> bat_psc <- 73:76  # psychosomatic
> bat_secondary <- 69:76  # (optional composite, not used in SEM)
>
> rrs_idx <- 77:98
> pswq_idx <- 99:114
> pswq_rev <- c(99, 101, 104, 105, 107)
>
> # --------------------------
> # Qualtrics scoring
> # --------------------------
> qual_scored <- qual_raw %>%
+   mutate(
+     Frequency = as.numeric(Frequency),
+     Duration  = as.numeric(Duration),
+     Type_clean = case_when(
+       is.na(Type_raw) ~ NA_character_,
+       grepl("No", Type_raw, ignore.case = TRUE) ~ "None",
+       grepl("Focused", Type_raw, ignore.case = TRUE) &
+         !grepl("Mindful movement|Other", Type_raw, ignore.case = TRUE) ~
"Focused",
+       grepl("Mindful movement", Type_raw, ignore.case = TRUE) &
+         !grepl("Focused|Other", Type_raw, ignore.case = TRUE) ~ "Movement",
+       grepl("Other", Type_raw, ignore.case = TRUE) &
+         !grepl("Focused|Mindful movement", Type_raw, ignore.case = TRUE) ~
"Other",
+       TRUE ~ "Mixed"
+     )
+   ) %>%
+   mutate(across(all_of(pss_idx),  ~ as.numeric(recode(as.character(.x),
!!!pss_map,  .default = NA_real_)))) %>%
+   mutate(across(all_of(pswq_idx), ~ as.numeric(recode(as.character(.x),
!!!pswq_map, .default = NA_real_)))) %>%
+   mutate(across(all_of(bat_idx),  ~ as.numeric(recode(as.character(.x),
!!!bat_map,  .default = NA_real_)))) %>%
+   mutate(across(all_of(bat_secondary), ~ as.numeric(recode(as.character(.x),
!!!bat_map, .default = NA_real_)))) %>%
+   mutate(across(all_of(rrs_idx), ~ as.numeric(recode(as.character(.x),
!!!rrs_map, .default = NA_real_)))) %>%
+   mutate(across(all_of(pss_rev),  ~ 4 - .x)) %>%
+   mutate(across(all_of(pswq_rev), ~ 6 - .x)) %>%
+   mutate(
+     brooding   = rowSums(across(all_of(rrs_idx[1:5])),  na.rm = TRUE),
+     reflection = rowSums(across(all_of(rrs_idx[6:10])), na.rm = TRUE)
```

```
+   ) %>%
+   rowwise() %>%
+   mutate(
+     PSS_total = sum(c_across(all_of(pss_idx)), na.rm = TRUE),
+
+     # BAT subscales (kept; secondary is split and BOTH parts are available)
+     BAT_total         = mean(c_across(all_of(bat_idx)), na.rm = TRUE),
+     BAT_exhaustion    = mean(c_across(all_of(bat_ex)),  na.rm = TRUE),
+     BAT_mental_dist   = mean(c_across(all_of(bat_md)),  na.rm = TRUE),
+     BAT_cognitive_imp = mean(c_across(all_of(bat_ci)),  na.rm = TRUE),
+     BAT_emotional_imp = mean(c_across(all_of(bat_ei)),  na.rm = TRUE),
+     BAT_psych_distress = mean(c_across(all_of(bat_pd)), na.rm = TRUE),
+     BAT_psychosomatic = mean(c_across(all_of(bat_psc)), na.rm = TRUE),
+
+     # Optional secondary composite — computed but NOT used in the model
+     BAT_secondary     = mean(c_across(all_of(bat_secondary)), na.rm = TRUE),
+
+     # Totals
+     RRS_total  = sum(c_across(all_of(rrs_idx)),  na.rm = TRUE),
+     PSWQ_total = sum(c_across(all_of(pswq_idx)), na.rm = TRUE)
+   ) %>%
+   ungroup()
>
> # ---------------------------
> # ANT scoring (fixed; uses numeric flanker = 1/2/3)
> # ---------------------------
> # 1. Filter out junk rows (cueCondition 0, flankerCondition 0)
> ant_means <- ant_raw %>%
+   filter(cueCondition %in% c("NoCue", "DoubleCue", "CenterCue",
"SpatialCue"),
+          flankerCondition %in% c(1, 2, 3)) %>%
+   mutate(
+     latency = as.numeric(latency),
+     correct = as.numeric(correct)
+   ) %>%
+   group_by(subject, cueCondition, flankerCondition) %>%
+   summarise(mean_rt = mean(latency, na.rm = TRUE), .groups = "drop")
>
> # 2. Your existing scoring code
> # Alerting: NoCue - DoubleCue
> alerting_scores <- ant_means %>%
+   group_by(subject, cueCondition) %>%
+   summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
+   pivot_wider(names_from = cueCondition, values_from = mean_rt) %>%
+   mutate(alerting = NoCue - DoubleCue) %>%
+   select(subject, alerting)
>
```

```
> # Orienting: CenterCue - SpatialCue
> orienting_scores <- ant_means %>%
+   group_by(subject, cueCondition) %>%
+   summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
+   pivot_wider(names_from = cueCondition, values_from = mean_rt) %>%
+   mutate(orienting = CenterCue - SpatialCue) %>%
+   select(subject, orienting)
>
> # Conflict: Incongruent (3) - Congruent (1)
> conflict_scores <- ant_means %>%
+   group_by(subject, flankerCondition) %>%
+   summarise(mean_rt = mean(mean_rt), .groups = "drop") %>%
+   pivot_wider(names_from = flankerCondition, values_from = mean_rt) %>%
+   mutate(conflict = `3` - `1`) %>%
+   select(subject, conflict)
> # Merge ANT scores
> ant_scores <- reduce(list(alerting_scores, orienting_scores, conflict_scores),
+                      full_join, by = "subject")
>
> # ---------------------------
> # Merge Qualtrics + ANT
> # ---------------------------
> qual_scored <- qual_scored %>%
+   mutate(ResponseID = as.character(.data[[colnames(qual_raw)[9]]]))
> combined_data <- left_join(
+   qual_scored,
+   ant_scores %>% mutate(subject = as.character(subject)),
+   by = c("ResponseID" = "subject")
+ )
>
> # ---------------------------
> # Z-scores for SEM predictors
> # ---------------------------
> combined_data <- combined_data %>%
+   mutate(
+     alerting_z  = scale(alerting)[,1],
+     orienting_z = scale(orienting)[,1],
+     conflict_z  = scale(conflict)[,1],
+     Frequency_z = scale(Frequency)[,1],
+     Duration_z  = scale(Duration)[,1]
+   )
>
> # Dummies for Type_clean
> combined_data <- combined_data %>%
+   mutate(
+     Type_Focused  = ifelse(Type_clean == "Focused", 1, 0),
+     Type_Movement = ifelse(Type_clean == "Movement", 1, 0),
```

```
+       Type_Other    = ifelse(Type_clean == "Other",    1, 0),
+       Type_Mixed    = ifelse(Type_clean == "Mixed",    1, 0)
+       # "None" is the reference
+    )
>
> #
```

**Phase 1 – Test Prereg theoretical model**

```
---------------------------
> # THEORY MODEL (UNCHANGED / PREREG)
> # ---------------------------
> full_model <- '
+   # Measurement
+   Mindfulness       =~ Frequency_z + Duration_z + Type_Focused +
Type_Movement + Type_Other + Type_Mixed
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination        =~ brooding + reflection
+   Stress           =~ PSS_total
+   Burnout           =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
+                   BAT_emotional_imp + BAT_psych_distress + BAT_psychosomatic
+
+   # Structural (as preregistered)
+   AttentionalControl ~ Mindfulness
+   Rumination        ~ Mindfulness + AttentionalControl + PSWQ_total
+   Stress           ~ AttentionalControl + Rumination
+   Burnout           ~ Stress + Rumination + PSWQ_total + Mindfulness
+   PSWQ_total        ~ Mindfulness
+ '
>
> # ---------------------------
> # Fit
> # ---------------------------
> fit_full <- sem(full_model, data = combined_data, missing = "ML", estimator =
"MLR")
Warning messages:
1: lavaan->lav_data_full():
  some observed variances are (at least) a factor 1000 times larger than others;
use varTable(fit) to investigate
2: lavaan->lav_lavaan_step11_estoptim():
  Model estimation FAILED! Returning starting values.
> summary(fit_full, fit.measures = TRUE, standardized = TRUE, rsquare = TRUE)
lavaan 0.6-19 did NOT end normally after 1363 iterations
** WARNING ** Estimates below are most likely unreliable

 Estimator                         ML
 Optimization method               NLMINB
```

```
  Number of model parameters                66

  Number of observations                   276
  Number of missing patterns                 5


Parameter Estimates:

  Standard errors                     Sandwich
  Information bread                   Observed
  Observed information based on       Hessian

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
 Mindfulness =~
   Frequency_z        1.000                              0.002   0.002
   Duration_z        -5.566       NA                    -0.011  -0.011
   Type_Focused       4.173       NA                     0.008   0.018
   Type_Movement      2.007       NA                     0.004   0.013
   Type_Other         0.504       NA                     0.001   0.005
   Type_Mixed         4.404       NA                     0.009   0.023
 AttentionalControl =~
   alerting_z         1.000                             NA      NA
   orienting_z        0.049       NA                    NA      NA
   conflict_z         0.366       NA                    NA      NA
 Rumination =~
   brooding           1.000                             2.879   0.817
   reflection         1.363       NA                    3.923   0.922
 Stress =~
   PSS_total          1.000                             2.755   1.000
 Burnout =~
   BAT_exhaustion     1.000                             0.859   0.882
   BAT_mental_dst     0.827       NA                    0.710   0.765
   BAT_cognitv_mp     0.885       NA                    0.760   0.823
   BAT_emotinl_mp     0.841       NA                    0.723   0.823
   BAT_psych_dstr     0.802       NA                    0.689   0.735
   BAT_psychosmtc     0.772       NA                    0.663   0.676

Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
 AttentionalControl ~
   Mindfulness       -5.149       NA                    NA      NA
 Rumination ~
   Mindfulness        9.773       NA                    0.007   0.007
   AttentinlCntrl     0.626       NA                    NA      NA
   PSWQ_total         0.186       NA                    0.065   0.554
 Stress ~
```

```
    AttentinlCntrl       1.650      NA                NA      NA
    Rumination           0.536      NA              0.560   0.560
  Burnout ~
    Stress               0.017      NA              0.055   0.055
    Rumination           0.233      NA              0.780   0.780
    PSWQ_total          -0.005      NA             -0.005  -0.047
    Mindfulness          5.305      NA              0.013   0.013
  PSWQ_total ~
    Mindfulness      45831.629      NA             92.775  10.834

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    .Frequency_z     -0.000       NA               -0.000  -0.000
    .Duration_z       0.000       NA                0.000   0.000
    .Type_Focused     0.297       NA                0.297   0.650
    .Type_Movement    0.109       NA                0.109   0.349
    .Type_Other       0.036       NA                0.036   0.194
    .Type_Mixed       0.185       NA                0.185   0.476
    .alerting_z       0.009       NA                0.009   0.009
    .orienting_z      0.000       NA                0.000   0.000
    .conflict_z       0.003       NA                0.003   0.003
    .brooding         1.184       NA                1.184   0.336
    .reflection       2.916       NA                2.916   0.685
    .PSS_total       15.834       NA               15.834   5.748
    .BAT_exhaustion   1.667       NA                1.667   1.712
    .BAT_mental_dst   1.484       NA                1.484   1.600
    .BAT_cognitv_mp   1.279       NA                1.279   1.386
    .BAT_emotinl_mp   1.026       NA                1.026   1.169
    .BAT_psych_dstr   2.261       NA                2.261   2.413
    .BAT_psychosmtc   1.433       NA                1.433   1.460
    .PSWQ_total      31.862       NA               31.862   3.721

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
    .Frequency_z      0.996       NA                0.996   1.000
    .Duration_z       0.998       NA                0.998   1.000
    .Type_Focused     0.209       NA                0.209   1.000
    .Type_Movement    0.097       NA                0.097   1.000
    .Type_Other       0.035       NA                0.035   1.000
    .Type_Mixed       0.151       NA                0.151   0.999
    .alerting_z       1.209       NA                1.209   1.205
    .orienting_z      0.995       NA                0.995   1.001
    .conflict_z       1.024       NA                1.024   1.028
    .brooding         4.118       NA                4.118   0.332
    .reflection       2.718       NA                2.718   0.150
    .PSS_total        0.000                         0.000   0.000
    .BAT_exhaustion   0.211       NA                0.211   0.223
```

```
  .BAT_mental_dst    0.357      NA               0.357    0.415
  .BAT_cognitv_mp    0.275      NA               0.275    0.322
  .BAT_emotinl_mp    0.249      NA               0.249    0.323
  .BAT_psych_dstr    0.404      NA               0.404    0.460
  .BAT_psychosmtc    0.523      NA               0.523    0.544
  .PSWQ_total    -8533.806      NA           -8533.806 -116.366
   Mindfulness       0.000      NA               1.000    1.000
  .AttentinlCntrl   -0.206      NA                  NA       NA
  .Rumination        5.368      NA               0.648    0.648
  .Stress            6.317      NA               0.833    0.833
  .Burnout           0.206      NA               0.280    0.280

R-Square:
               Estimate
   Frequency_z       0.000
   Duration_z        0.000
   Type_Focused      0.000
   Type_Movement     0.000
   Type_Other        0.000
   Type_Mixed        0.001
   alerting_z       -0.205
   orienting_z      -0.001
   conflict_z       -0.028
   brooding          0.668
   reflection        0.850
   PSS_total         1.000
   BAT_exhaustion    0.777
   BAT_mental_dst    0.585
   BAT_cognitv_mp    0.678
   BAT_emotinl_mp    0.677
   BAT_psych_dstr    0.540
   BAT_psychosmtc    0.456
   PSWQ_total           NA
   AttentinlCntrl       NA
   Rumination        0.352
   Stress            0.167
   Burnout           0.720

Warning message:
lavaan->lav_object_summary():
  fit measures not available if model did not converge
```

**Phase 2 – step by step remove weakest factor**

```
> #Remove type_movement (weakest)
>
>
```

```
> # --- STEP A (fixed names + remove Type_Movement) ----------------------------
> model_obs_no_movement <- '
+   # Measurement (names aligned with your dataset)
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
+                       BAT_emotional_imp + BAT_psych_distress + BAT_psychosomatic
+
+   # Structural (Mindfulness proxies as observed predictors; Type_Movement
removed)
+   AttentionalControl ~ Frequency_z + Duration_z + Type_Focused + Type_Other +
Type_Mixed
+   Rumination       ~ Frequency_z + Duration_z + Type_Focused + Type_Other +
Type_Mixed +
+                      AttentionalControl + PSWQ_total
+   Stress           ~ AttentionalControl + Rumination
+   Burnout          ~ Stress + Rumination + PSWQ_total +
+                      Frequency_z + Duration_z + Type_Focused + Type_Other + Type_Mixed
+   PSWQ_total       ~ Frequency_z + Duration_z + Type_Focused + Type_Other +
Type_Mixed
+ '
>
> # --- STEP B: Fit the updated model ------------------------------------------
> fit_obs_no_movement <- sem(
+   model_obs_no_movement,
+   data     = combined_data,
+   missing  = "ML",
+   estimator = "MLR",
+   fixed.x  = FALSE,
+   std.lv   = TRUE
+ )
Warning messages:
1: lavaan->lav_data_full():
  some observed variances are (at least) a factor 1000 times larger than others;
use varTable(fit) to investigate
2: lavaan->lav_model_vcov():
  The variance-covariance matrix of the estimated parameters (vcov) does not
appear to be positive definite! The smallest
  eigenvalue (= -4.614436e-05) is smaller than zero. This may be a symptom that
the model is not identified.
3: lavaan->lav_object_post_check():
  some estimated ov variances are negative
>
> # Quick fit check (optional)
> fitMeasures(fit_obs_no_movement, c("cfi","tli","rmsea","srmr"))
  cfi   tli rmsea  srmr
```

```
0.896 0.858 0.077 0.055
Warning messages:
1: lavaan->lav_fit_cfi_lavobject():
  computation of robust CFI failed.
2: lavaan->lav_fit_rmsea_lavobject():
  computation of robust RMSEA failed.
>
> # --- STEP C: Recompute the weak table ---------------------------------------
> library(dplyr)
>
> pe2 <- parameterEstimates(fit_obs_no_movement, standardized = TRUE)
>
> mind_vars2 <-
c("Frequency_z","Duration_z","Type_Focused","Type_Other","Type_Mixed")
>
> struct2 <- pe2 %>%
+   filter(
+     op == "~",
+     lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
+     rhs %in% mind_vars2
+   ) %>%
+   select(lhs, rhs, std = std.all, p = pvalue)
>
> weak_table2 <- struct2 %>%
+   group_by(rhs) %>%
+   summarise(
+     max_abs_std = max(abs(std), na.rm = TRUE),
+     any_sig    = any(p < .05, na.rm = TRUE),
+     .groups = "drop"
+   ) %>%
+   arrange(max_abs_std)
>
> # Show results
> weak_table2
# A tibble: 5 × 3
  rhs        max_abs_std any_sig
  <chr>            <dbl> <lgl>
1 Type_Other       0.0644 FALSE
2 Frequency_z      0.0880 TRUE
3 Type_Focused     0.113  TRUE
4 Duration_z       0.142  FALSE
5 Type_Mixed       0.205  TRUE
> struct2 %>% arrange(lhs, desc(abs(std)))
             lhs        rhs    std    p
1  AttentionalControl Type_Focused -0.007 0.106
2  AttentionalControl   Duration_z -0.006 0.069
```

```
3  AttentionalControl  Type_Other -0.001 0.522
4  AttentionalControl  Type_Mixed -0.001 0.750
5  AttentionalControl  Frequency_z  0.000 0.684
6           Burnout Type_Focused -0.098 0.029
7           Burnout   Type_Other  0.047 0.168
8           Burnout   Type_Mixed -0.040 0.298
9           Burnout  Frequency_z -0.021 0.670
10           Burnout   Duration_z -0.002 0.968
11        PSWQ_total   Type_Mixed  0.205 0.000
12        PSWQ_total   Duration_z -0.142 0.092
13        PSWQ_total Type_Focused  0.113 0.085
14        PSWQ_total   Type_Other  0.056 0.295
15        PSWQ_total  Frequency_z -0.008 0.856
16        Rumination  Frequency_z  0.088 0.015
17        Rumination Type_Focused  0.088 0.184
18        Rumination   Type_Other -0.064 0.147
19        Rumination   Duration_z  0.061 0.448
20        Rumination   Type_Mixed -0.008 0.889
>
> #Remove type_other (next weakest)
>
> # --- STEP D: Remove Type_Other as well -------------------------------------
> model_obs_no_move_other <- '
+   # Measurement (unchanged)
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
+                       BAT_emotional_imp + BAT_psych_distress + BAT_psychosomatic
+
+   # Structural (Mindfulness proxies as observed predictors; Type_Movement &
Type_Other removed)
+   AttentionalControl ~ Frequency_z + Duration_z + Type_Focused + Type_Mixed
+   Rumination       ~ Frequency_z + Duration_z + Type_Focused + Type_Mixed +
+                      AttentionalControl + PSWQ_total
+   Stress           ~ AttentionalControl + Rumination
+   Burnout          ~ Stress + Rumination + PSWQ_total +
+                      Frequency_z + Duration_z + Type_Focused + Type_Mixed
+   PSWQ_total       ~ Frequency_z + Duration_z + Type_Focused + Type_Mixed
+ '
>
> fit_obs_no_move_other <- sem(
+    model_obs_no_move_other,
+    data     = combined_data,
+    missing   = "ML",
+    estimator = "MLR",
+    fixed.x   = FALSE,
```

```
+    std.lv   = TRUE
+ )
Warning messages:
1: lavaan->lav_model_vcov():
  The variance-covariance matrix of the estimated parameters (vcov) does not
appear to be positive definite! The smallest
  eigenvalue (= -1.018498e-04) is smaller than zero. This may be a symptom that
the model is not identified.
2: lavaan->lav_object_post_check():
  some estimated ov variances are negative
>
> # Quick fit snapshot
> fitMeasures(fit_obs_no_move_other, c("cfi","tli","rmsea","srmr"))
  cfi   tli rmsea  srmr
0.896 0.859 0.080 0.057
Warning messages:
1: lavaan->lav_fit_cfi_lavobject():
  computation of robust CFI failed.
2: lavaan->lav_fit_rmsea_lavobject():
  computation of robust RMSEA failed.
>
> # --- Updated weak-table after dropping Type_Other ----------------------------
> pe3 <- parameterEstimates(fit_obs_no_move_other, standardized = TRUE)
>
> mind_vars3 <- c("Frequency_z","Duration_z","Type_Focused","Type_Mixed")
>
> struct3 <- pe3 %>%
+    dplyr::filter(
+       op == "~",
+       lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
+       rhs %in% mind_vars3
+    ) %>%
+    dplyr::select(lhs, rhs, std = std.all, p = pvalue)
>
> weak_table3 <- struct3 %>%
+    dplyr::group_by(rhs) %>%
+    dplyr::summarise(
+       max_abs_std = max(abs(std), na.rm = TRUE),
+       any_sig     = any(p < .05, na.rm = TRUE),
+       .groups = "drop"
+    ) %>%
+    dplyr::arrange(max_abs_std)
>
> weak_table3
# A tibble: 4 × 3
  rhs        max_abs_std any_sig
```

```
 <chr>          <dbl> <lgl>
1 Frequency_z      0.0836 TRUE
2 Type_Focused     0.108  TRUE
3 Duration_z       0.143  FALSE
4 Type_Mixed       0.201  TRUE
> struct3 %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))
            lhs        rhs    std    p
1  AttentionalControl Type_Focused -0.006 0.109
2  AttentionalControl   Duration_z -0.005 0.072
3  AttentionalControl  Frequency_z -0.001 0.599
4  AttentionalControl   Type_Mixed  0.000 0.830
5           Burnout Type_Focused -0.108 0.017
6           Burnout   Type_Mixed -0.048 0.218
7           Burnout  Frequency_z -0.013 0.791
8           Burnout   Duration_z -0.007 0.896
9        PSWQ_total   Type_Mixed  0.201 0.000
10       PSWQ_total   Duration_z -0.143 0.087
11       PSWQ_total Type_Focused  0.108 0.088
12       PSWQ_total  Frequency_z -0.007 0.866
13       Rumination Type_Focused  0.103 0.104
14       Rumination  Frequency_z  0.084 0.014
15       Rumination   Duration_z  0.064 0.422
16       Rumination   Type_Mixed  0.005 0.924
>
>
> #Next remove type_focused (frequency was actual next weakest but due to
theory remove all ‘type’ first).
>
> # --- STEP E (Types only): Remove Type_Focused as well ------------------------
> model_obs_types_only_drop_focused <- '
+   # Measurement (unchanged)
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
+                  BAT_emotional_imp + BAT_psych_distress + BAT_psychosomatic
+
+   # Structural (Mindfulness proxies as observed predictors; Type_Movement,
Type_Other, Type_Focused removed)
+   AttentionalControl ~ Frequency_z + Duration_z + Type_Mixed
+   Rumination       ~ Frequency_z + Duration_z + Type_Mixed +
+                  AttentionalControl + PSWQ_total
+   Stress           ~ AttentionalControl + Rumination
+   Burnout          ~ Stress + Rumination + PSWQ_total +
+                  Frequency_z + Duration_z + Type_Mixed
+   PSWQ_total       ~ Frequency_z + Duration_z + Type_Mixed
+ '
```

```
>
> fit_obs_types_only_drop_focused <- sem(
+    model_obs_types_only_drop_focused,
+    data     = combined_data,
+    missing   = "ML",
+    estimator = "MLR",
+    fixed.x   = FALSE,
+    std.lv    = TRUE
+ )
Warning message:
lavaan->lav_model_vcov():
  The variance-covariance matrix of the estimated parameters (vcov) does not
appear to be positive definite! The smallest
  eigenvalue (= -3.814033e-19) is smaller than zero. This may be a symptom that
the model is not identified.
>
> # Quick fit snapshot
> fitMeasures(fit_obs_types_only_drop_focused, c("cfi","tli","rmsea","srmr"))
  cfi   tli rmsea  srmr
0.895 0.859 0.084 0.052
>
> # --- Updated weak table (mindfulness proxies that remain) ----------------------
> pe_next <- parameterEstimates(fit_obs_types_only_drop_focused, standardized
= TRUE)
>
> mind_vars_next <- c("Frequency_z","Duration_z","Type_Mixed")
>
> struct_next <- pe_next %>%
+    dplyr::filter(
+       op == "~",
+       lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
+       rhs %in% mind_vars_next
+    ) %>%
+    dplyr::select(lhs, rhs, std = std.all, p = pvalue)
>
> weak_table_next <- struct_next %>%
+    dplyr::group_by(rhs) %>%
+    dplyr::summarise(
+       max_abs_std = max(abs(std), na.rm = TRUE),
+       any_sig     = any(p < .05, na.rm = TRUE),
+       .groups = "drop"
+    ) %>%
+    dplyr::arrange(max_abs_std)
>
> weak_table_next
# A tibble: 3 × 3
```

```
 rhs       max_abs_std any_sig
 <chr>           <dbl> <lgl>
1 Frequency_z     0.0671 FALSE
2 Type_Mixed      0.170  TRUE
3 Duration_z      0.190  FALSE
> struct_next %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))
            lhs       rhs   std    p
1  AttentionalControl  Duration_z -0.190 0.511
2  AttentionalControl  Type_Mixed  0.049 0.593
3  AttentionalControl Frequency_z -0.001 0.988
4           Burnout  Duration_z  0.019 0.701
5           Burnout  Type_Mixed -0.017 0.629
6           Burnout Frequency_z  0.001 0.985
7        PSWQ_total  Type_Mixed  0.170 0.001
8        PSWQ_total  Duration_z -0.126 0.132
9        PSWQ_total Frequency_z -0.002 0.951
10        Rumination Frequency_z  0.067 0.064
11        Rumination  Duration_z  0.024 0.803
12        Rumination  Type_Mixed -0.024 0.629
>
> Remove type_mixed
Error: unexpected symbol in "Remove type_mixed"
> #Remove type_mixed
>
> # --- STEP F (Types only): Remove Type_Mixed as well -------------------------
> model_obs_types_only_drop_mixed <- '
+   # Measurement (unchanged)
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
+                       BAT_emotional_imp + BAT_psych_distress + BAT_psychosomatic
+
+   # Structural (Mindfulness proxies as observed predictors; all Type vars removed)
+   AttentionalControl ~ Frequency_z + Duration_z
+   Rumination       ~ Frequency_z + Duration_z +
+                      AttentionalControl + PSWQ_total
+   Stress           ~ AttentionalControl + Rumination
+   Burnout          ~ Stress + Rumination + PSWQ_total +
+                      Frequency_z + Duration_z
+   PSWQ_total       ~ Frequency_z + Duration_z
+ '
>
> fit_obs_types_only_drop_mixed <- sem(
+    model_obs_types_only_drop_mixed,
+    data     = combined_data,
+    missing  = "ML",
```

```
+    estimator = "MLR",
+    fixed.x   = FALSE,
+    std.lv    = TRUE
+ )
>
> # Quick fit snapshot
> fitMeasures(fit_obs_types_only_drop_mixed, c("cfi","tli","rmsea","srmr"))
  cfi   tli rmsea  srmr
0.892 0.856 0.090 0.055
>
> # --- Updated weak table (mindfulness proxies that remain) ----------------------
> pe_next2 <- parameterEstimates(fit_obs_types_only_drop_mixed, standardized
= TRUE)
>
> mind_vars_next2 <- c("Frequency_z","Duration_z")
>
> struct_next2 <- pe_next2 %>%
+    dplyr::filter(
+       op == "~",
+       lhs %in%
c("AttentionalControl","Rumination","Stress","Burnout","PSWQ_total"),
+       rhs %in% mind_vars_next2
+    ) %>%
+    dplyr::select(lhs, rhs, std = std.all, p = pvalue)
>
> weak_table_next2 <- struct_next2 %>%
+    dplyr::group_by(rhs) %>%
+    dplyr::summarise(
+       max_abs_std = max(abs(std), na.rm = TRUE),
+       any_sig     = any(p < .05, na.rm = TRUE),
+       .groups = "drop"
+    ) %>%
+    dplyr::arrange(max_abs_std)
>
> weak_table_next2
# A tibble: 2 × 3
  rhs       max_abs_std any_sig
  <chr>           <dbl> <lgl>
1 Frequency_z     0.0665 FALSE
2 Duration_z      0.165  FALSE
> struct_next2 %>% dplyr::arrange(lhs, dplyr::desc(abs(std)))
            lhs       rhs   std    p
1 AttentionalControl  Duration_z -0.165 0.550
2 AttentionalControl Frequency_z -0.008 0.793
3         Burnout  Duration_z  0.019 0.687
4         Burnout Frequency_z  0.001 0.977
5       PSWQ_total  Duration_z -0.096 0.275
```

```
6       PSWQ_total Frequency_z  0.000 0.992
7       Rumination Frequency_z  0.066 0.066
8       Rumination  Duration_z  0.023 0.809
```

###mindfulness makes no affect. But there is a link between rumination and stress. Stress and burnout. Worry and rumination. PC path supported. Worry to rumination to stress to burnout. ANT not useable due to conflict measure. Real data that is odd not calculation.

**Phase 3 (using composite factor of self-reported mindfulness per minute)**

Use composite factor with all sample

test with mindfulness minutes per week as a single variable in the model

```
> # 1) Create the composite
> combined_data <- combined_data %>%
+   mutate(
+     minutes_week = ifelse(is.finite(Frequency) & is.finite(Duration),
+                           pmax(Frequency, 0) * pmax(Duration, 0), NA_real_),
+     minutes_z = as.numeric(scale(minutes_week))
+   )
>
> # (Optional but wise) Handle heavy skew / zeros:
> # combined_data <- combined_data %>%
> #   mutate(minutes_log = ifelse(!is.na(minutes_week), log1p(minutes_week),
NA_real_),
> #          minutes_log_z = as.numeric(scale(minutes_log)))
>
> # 2) Use minutes_z as the mindfulness predictor in your reduced model
> model_minutes <- '
+   # Measurement
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ 1*PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
BAT_emotional_imp
+
+   # Structural (replace Mindfulness with minutes_z)
+   Rumination ~ AttentionalControl + PSWQ_total + minutes_z
+   Stress     ~ Rumination + AttentionalControl
+   Burnout    ~ Stress + Rumination + PSWQ_total + minutes_z
+   PSWQ_total ~ minutes_z
+ '
>
> fit_minutes <- sem(model_minutes, data = combined_data, missing = "ML",
estimator = "MLR", std.lv = TRUE)
```

```
Warning message:
lavaan->lav_data_full():
  103 cases were deleted due to missing values in exogenous variable(s), while
fixed.x = TRUE.
> summary(fit_minutes, fit.measures = TRUE, standardized = TRUE)
lavaan 0.6-19 ended normally after 110 iterations

  Estimator                         ML
  Optimization method           NLMINB
  Number of model parameters        40

                                              Used       Total
  Number of observations                       173         276
  Number of missing patterns                     2

Model Test User Model:
                                            Standard     Scaled
  Test Statistic                           98.711     113.292
  Degrees of freedom                           48          48
  P-value (Chi-square)                      0.000       0.000
  Scaling correction factor                                0.871
    Yuan-Bentler correction (Mplus variant)

Model Test Baseline Model:

  Test statistic                          730.737     797.584
  Degrees of freedom                           66          66
  P-value                                   0.000       0.000
  Scaling correction factor                                0.916

User Model versus Baseline Model:

  Comparative Fit Index (CFI)               0.924       0.911
  Tucker-Lewis Index (TLI)                  0.895       0.877

  Robust Comparative Fit Index (CFI)                    0.942
  Robust Tucker-Lewis Index (TLI)                       0.920

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)         -2918.020   -2918.020
  Scaling correction factor                                2.560
    for the MLR correction
  Loglikelihood unrestricted model (H1) -2868.664   -2868.664
  Scaling correction factor                                1.639
    for the MLR correction
```

```
 Akaike (AIC)                              5916.040   5916.040
 Bayesian (BIC)                            6042.172   6042.172
 Sample-size adjusted Bayesian (SABIC)     5915.509   5915.509

Root Mean Square Error of Approximation:

 RMSEA                                     0.078      0.089
 90 Percent confidence interval - lower    0.056      0.066
 90 Percent confidence interval - upper    0.100      0.111
 P-value H_0: RMSEA <= 0.050               0.020      0.003
 P-value H_0: RMSEA >= 0.080               0.465      0.751

 Robust RMSEA                              0.068
 90 Percent confidence interval - lower    0.022
 90 Percent confidence interval - upper    0.103
 P-value H_0: Robust RMSEA <= 0.050        0.213
 P-value H_0: Robust RMSEA >= 0.080        0.305

Standardized Root Mean Square Residual:

 SRMR                                      0.073      0.073

Parameter Estimates:

 Standard errors                           Sandwich
 Information bread                         Observed
 Observed information based on             Hessian

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
 AttentionalControl =~
   alerting_z         0.037    0.073    0.509    0.611    0.037    0.052
   orienting_z       -0.049    0.055   -0.881    0.378   -0.049   -0.054
   conflict_z        -0.068    0.096   -0.710    0.478   -0.068   -0.068
 Rumination =~
   brooding           2.270    0.215   10.564    0.000    2.630    0.785
   reflection         3.006    0.219   13.742    0.000    3.481    0.896
 Stress =~
   PSS_total          1.000                      2.594    1.000
 Burnout =~
   BAT_exhaustion     0.441    0.051    8.652    0.000    0.660    0.802
   BAT_mental_dst     0.396    0.055    7.167    0.000    0.592    0.757
   BAT_cognitv_mp     0.441    0.059    7.512    0.000    0.659    0.787
   BAT_emotinl_mp     0.447    0.053    8.434    0.000    0.669    0.848

Regressions:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
```

```
 Rumination ~
  AttentinlCntrl  -0.113   0.160  -0.707   0.480  -0.098  -0.098
  PSWQ_total       0.081   0.021   3.926   0.000   0.070   0.488
  minutes_z        0.104   0.067   1.556   0.120   0.089   0.089
 Stress ~
  Rumination       1.110   0.307   3.618   0.000   0.496   0.496
  AttentinlCntrl   2.148   0.160  13.426   0.000   0.828   0.828
 Burnout ~
  Stress           0.039   0.037   1.057   0.290   0.068   0.068
  Rumination       0.820   0.180   4.563   0.000   0.635   0.635
  PSWQ_total       0.030   0.025   1.228   0.219   0.020   0.140
  minutes_z       -0.019   0.055  -0.348   0.728  -0.013  -0.013
 PSWQ_total ~
  minutes_z       -0.050   0.318  -0.158   0.875  -0.050  -0.007

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  .alerting_z       0.078    0.066    1.193    0.233    0.078    0.109
  .orienting_z      0.030    0.080    0.374    0.708    0.030    0.033
  .conflict_z       0.053    0.091    0.577    0.564    0.053    0.052
  .brooding         1.222    1.351    0.905    0.366    1.222    0.365
  .reflection       3.219    1.916    1.681    0.093    3.219    0.828
  .PSS_total       16.265    1.019   15.966    0.000   16.265    6.271
  .BAT_exhaustion   1.533    0.372    4.120    0.000    1.533    1.863
  .BAT_mental_dst   1.273    0.344    3.700    0.000    1.273    1.628
  .BAT_cognitv_mp   0.960    0.368    2.606    0.009    0.960    1.146
  .BAT_emotinl_mp   0.669    0.357    1.877    0.061    0.669    0.848
  .PSWQ_total      33.306    0.528   63.078    0.000   33.306    4.796

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  .alerting_z       0.519    0.301    1.726    0.084    0.519    0.997
  .orienting_z      0.798    0.516    1.546    0.122    0.798    0.997
  .conflict_z       1.004    0.505    1.988    0.047    1.004    0.995
  .brooding         4.313    0.612    7.044    0.000    4.313    0.384
  .reflection       2.990    0.991    3.017    0.003    2.990    0.198
  .PSS_total        0.000                              0.000    0.000
  .BAT_exhaustion   0.241    0.035    6.840    0.000    0.241    0.357
  .BAT_mental_dst   0.261    0.030    8.827    0.000    0.261    0.427
  .BAT_cognitv_mp   0.267    0.042    6.338    0.000    0.267    0.381
  .BAT_emotinl_mp   0.175    0.026    6.684    0.000    0.175    0.281
  .PSWQ_total      48.233    9.801    4.921    0.000   48.233    1.000
   AttentinlCntrl   1.000                              1.000    1.000
  .Rumination       1.000                              0.745    0.745
  .Stress           1.000                              0.149    0.149
  .Burnout          1.000                              0.447    0.447
```

Use composite factor (mindfulness minutes per week) for practitioners only.

```
>
> # 1) Practitioners-only data
> # --------------------------
> practice_data <- combined_data %>%
+   filter(!is.na(Frequency) & Frequency > 0) %>%     # keep only practitioners
+   mutate(
+     minutes_week = ifelse(is.finite(Frequency) & is.finite(Duration),
+                           pmax(Frequency, 0) * pmax(Duration, 0), NA_real_),
+     minutes_z = as.numeric(scale(minutes_week))
+     # If minutes are very skewed, consider:
+     # minutes_log = log1p(pmax(minutes_week, 0)),
+     # minutes_z   = as.numeric(scale(minutes_log))
+   )
>
> # Quick check (optional)
> # summary(practice_data$minutes_week);
sum(is.na(practice_data$minutes_z))
>
> # ----------------------------------------------------------
> # 2) Prereg structural model with minutes_z in place of "Mindfulness"
> #    (AttentionalControl, Rumination, Stress, Burnout as in prereg)
> #    + labeled paths and indirect/total effects
> # ----------------------------------------------------------
> model_prereg_minutes <- '
+   # Measurement (same as prereg)
+   AttentionalControl =~ alerting_z + orienting_z + conflict_z
+   Rumination       =~ brooding + reflection
+   Stress           =~ 1*PSS_total
+   Burnout          =~ BAT_exhaustion + BAT_mental_dist + BAT_cognitive_imp +
BAT_emotional_imp
+
+   # ------------------------------
+   # Structural (Mindfulness → minutes_z)
+   # ------------------------------
+   # minutes → AttentionalControl
+   AttentionalControl ~ a1*minutes_z
+
+   # minutes → Rumination (direct) + via AttentionalControl; PSWQ as prereg
covariate
+   Rumination ~ b1*minutes_z + b2*AttentionalControl + b3*PSWQ_total
+
+   # Stress ~ AttentionalControl + Rumination (as prereg)
+   Stress ~ c1*AttentionalControl + c2*Rumination
+
```

```
+   # Burnout ~ Stress + Rumination + PSWQ_total + minutes (direct, per prereg)
+   Burnout ~ d1*Stress + d2*Rumination + d3*PSWQ_total + d4*minutes_z
+
+   # PSWQ_total ~ minutes (as prereg)
+   PSWQ_total ~ e1*minutes_z
+
+   # --------------------------------
+   # Indirect and total effects of minutes_z
+   # --------------------------------
+   # Minutes → AttentionalControl → Rumination
+   ind_min_AC_to_Rum := a1*b2
+
+   # Minutes → Rumination (direct + via AC)
+   dir_min_to_Rum    := b1
+   tot_min_to_Rum    := dir_min_to_Rum + ind_min_AC_to_Rum
+
+   # Minutes → Stress:
+   #   via AC only (minutes→AC→Stress)
+   ind_min_AC_to_Stress := a1*c1
+   #   via Rum only (minutes→Rum→Stress)
+   ind_min_Rum_to_Stress := (b1 + a1*b2)*c2    # direct to Rum + via AC, then to
Stress
+   #   total to Stress
+   tot_min_to_Stress := ind_min_AC_to_Stress + ind_min_Rum_to_Stress
+
+   # Minutes → Burnout:
+   #   via Stress (minutes→...→Stress→Burnout)
+   ind_min_to_Burn_via_Stress := tot_min_to_Stress * d1
+   #   via Rumination directly to Burnout
+   ind_min_to_Burn_via_Rum    := (b1 + a1*b2) * d2
+   #   plus direct path to Burnout
+   dir_min_to_Burn          := d4
+   #   total to Burnout
+   tot_min_to_Burn          := ind_min_to_Burn_via_Stress +
ind_min_to_Burn_via_Rum + dir_min_to_Burn
+ '
>
> fit_prereg_minutes <- sem(
+    model_prereg_minutes,
+    data     = practice_data,
+    missing  = "ML",
+    estimator = "MLR",
+    std.lv   = TRUE,
+    fixed.x  = FALSE   # keeps cases with missing minutes_z under FIML
+ )
>
> # Full results
```

```
> summary(fit_prereg_minutes, fit.measures = TRUE, standardized = TRUE,
rsquare = TRUE)
lavaan 0.6-19 ended normally after 117 iterations

  Estimator                         ML
  Optimization method           NLMINB
  Number of model parameters        43

  Number of observations           172
  Number of missing patterns         2

Model Test User Model:
                      Standard     Scaled
  Test Statistic        97.393    111.120
  Degrees of freedom        47         47
  P-value (Chi-square)   0.000      0.000
  Scaling correction factor                  0.876
    Yuan-Bentler correction (Mplus variant)

Model Test Baseline Model:

  Test statistic       718.630    785.134
  Degrees of freedom        66         66
  P-value                0.000      0.000
  Scaling correction factor                  0.915

User Model versus Baseline Model:

  Comparative Fit Index (CFI)    0.923      0.911
  Tucker-Lewis Index (TLI)       0.892      0.875

  Robust Comparative Fit Index (CFI)         0.941
  Robust Tucker-Lewis Index (TLI)            0.918

Loglikelihood and Information Criteria:

  Loglikelihood user model (H0)      -3145.659   -3145.659
  Scaling correction factor                          2.806
    for the MLR correction
  Loglikelihood unrestricted model (H1)  -3096.962   -3096.962
  Scaling correction factor                          1.798
    for the MLR correction

  Akaike (AIC)                   6377.317   6377.317
  Bayesian (BIC)                 6512.659   6512.659
  Sample-size adjusted Bayesian (SABIC)     6376.500   6376.500
```

Root Mean Square Error of Approximation:

```
 RMSEA                          0.079      0.089
 90 Percent confidence interval - lower       0.057      0.066
 90 Percent confidence interval - upper       0.101      0.112
 P-value H_0: RMSEA <= 0.050              0.019      0.003
 P-value H_0: RMSEA >= 0.080              0.490      0.758

 Robust RMSEA                               0.068
 90 Percent confidence interval - lower             0.020
 90 Percent confidence interval - upper             0.104
 P-value H_0: Robust RMSEA <= 0.050                 0.214
 P-value H_0: Robust RMSEA >= 0.080                 0.316
```

Standardized Root Mean Square Residual:

```
 SRMR                           0.073      0.073
```

Parameter Estimates:

```
 Standard errors                Sandwich
 Information bread                Observed
 Observed information based on          Hessian
```

Latent Variables:

| | Estimate | Std.Err | z-value | P(>\|z\|) | Std.lv | Std.all |
|---|---|---|---|---|---|---|
| AttentionalControl =~ | | | | | | |
| alerting_z | 0.040 | 0.075 | 0.530 | 0.596 | 0.040 | 0.055 |
| orienting_z | -0.047 | 0.054 | -0.862 | 0.389 | -0.047 | -0.052 |
| conflict_z | -0.069 | 0.098 | -0.705 | 0.481 | -0.069 | -0.068 |
| Rumination =~ | | | | | | |
| brooding | 2.252 | 0.216 | 10.416 | 0.000 | 2.621 | 0.782 |
| reflection | 2.982 | 0.218 | 13.657 | 0.000 | 3.472 | 0.896 |
| Stress =~ | | | | | | |
| PSS_total | 1.000 | | | | 2.596 | 1.000 |
| Burnout =~ | | | | | | |
| BAT_exhaustion | 0.438 | 0.051 | 8.600 | 0.000 | 0.651 | 0.798 |
| BAT_mental_dst | 0.393 | 0.055 | 7.098 | 0.000 | 0.584 | 0.752 |
| BAT_cognitv_mp | 0.441 | 0.059 | 7.471 | 0.000 | 0.656 | 0.785 |
| BAT_emotinl_mp | 0.449 | 0.053 | 8.395 | 0.000 | 0.667 | 0.847 |

Regressions:

| | Estimate | Std.Err | z-value | P(>\|z\|) | Std.lv | Std.all |
|---|---|---|---|---|---|---|
| AttentionalControl ~ | | | | | | |
| minutes_z (a1) | -0.073 | 0.070 | -1.051 | 0.293 | -0.073 | -0.073 |
| Rumination ~ | | | | | | |
| minutes_z (b1) | 0.102 | 0.066 | 1.546 | 0.122 | 0.088 | 0.088 |

```
  AttntnlCn (b2)     -0.140   0.159  -0.875   0.381  -0.120  -0.120
  PSWQ_totl (b3)      0.082   0.021   3.920   0.000   0.070   0.489
 Stress ~
  AttntnlCn (c1)      2.157   0.163  13.265   0.000   0.833   0.833
  Ruminatin (c2)      1.150   0.299   3.842   0.000   0.516   0.516
 Burnout ~
  Stress    (d1)      0.038   0.037   1.032   0.302   0.066   0.066
  Ruminatin (d2)      0.800   0.178   4.498   0.000   0.626   0.626
  PSWQ_totl (d3)      0.032   0.025   1.291   0.197   0.021   0.149
  minutes_z (d4)     -0.028   0.055  -0.514   0.607  -0.019  -0.019
 PSWQ_total ~
  minutes_z (e1)     -0.048   0.320  -0.151   0.880  -0.048  -0.007

Intercepts:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  .alerting_z         0.078    0.066    1.182    0.237    0.078    0.108
  .orienting_z        0.028    0.080    0.344    0.731    0.028    0.031
  .conflict_z         0.052    0.092    0.563    0.574    0.052    0.051
  .brooding           1.258    1.355    0.928    0.353    1.258    0.375
  .reflection         3.269    1.924    1.699    0.089    3.269    0.843
  .PSS_total         16.152    0.997   16.206    0.000   16.152    6.223
  .BAT_exhaustion     1.549    0.369    4.195    0.000    1.549    1.899
  .BAT_mental_dst     1.285    0.342    3.756    0.000    1.285    1.654
  .BAT_cognitv_mp     0.957    0.368    2.603    0.009    0.957    1.145
  .BAT_emotinl_mp     0.664    0.356    1.867    0.062    0.664    0.843
  .PSWQ_total        33.302    0.531   62.707    0.000   33.302    4.781
  minutes_z           0.000    0.076    0.000    1.000    0.000    0.000

Variances:
                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
  .alerting_z         0.523    0.303    1.727    0.084    0.523    0.997
  .orienting_z        0.804    0.521    1.545    0.122    0.804    0.997
  .conflict_z         1.012    0.509    1.988    0.047    1.012    0.995
  .brooding           4.354    0.619    7.035    0.000    4.354    0.388
  .reflection         2.975    1.000    2.974    0.003    2.975    0.198
  .PSS_total          0.000                      0.000    0.000
  .BAT_exhaustion     0.242    0.035    6.847    0.000    0.242    0.364
  .BAT_mental_dst     0.262    0.030    8.848    0.000    0.262    0.434
  .BAT_cognitv_mp     0.269    0.042    6.322    0.000    0.269    0.384
  .BAT_emotinl_mp     0.175    0.026    6.640    0.000    0.175    0.282
  .PSWQ_total        48.511    9.852    4.924    0.000   48.511    1.000
  .AttentinlCntrl     1.000                      0.995    0.995
  .Rumination         1.000                      0.738    0.738
  .Stress             1.000                      0.148    0.148
  .Burnout            1.000                      0.453    0.453
  minutes_z           0.994    0.444    2.238    0.025    0.994    1.000
```

```
R-Square:
               Estimate
  alerting_z      0.003
  orienting_z     0.003
  conflict_z      0.005
  brooding        0.612
  reflection      0.802
  PSS_total       1.000
  BAT_exhaustion  0.636
  BAT_mental_dst  0.566
  BAT_cognitv_mp  0.616
  BAT_emotinl_mp  0.718
  PSWQ_total      0.000
  AttentinlCntrl  0.005
  Rumination      0.262
  Stress          0.852
  Burnout         0.547

Defined Parameters:
               Estimate  Std.Err  z-value  P(>|z|)  Std.lv  Std.all
  ind_mn_AC_t_Rm   0.010   0.016   0.621   0.535   0.009   0.009
  dir_min_to_Rum   0.102   0.066   1.546   0.122   0.088   0.088
  tot_min_to_Rum   0.113   0.072   1.570   0.116   0.097   0.096
  ind_mn_AC_t_St  -0.158   0.151  -1.046   0.295  -0.061  -0.061
  ind_mn_Rm_t_St   0.129   0.088   1.479   0.139   0.050   0.050
  tot_mn_t_Strss  -0.028   0.108  -0.260   0.795  -0.011  -0.011
  ind_mn_t_Br__S  -0.001   0.004  -0.244   0.808  -0.001  -0.001
  ind_mn_t_Br__R   0.090   0.060   1.488   0.137   0.061   0.060
  dir_min_to_Brn  -0.028   0.055  -0.514   0.607  -0.019  -0.019
  tot_min_to_Brn   0.061   0.086   0.711   0.477   0.041   0.041

>
> # If you want a compact table of the structural paths + indirects:
> pe <- parameterEstimates(fit_prereg_minutes, standardized = TRUE)
> subset(pe, op %in% c("~",":="))[,
c("lhs","op","rhs","label","est","se","pvalue","std.all")]
                lhs op                                rhs              label
11      AttentionalControl ~                         minutes_z             a1
12           Rumination ~                         minutes_z             b1
13           Rumination ~                  AttentionalControl             b2
14           Rumination ~                       PSWQ_total               b3
15              Stress ~                  AttentionalControl             c1
16              Stress ~                         Rumination              c2
17             Burnout ~                            Stress              d1
18             Burnout ~                         Rumination              d2
19             Burnout ~                       PSWQ_total               d3
20             Burnout ~                         minutes_z              d4
```

```
21            PSWQ_total ~                                  minutes_z                e1
54       ind_min_AC_to_Rum :=                                   a1*b2
ind_min_AC_to_Rum
55         dir_min_to_Rum :=                                    b1
dir_min_to_Rum
56         tot_min_to_Rum :=
dir_min_to_Rum+ind_min_AC_to_Rum         tot_min_to_Rum
57     ind_min_AC_to_Stress :=                                   a1*c1
ind_min_AC_to_Stress
58    ind_min_Rum_to_Stress :=                                (b1+a1*b2)*c2
ind_min_Rum_to_Stress
59       tot_min_to_Stress :=
ind_min_AC_to_Stress+ind_min_Rum_to_Stress       tot_min_to_Stress
60 ind_min_to_Burn_via_Stress :=                          tot_min_to_Stress*d1
ind_min_to_Burn_via_Stress
61   ind_min_to_Burn_via_Rum :=                             (b1+a1*b2)*d2
ind_min_to_Burn_via_Rum
62         dir_min_to_Burn :=                                   d4
dir_min_to_Burn
63         tot_min_to_Burn :=
ind_min_to_Burn_via_Stress+ind_min_to_Burn_via_Rum+dir_min_to_Burn
tot_min_to_Burn
    est    se pvalue std.all
11 -0.073 0.070  0.293  -0.073
12  0.102 0.066  0.122   0.088
13 -0.140 0.159  0.381  -0.120
14  0.082 0.021  0.000   0.489
15  2.157 0.163  0.000   0.833
16  1.150 0.299  0.000   0.516
17  0.038 0.037  0.302   0.066
18  0.800 0.178  0.000   0.626
19  0.032 0.025  0.197   0.149
20 -0.028 0.055  0.607  -0.019
21 -0.048 0.320  0.880  -0.007
54  0.010 0.016  0.535   0.009
55  0.102 0.066  0.122   0.088
56  0.113 0.072  0.116   0.096
57 -0.158 0.151  0.295  -0.061
58  0.129 0.088  0.139   0.050
59 -0.028 0.108  0.795  -0.011
60 -0.001 0.004  0.808  -0.001
61  0.090 0.060  0.137   0.060
62 -0.028 0.055  0.607  -0.019
63  0.061 0.086  0.477   0.041
```

Winsorize

```
> # ============================================================ > # Phase 3: winsorize only |z| > 3 back to ±2 SD, then re-run SEM > # - Creates practice_data_winsor3to2 > # - Re-fits model_prereg_minutes on both original & winsorized > # - Compares fit measures & selected paths > # ============================================================ > > library(dplyr) > library(tidyr) > library(lavaan) > library(readr) > library(tibble) > library(purrr) > > stopifnot(exists("practice_data")) > stopifnot(exists("model_prereg_minutes")) > > # ------------------------------ > # Observed variables in Phase 3 > # ------------------------------ > obs_vars_phase3 <- c( +   "alerting_z","orienting_z","conflict_z",     # ANT indicators +   "brooding","reflection",                    # Rumination indicators +   "PSS_total",                               # Stress indicator +   "BAT_exhaustion","BAT_mental_dist", +   "BAT_cognitive_imp","BAT_emotional_imp",     # Burnout indicators +   "PSWQ_total",                              # Covariate +   "minutes_z"                                # Mindfulness predictor + ) > obs_vars_phase3 <- intersect(obs_vars_phase3, names(practice_data)) > > # ---------------------------------------- > # Winsorize function: ONLY values with |z|>3 > # are moved back to mean ± 2*SD (keeping sign) > # ---------------------------------------- > winsorize_3to2sd <- function(x) { +   if (!is.numeric(x)) return(x) +   m <- mean(x, na.rm = TRUE) +   s <- sd(x, na.rm = TRUE) +   if (!is.finite(m) || !is.finite(s) || s == 0) return(x) +   z <- (x - m) / s +   # Compute the two caps at ±2 SD around mean +   lower_cap <- m - 2*s +   upper_cap <- m + 2*s +   # Only replace if |z| > 3 +   x[is.finite(z) & z >  3] <- upper_cap +   x[is.finite(z) & z < -3] <- lower_cap +   x + } > > # ---------------------------------------- > # Create winsorized copy (3SD -> 2SD for extremes) > # ---------------------------------------- > practice_data_winsor3to2 <- practice_data %>% +   mutate(across(all_of(obs_vars_phase3), winsorize_3to2sd)) > > # How many values were changed per variable? > winsor_changes <- map_dfr(obs_vars_phase3, function(v){ +   orig <- practice_data[[v]] +   win  <- practice_data_winsor3to2[[v]] +   tibble( +     Variable = v, +     N_changed = sum(is.finite(orig) & is.finite(win) & !is.na(orig) & !is.na(win) & orig != win) +   ) + }) %>% arrange(desc(N_changed)) > > print(winsor_changes) # A tibble: 12 × 2   Variable        N_changed   <chr>               <int> 1 minutes_z             4 2 orienting_z           3 3 conflict_z            3 4 alerting_z            2 5 PSS_total             2 6 PSWQ_total            2 7 brooding              0 8 reflection            0 9 BAT_exhaustion        0 10 BAT_mental_dist      0 11 BAT_cognitive_imp    0 12 BAT_emotional_imp    0 > write_csv(winsor_changes, "phase3_winsor_changes_3to2sd.csv") >                                     > # ---------------------------------------- > # Fit SEM: original vs winsorized > # ---------------------------------------- > fit_phase3_orig <- sem( +   model_prereg_minutes, +   data     = practice_data, +   missing  = "ML", +   estimator = "MLR", +   std.lv   = TRUE, +   fixed.x  = FALSE + ) > > fit_phase3_win <- sem( +   model_prereg_minutes, +   data     = practice_data_winsor3to2, +   missing  = "ML", +   estimator = "MLR", +   std.lv   = TRUE, +   fixed.x  = FALSE + ) > > # ---------------------------------------- > # Compare key fit indices > # ---------------------------------------- > fit_names <-
```

```
c("cfi","tli","rmsea","srmr","chisq","df","pvalue","bic","aic") > fit_cmp <- tibble(
+    metric = toupper(fit_names), +    Original =
as.numeric(fitMeasures(fit_phase3_orig, fit_names)), +    Winsor_3to2 =
as.numeric(fitMeasures(fit_phase3_win, fit_names)) + ) > print(fit_cmp) # A tibble:
9 × 3   metric    Original Winsor_3to2   <chr>       <dbl>      <dbl> 1
CFI     0.923       0.964  2 TLI      0.892       0.949  3 RMSEA    0.0790       0.0535 4
SRMR     0.0733       0.0544 5 CHISQ    97.4         70.1    6 DF      47          47     7
PVALUE    0.0000223     0.0160 8 BIC    6513.        5825.    9
AIC    6377.        5690.    > write_csv(fit_cmp,
"phase3_fit_compare_original_vs_winsor3to2.csv")
>
                                    > # ----------------------------------------- > # Compare
selected structural paths (standardized) > # (add/remove any you care about) > # --
----------------------------------------- > paths_of_interest <- tribble(
+    ~lhs,           ~op, ~rhs,          ~label, +    "Rumination",      "~",
"PSWQ_total",    "b3", +    "Rumination",      "~", "AttentionalControl", "b2",
+    "Rumination",      "~", "minutes_z",     "b1", +    "Stress",         "~",
"AttentionalControl", "c1", +    "Stress",         "~", "Rumination",    "c2",
+    "Burnout",        "~", "Stress",        "d1", +    "Burnout",        "~",
"Rumination",    "d2", +    "Burnout",        "~", "PSWQ_total",    "d3",
+    "Burnout",        "~", "minutes_z",     "d4", +    "PSWQ_total",      "~",
"minutes_z",     "e1" + ) >  > get_std <- function(fit, lhs, op, rhs){ +    pe <-
parameterEstimates(fit, standardized = TRUE) +    row <- pe[pe$lhs==lhs &
pe$op==op & pe$rhs==rhs, ] +    if (nrow(row)) return(row$std.all[1]) else
return(NA_real_) + } >  > path_cmp <- paths_of_interest %>% +    rowwise() %>%
+    mutate( +       Std_Orig = get_std(fit_phase3_orig, lhs, op, rhs), +       Std_Win  =
get_std(fit_phase3_win,  lhs, op, rhs) +    ) %>% ungroup() >  > print(path_cmp, n =
nrow(path_cmp)) # A tibble: 10 × 6   lhs       op    rhs            label Std_Orig
Std_Win   <chr>     <chr> <chr>          <chr>    <dbl>   <dbl>  1 Rumination
~    PSWQ_total       b3    0.489    0.527   2 Rumination ~    AttentionalControl b2    -
0.120    0.147   3 Rumination ~    minutes_z        b1    0.0877   0.0749  4
Stress    ~    AttentionalControl c1    0.833   -0.831   5
Stress    ~    Rumination       c2    0.516    0.529   6
Burnout   ~    Stress           d1    0.0664   0.0601  7
Burnout   ~    Rumination       d2    0.626    0.601   8
Burnout   ~    PSWQ_total       d3    0.149    0.197   9
Burnout   ~    minutes_z        d4   -0.0188  -0.0191 10 PSWQ_total
~    minutes_z        e1   -0.00690 -0.0330 > write_csv(path_cmp,
"phase3_path_compare_original_vs_winsor3to2.csv")

> # 90% CI for RMSEA
> fitMeasures(fit_phase3_win, c("rmsea.ci.lower","rmsea.ci.upper"))
rmsea.ci.lower rmsea.ci.upper
       0.024        0.078
>
> # R^2 for each endogenous latent variable
> inspect(fit_phase3_win, "r2")# 90% CI for RMSEA
```

```
    alerting_z     orienting_z     conflict_z       brooding      reflection
PSS_total
         0.000           0.000           0.001           0.621           0.791           1.000
  BAT_exhaustion  BAT_mental_dist BAT_cognitive_imp BAT_emotional_imp
PSWQ_total AttentionalControl
         0.635           0.567           0.617           0.716           0.001           0.002
    Rumination          Stress         Burnout
         0.303           0.839           0.563
> fitMeasures(fit_phase3_win, c("rmsea.ci.lower","rmsea.ci.upper"))
rmsea.ci.lower rmsea.ci.upper
         0.024           0.078
>
> # R^2 for each endogenous latent variable
> inspect(fit_phase3_win, "r2")
    alerting_z     orienting_z     conflict_z       brooding      reflection
PSS_total
         0.000           0.000           0.001           0.621           0.791           1.000
  BAT_exhaustion  BAT_mental_dist BAT_cognitive_imp BAT_emotional_imp
PSWQ_total AttentionalControl
         0.635           0.567           0.617           0.716           0.001           0.002
    Rumination          Stress         Burnout
         0.303           0.839           0.563
```

Coding created with the assistance of Chat GPT (OpenAI, 2025)

Appendix XVI. Study 4 - SEM Assumption Checks

```
# SEM Assumption Checks (Observed Stress: PSS_total)
> ## Phase 3 (all practitioners) & Phase 4 (focused-only)
> ## ============================================================
>
> suppressPackageStartupMessages({
+   library(lavaan)
+   library(ggplot2)
+   library(dplyr)
+   library(lmtest)   # dwtest, bptest
+   library(gvlma)    # global validation
+ })
>
> # ------------------------------------------------------
> # Helper: run assumption checks and save plots to PDF
> # ------------------------------------------------------
> check_sem_assumptions <- function(fit, data, phase_label, dvs, pdf_file) {
+   cat("\n============================\n")
+   cat("Assumption checks for", phase_label, "\n")
+   cat("============================\n")
+
+   # Get latent factor scores
+   lv_scores <- as.data.frame(lavPredict(fit, type = "lv"))
+   # Add observed DVs
+   for (dv in dvs) {
+     lv_scores[[dv]] <- data[[dv]]
+   }
+
+   pdf(pdf_file, width = 7, height = 5)
+
+   for (dv in dvs) {
+     cat("\n---- Dependent Variable:", dv, "----\n")
+
+     # Build regression model: DV ~ all others
+     predictors <- setdiff(colnames(lv_scores), dv)
+     f <- as.formula(paste(dv, "~", paste(predictors, collapse = " + ")))
+     lm_model <- lm(f, data = lv_scores)
+
+     # Extract fitted + residuals
+     df_plot <- data.frame(
+       Fitted = fitted(lm_model),
+       Residuals = resid(lm_model)
+     )
+
+     # 1. Scatterplots DV vs predictors
+     for (pred in predictors) {
```

```
+       p_scatter <- ggplot(lv_scores, aes_string(x = pred, y = dv)) +
+         geom_point(alpha = 0.6) +
+         geom_smooth(method = "lm", se = FALSE, color = "blue") +
+         theme_minimal() +
+         labs(title = paste("Scatterplot:", dv, "vs", pred, "-", phase_label))
+       print(p_scatter)
+     }
+
+     # 2. Residuals vs Fitted
+     p_resid <- ggplot(df_plot, aes(x = Fitted, y = Residuals)) +
+       geom_point(alpha = 0.6) +
+       geom_hline(yintercept = 0, linetype = "dashed", color = "red") +
+       theme_minimal() +
+       labs(title = paste("Residuals vs Fitted:", dv, "-", phase_label))
+     print(p_resid)
+
+     # 3. Histogram of residuals
+     p_hist <- ggplot(df_plot, aes(x = Residuals)) +
+       geom_histogram(color = "white", fill = "skyblue", bins = 20) +
+       theme_minimal() +
+       labs(title = paste("Histogram of Residuals:", dv, "-", phase_label))
+     print(p_hist)
+
+     # 4. QQ plot
+     qqnorm(resid(lm_model),
+            main = paste("QQ Plot of Residuals:", dv, "-", phase_label))
+     qqline(resid(lm_model), col = "red")
+
+     # 5. Durbin-Watson Test
+     cat("\nDurbin-Watson Test:\n")
+     print(dwtest(lm_model))
+
+     # 6. Breusch-Pagan Test
+     cat("\nBreusch-Pagan Test:\n")
+     print(bptest(lm_model))
+
+     # 7. GVLMA global test
+     cat("\nGVLMA Results:\n")
+     print(gvlma(lm_model))
+   }
+
+   dev.off()
+   cat("\nPlots saved to:", pdf_file, "\n")
+ }
>
> # ------------------------------------------------
> # Run for Phase 3 (observed Stress)
```

```
> # ----------------------------------------------------
> phase3_dvs <- c("PSS_total", "brooding", "reflection",
+             "BAT_exhaustion", "BAT_mental_dist",
+             "BAT_cognitive_imp", "BAT_emotional_imp")
>
> check_sem_assumptions(
+   fit_p3_obsStress,
+   practice_data_winsor3to2,
+   "Phase 3 (All Mindfulness Practitioners, Stress observed)",
+   phase3_dvs,
+   "phase3_obsStress_assumptions.pdf"
+ )

============================
Assumption checks for Phase 3 (All Mindfulness Practitioners, Stress observed)
============================

---- Dependent Variable: PSS_total ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.7922, p-value = 0.07809
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 10.124, df = 9, p-value = 0.3405


GVLMA Results:
```

```
Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout          brooding
reflection
        11.1572           -0.7669           23.1714          -18.0980           -1.9565           -
3.2526
  BAT_exhaustion    BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp
         6.5871            5.4244            6.1020            9.2891


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value p-value                Decision
Global Stat        4.384e+02  0.0000 Assumptions NOT satisfied!
Skewness           1.550e+02  0.0000 Assumptions NOT satisfied!
Kurtosis           2.833e+02  0.0000 Assumptions NOT satisfied!
Link Function      1.177e-03  0.9726    Assumptions acceptable.
Heteroscedasticity 5.204e-02  0.8196    Assumptions acceptable.

---- Dependent Variable: brooding ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.7925, p-value = 0.07843
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:
```

studentized Breusch-Pagan test

data: lm_model
BP = 4.8524, df = 9, p-value = 0.847

GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:

| (Intercept) | AttentionalControl | Rumination | Burnout | PSS_total | reflection |
|---|---|---|---|---|---|
| 5.2874 | -0.3808 | 11.7226 | -9.1517 | -0.4843 | -1.6450 |

| BAT_exhaustion | BAT_mental_dist | BAT_cognitive_imp | BAT_emotional_imp |
|---|---|---|---|
| 3.3421 | 2.7449 | 3.0905 | 4.6764 |

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance = 0.05

Call:
gvlma(x = lm_model)

| | Value | p-value | Decision |
|---|---|---|---|
| Global Stat | 538.38996 | 0.0000 | Assumptions NOT satisfied! |
| Skewness | 174.75848 | 0.0000 | Assumptions NOT satisfied! |
| Kurtosis | 363.47494 | 0.0000 | Assumptions NOT satisfied! |
| Link Function | 0.10057 | 0.7512 | Assumptions acceptable. |
| Heteroscedasticity | 0.05598 | 0.8130 | Assumptions acceptable. |

---- Dependent Variable: reflection ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

```
        Durbin-Watson test

data:  lm_model
DW = 1.7517, p-value = 0.04616
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 9.4323, df = 9, p-value = 0.3984


GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
         3.1908           -0.2327            7.0837           -5.5309           -0.2920           -0.5965
  BAT_exhaustion    BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp
         2.0228            1.6624            1.8667            2.8206


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value p-value                Decision
Global Stat      465.43071  0.0000 Assumptions NOT satisfied!
Skewness         156.67512  0.0000 Assumptions NOT satisfied!
Kurtosis         308.63126  0.0000 Assumptions NOT satisfied!
Link Function      0.00953  0.9222    Assumptions acceptable.
Heteroscedasticity  0.11480  0.7347    Assumptions acceptable.

---- Dependent Variable: BAT_exhaustion ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
```

```
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
```

Durbin-Watson Test:

```
        Durbin-Watson test

data:  lm_model
DW = 1.7991, p-value = 0.08493
alternative hypothesis: true autocorrelation is greater than 0
```

Breusch-Pagan Test:

```
        studentized Breusch-Pagan test

data:  lm_model
BP = 6.2278, df = 9, p-value = 0.7169
```

GVLMA Results:

```
Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
        -1.5370           0.1126          -3.4454           2.6934           0.1421           0.2912
     reflection    BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp
         0.4860           -0.8060           -0.9071           -1.3697


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                Value p-value                Decision
Global Stat      529.0226  0.0000 Assumptions NOT satisfied!
Skewness         169.2162  0.0000 Assumptions NOT satisfied!
Kurtosis         359.1921  0.0000 Assumptions NOT satisfied!
```

Link Function 0.3555 0.5510 Assumptions acceptable.
Heteroscedasticity 0.2589 0.6109 Assumptions acceptable.

---- Dependent Variable: BAT_mental_dist ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

Durbin-Watson test

data: lm_model
DW = 1.7805, p-value = 0.06758
alternative hypothesis: true autocorrelation is greater than 0

Breusch-Pagan Test:

studentized Breusch-Pagan test

data: lm_model
BP = 10.157, df = 9, p-value = 0.3379

GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:

| (Intercept) | AttentionalControl | Rumination | Burnout | PSS_total | brooding |
|---|---|---|---|---|---|
| -1.8581 | 0.1354 | -4.1623 | 3.2531 | 0.1717 | 0.3509 |

| reflection | BAT_exhaustion | BAT_cognitive_imp | BAT_emotional_imp |
|---|---|---|---|
| 0.5860 | -1.1825 | -1.0915 | -1.6526 |

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance = 0.05

```
Call:
 gvlma(x = lm_model)

                    Value p-value                Decision
Global Stat        431.06305  0.0000 Assumptions NOT satisfied!
Skewness           152.01448  0.0000 Assumptions NOT satisfied!
Kurtosis           279.02439  0.0000 Assumptions NOT satisfied!
Link Function        0.01095  0.9166    Assumptions acceptable.
Heteroscedasticity   0.01323  0.9084    Assumptions acceptable.

---- Dependent Variable: BAT_cognitive_imp ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.7723, p-value = 0.0608
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 11.525, df = 9, p-value = 0.2414


GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
```

```
      -1.6783         0.1204        -3.7289         2.9144         0.1540         0.3151
    reflection    BAT_exhaustion   BAT_mental_dist  BAT_emotional_imp
      0.5248         -1.0616        -0.8706         -1.4807


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                Value p-value              Decision
Global Stat      443.9255 0.00000 Assumptions NOT satisfied!
Skewness         150.6063 0.00000 Assumptions NOT satisfied!
Kurtosis         290.4528 0.00000 Assumptions NOT satisfied!
Link Function      2.7663 0.09627    Assumptions acceptable.
Heteroscedasticity  0.1001 0.75176    Assumptions acceptable.

---- Dependent Variable: BAT_emotional_imp ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.767, p-value = 0.05672
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 6.7614, df = 9, p-value = 0.6619
```

```
GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
     (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
       -1.13145           0.08157          -2.48086           1.93915           0.10316
0.20979
      reflection     BAT_exhaustion    BAT_mental_dist   BAT_cognitive_imp
         0.34893          -0.70526          -0.57999          -0.65148


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value p-value                Decision
Global Stat       490.3689  0.0000 Assumptions NOT satisfied!
Skewness          165.7359  0.0000 Assumptions NOT satisfied!
Kurtosis          323.4149  0.0000 Assumptions NOT satisfied!
Link Function       1.0939  0.2956    Assumptions acceptable.
Heteroscedasticity  0.1241  0.7246    Assumptions acceptable.

Plots saved to: phase3_obsStress_assumptions.pdf
>
> # ------------------------------------------------
> # Run for Phase 4 (focused-only, observed Stress)
> # ------------------------------------------------
> phase4_dvs <- phase3_dvs
>
> check_sem_assumptions(
+    fit_p4_obsStress,
+    practice_data_focused_win,
+    "Phase 4 (Focused Meditation Only, Stress observed)",
+    phase4_dvs,
+    "phase4_obsStress_assumptions.pdf"
+ )

============================
Assumption checks for Phase 4 (Focused Meditation Only, Stress observed)
============================
```

---- Dependent Variable: PSS_total ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

	Durbin-Watson test

data:  lm_model
DW = 1.8618, p-value = 0.243
alternative hypothesis: true autocorrelation is greater than 0

Breusch-Pagan Test:

	studentized Breusch-Pagan test

data:  lm_model
BP = 15.543, df = 9, p-value = 0.07706

GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout          brooding 
reflection 
       13.42177         0.09544        14.33381        -8.87259        -1.52287        -
1.71251 
  BAT_exhaustion   BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp 
        3.90221         2.36492         2.60259         5.25492 

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:

```
 gvlma(x = lm_model)

                    Value  p-value                Decision
Global Stat        11.576038 0.020799 Assumptions NOT satisfied!
Skewness            1.702449 0.191968    Assumptions acceptable.
Kurtosis            0.012649 0.910453    Assumptions acceptable.
Link Function       9.851917 0.001697 Assumptions NOT satisfied!
Heteroscedasticity  0.009023 0.924325    Assumptions acceptable.

---- Dependent Variable: brooding ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.9809, p-value = 0.435
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 4.0648, df = 9, p-value = 0.9071


GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
reflection
         0.1459           0.0423           8.5871          -5.3820          -0.1057          -1.0891
  BAT_exhaustion    BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp
```

```
        2.1513          1.6061          1.6687          3.0864


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value   p-value                Decision
Global Stat       113.2249 0.000e+00 Assumptions NOT satisfied!
Skewness           48.9035 2.689e-12 Assumptions NOT satisfied!
Kurtosis           62.8262 2.220e-15 Assumptions NOT satisfied!
Link Function       0.4953 4.816e-01    Assumptions acceptable.
Heteroscedasticity  1.0000 3.173e-01    Assumptions acceptable.

---- Dependent Variable: reflection ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 1.9034, p-value = 0.3045
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 5.5656, df = 9, p-value = 0.7825


GVLMA Results:
```

```
Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
        0.13618          0.04629          7.34029         -4.61602         -0.08423         -
0.77205
  BAT_exhaustion    BAT_mental_dist  BAT_cognitive_imp  BAT_emotional_imp
        1.88711          1.45703          1.42101          2.53574


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value   p-value                Decision
Global Stat       98.8521 0.000e+00 Assumptions NOT satisfied!
Skewness          47.3359 5.981e-12 Assumptions NOT satisfied!
Kurtosis          45.7863 1.319e-11 Assumptions NOT satisfied!
Link Function      5.5524 1.846e-02 Assumptions NOT satisfied!
Heteroscedasticity 0.1775 6.736e-01    Assumptions acceptable.

---- Dependent Variable: BAT_exhaustion ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

        Durbin-Watson test

data:  lm_model
DW = 2.1433, p-value = 0.7144
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:
```

studentized Breusch-Pagan test

data: lm_model
BP = 13.725, df = 9, p-value = 0.1325

GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
(Intercept) AttentionalControl Rumination Burnout PSS_total
brooding
0.007327 -0.010523 -3.099918 1.961503 0.042454
0.337312
reflection BAT_mental_dist BAT_cognitive_imp BAT_emotional_imp
0.417408 -0.545580 -0.590363 -1.009374

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance = 0.05

Call:
gvlma(x = lm_model)

Value p-value Decision
Global Stat 59.11921 4.442e-12 Assumptions NOT satisfied!
Skewness 30.94586 2.653e-08 Assumptions NOT satisfied!
Kurtosis 27.04351 1.989e-07 Assumptions NOT satisfied!
Link Function 0.03621 8.491e-01 Assumptions acceptable.
Heteroscedasticity 1.09364 2.957e-01 Assumptions acceptable.

---- Dependent Variable: BAT_mental_dist ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

```
        Durbin-Watson test

data:  lm_model
DW = 1.9551, p-value = 0.39
alternative hypothesis: true autocorrelation is greater than 0


Breusch-Pagan Test:

        studentized Breusch-Pagan test

data:  lm_model
BP = 25.669, df = 9, p-value = 0.002314


GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
    (Intercept)  AttentionalControl        Rumination           Burnout         PSS_total
brooding
        0.11017          -0.01880          -3.57286           2.26446           0.03839
0.37574
     reflection     BAT_exhaustion   BAT_cognitive_imp   BAT_emotional_imp
        0.48086          -0.81404          -0.61762          -1.19214


ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value  p-value                Decision
Global Stat        11.163509 0.024787 Assumptions NOT satisfied!
Skewness           10.244183 0.001371 Assumptions NOT satisfied!
Kurtosis           0.649322 0.420355    Assumptions acceptable.
Link Function      0.266894 0.605423    Assumptions acceptable.
Heteroscedasticity  0.003109 0.955538    Assumptions acceptable.

---- Dependent Variable: BAT_cognitive_imp ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
```

`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

Durbin-Watson test

data: lm_model
DW = 1.9275, p-value = 0.3431
alternative hypothesis: true autocorrelation is greater than 0

Breusch-Pagan Test:

studentized Breusch-Pagan test

data: lm_model
BP = 14.419, df = 9, p-value = 0.1082

GVLMA Results:

Call:
lm(formula = f, data = lv_scores)

Coefficients:
(Intercept) AttentionalControl Rumination Burnout PSS_total
brooding
0.001541 -0.024456 -3.669409 2.330983 0.043122
0.398461
reflection BAT_exhaustion BAT_mental_dist BAT_emotional_imp
0.478675 -0.899082 -0.630393 -1.149123

ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance = 0.05

Call:
gvlma(x = lm_model)

Value p-value Decision

Global Stat 48.81555 6.380e-10 Assumptions NOT satisfied!
Skewness 23.83175 1.051e-06 Assumptions NOT satisfied!
Kurtosis 16.88609 3.969e-05 Assumptions NOT satisfied!
Link Function 8.02541 4.613e-03 Assumptions NOT satisfied!
Heteroscedasticity 0.07229 7.880e-01 Assumptions acceptable.

---- Dependent Variable: BAT_emotional_imp ----
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'
`geom_smooth()` using formula = 'y ~ x'

Durbin-Watson Test:

Durbin-Watson test

data: lm_model
DW = 1.8887, p-value = 0.2822
alternative hypothesis: true autocorrelation is greater than 0

Breusch-Pagan Test:

studentized Breusch-Pagan test

data: lm_model
BP = 7.009, df = 9, p-value = 0.6362

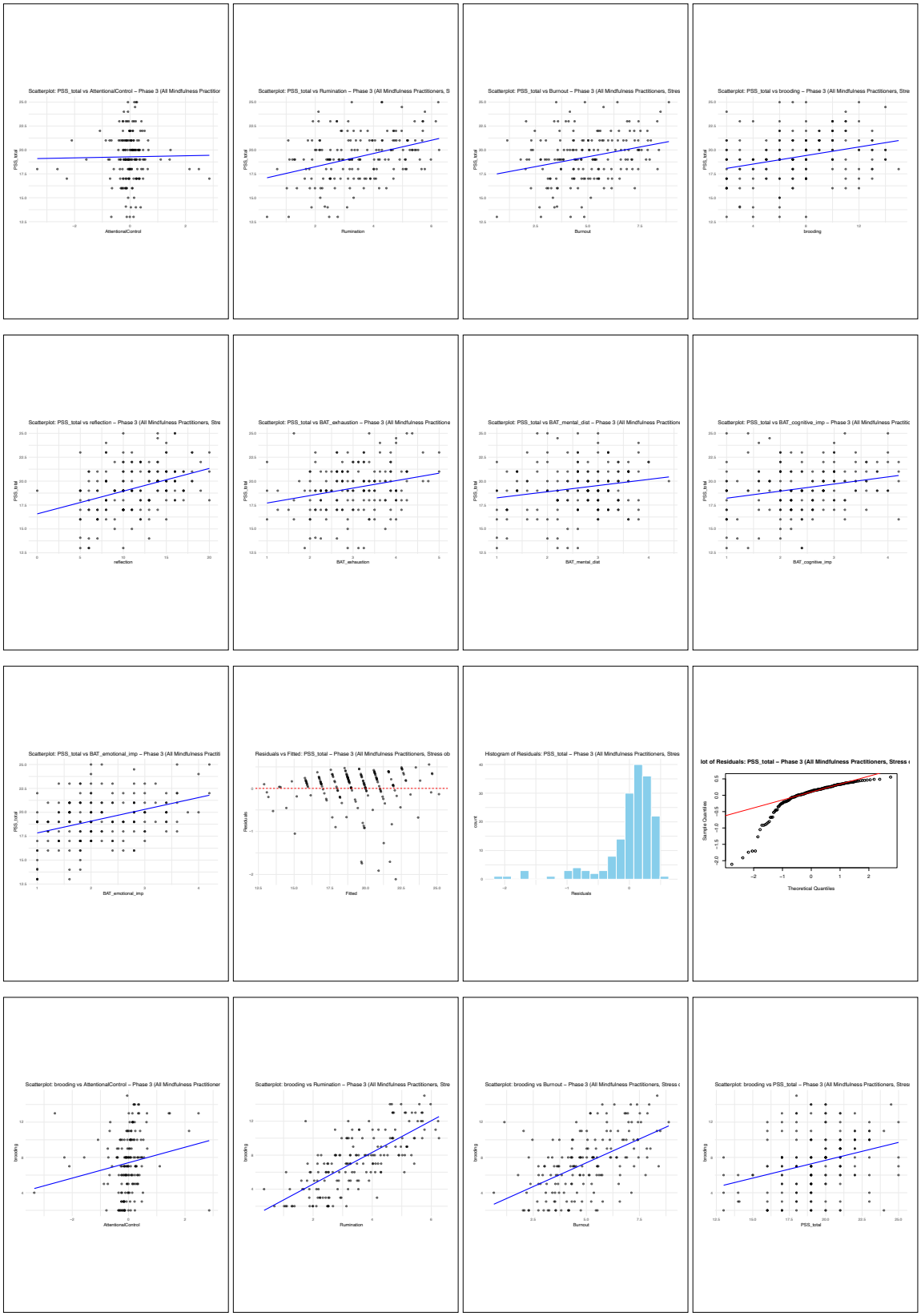
GVLMA Results:

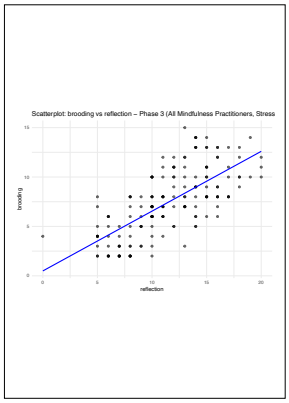
Call:
lm(formula = f, data = lv_scores)

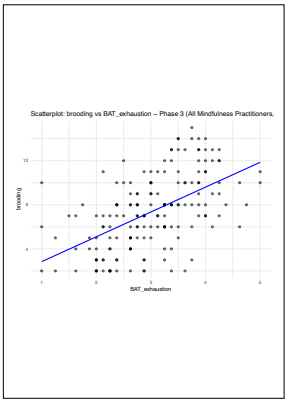
Coefficients:
(Intercept) AttentionalControl Rumination Burnout PSS_total
brooding
-0.09315 -0.01363 -2.37118 1.50454 0.03124
0.26446
reflection BAT_exhaustion BAT_mental_dist BAT_cognitive_imp
0.30650 -0.55159 -0.43662 -0.41234

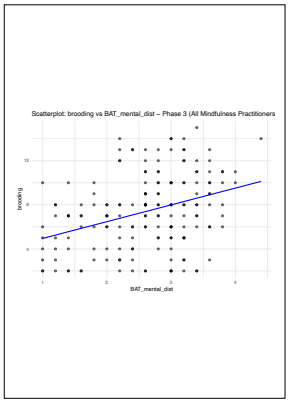
```
ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
Level of Significance =  0.05

Call:
 gvlma(x = lm_model)

                    Value   p-value                Decision
Global Stat       101.8103 0.000e+00 Assumptions NOT satisfied!sw
Skewness           36.1739 1.805e-09 Assumptions NOT satisfied!
Kurtosis           53.3449 2.799e-13 Assumptions NOT satisfied!
Link Function      11.4617 7.104e-04 Assumptions NOT satisfied!
Heteroscedasticity  0.8298 3.623e-01    Assumptions acceptable.

Plots saved to: phase4_obsStress_assumptions.pdf
```

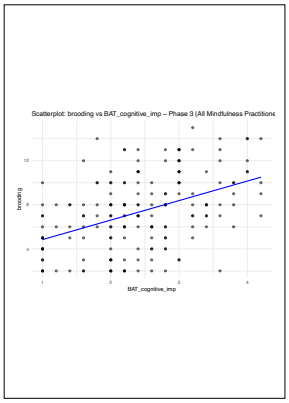
Coding created with the assistance of Chat GPT (OpenAI, 2025)

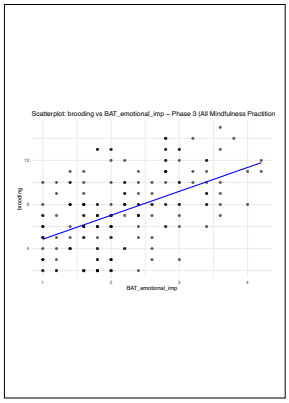

Scatterplot: PSS_total vs AttentionalControl – Phase 3 (All Mindfulness Practitior
PSS_total
AttentionalControl
Scatterplot: PSS_total vs Rumination – Phase 3 (All Mindfulness Practitioners, S
PSS_total
Rumination
Scatterplot: PSS_total vs Burnout – Phase 3 (All Mindfulness Practitioners, Stres
PSS_total
Burnout
Scatterplot: PSS_total vs brooding – Phase 3 (All Mindfulness Practitioners, Stre
PSS_total
brooding
Scatterplot: PSS_total vs reflection – Phase 3 (All Mindfulness Practitioners, Stre
PSS_total
reflection
Scatterplot: PSS_total vs BAT_exhaustion – Phase 3 (All Mindfulness Practitione
PSS_total
BAT_exhaustion
Scatterplot: PSS_total vs BAT_mental_dist – Phase 3 (All Mindfulness Practition
PSS_total
BAT_mental_dist
Scatterplot: PSS_total vs BAT_cognitive_imp – Phase 3 (All Mindfulness Practitic
PSS_total
BAT_cognitive_imp
Scatterplot: PSS_total vs BAT_emotional_imp – Phase 3 (All Mindfulness Practiti
PSS_total
BAT_emotional_imp
Residuals vs Fitted: PSS_total – Phase 3 (All Mindfulness Practitioners, Stress ob
Residuals
Fitted
Histogram of Residuals: PSS_total – Phase 3 (All Mindfulness Practitioners, Stres
count
Residuals
lot of Residuals: PSS_total – Phase 3 (All Mindfulness Practitioners, Stress
Sample Quantiles
Theoretical Quantiles
Scatterplot: brooding vs AttentionalControl – Phase 3 (All Mindfulness Practitioner
brooding
AttentionalControl
Scatterplot: brooding vs Rumination – Phase 3 (All Mindfulness Practitioners, Stre
brooding
Rumination
Scatterplot: brooding vs Burnout – Phase 3 (All Mindfulness Practitioners, Stress
brooding
Burnout
Scatterplot: brooding vs PSS_total – Phase 3 (All Mindfulness Practitioners, Stres
brooding
PSS_total

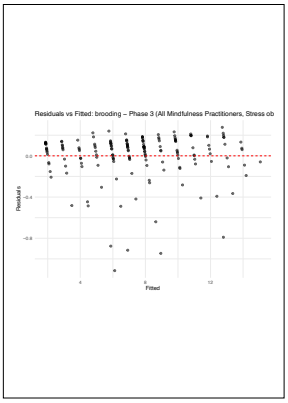

Scatterplot: brooding vs reflection – Phase 3 (All Mindfulness Practitioners, Stress
brooding
reflection

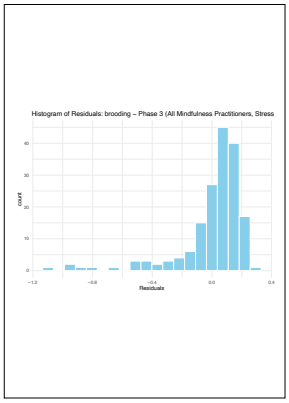

Scatterplot: brooding vs BAT_exhaustion – Phase 3 (All Mindfulness Practitioners,
brooding
BAT_exhaustion

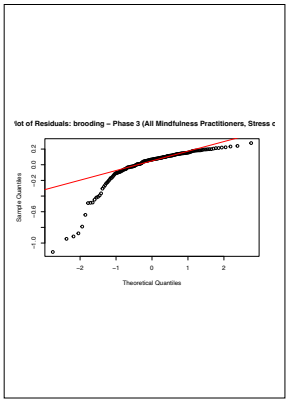

Scatterplot: brooding vs BAT_mental_dist – Phase 3 (All Mindfulness Practitioners
brooding
BAT_mental_dist

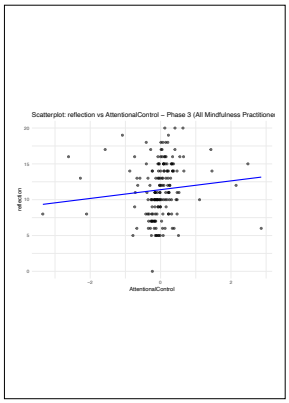

Scatterplot: brooding vs BAT_cognitive_imp – Phase 3 (All Mindfulness Practitione
brooding
BAT_cognitive_imp

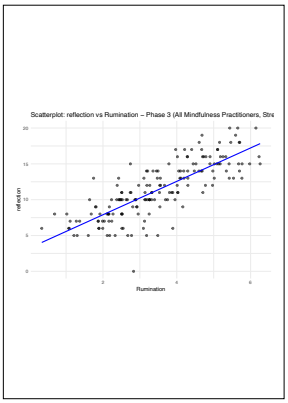

Scatterplot: brooding vs BAT_emotional_imp – Phase 3 (All Mindfulness Practition
brooding
BAT_emotional_imp

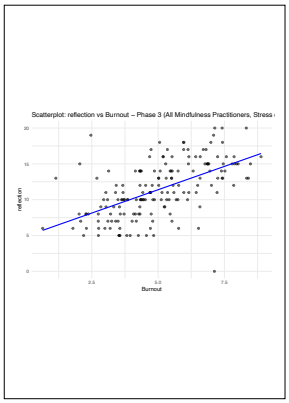

Residuals vs Fitted: brooding – Phase 3 (All Mindfulness Practitioners, Stress ob
Residuals
Fitted

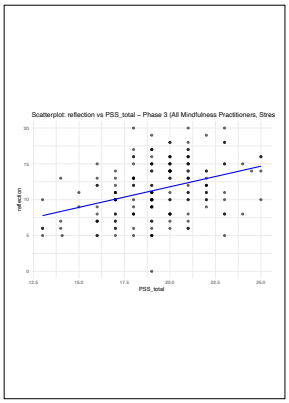

Histogram of Residuals: brooding – Phase 3 (All Mindfulness Practitioners, Stress
count
Residuals

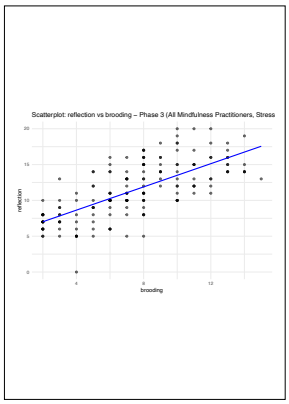

lot of Residuals: brooding – Phase 3 (All Mindfulness Practitioners, Stress c
Sample Quantiles
Theoretical Quantiles

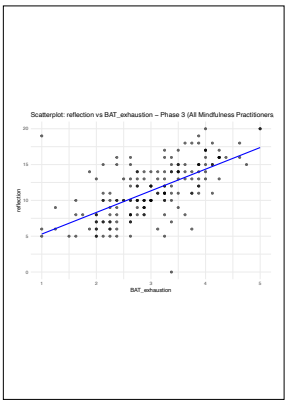

Scatterplot: reflection vs AttentionalControl – Phase 3 (All Mindfulness Practitione
reflection
AttentionalControl


Scatterplot: reflection vs Rumination – Phase 3 (All Mindfulness Practitioners, Stre
reflection
Rumination


Scatterplot: reflection vs Burnout – Phase 3 (All Mindfulness Practitioners, Stress
reflection
Burnout


Scatterplot: reflection vs PSS_total – Phase 3 (All Mindfulness Practitioners, Stres
reflection
PSS_total


Scatterplot: reflection vs brooding – Phase 3 (All Mindfulness Practitioners, Stress
reflection
brooding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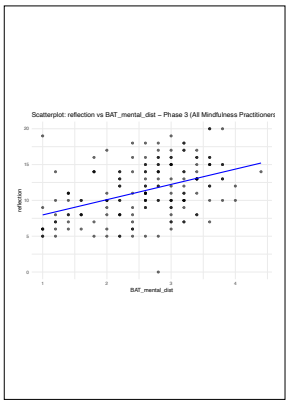
reflection
BAT_exhaustion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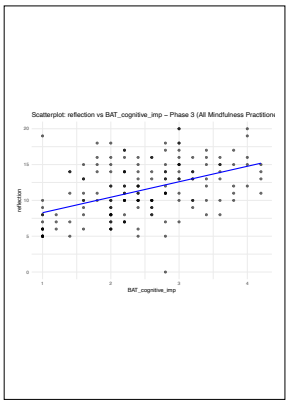
BAT_mental_dist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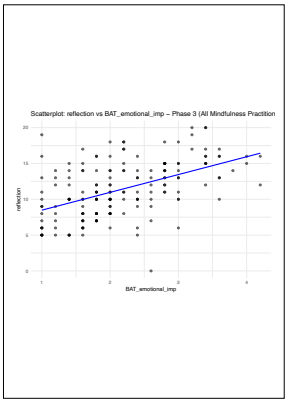
BAT_cognitive_imp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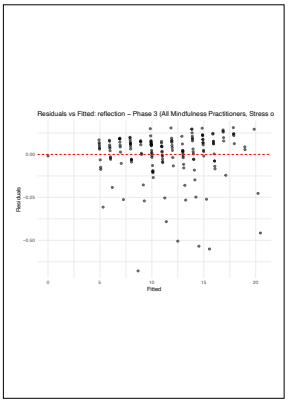
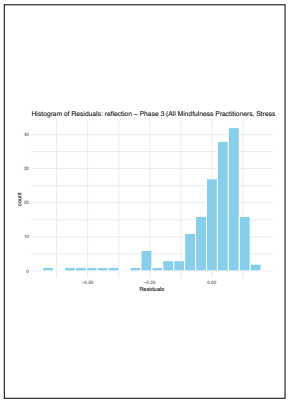

Residuals vs Fitted: reflection – Phase 3 (All Mindfulness Practitioners, Stress o
Residuals
Fitted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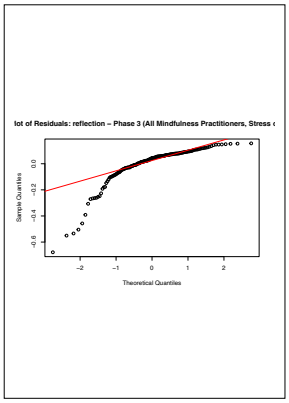
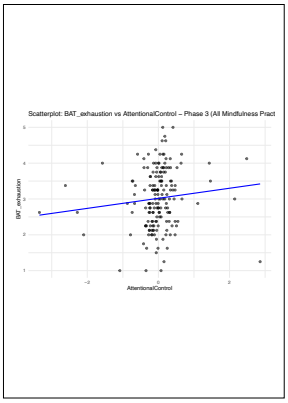
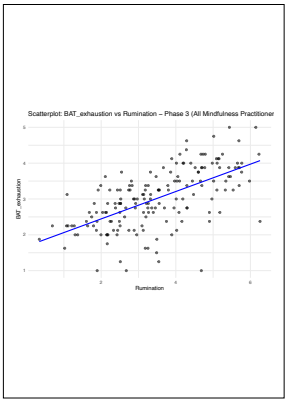
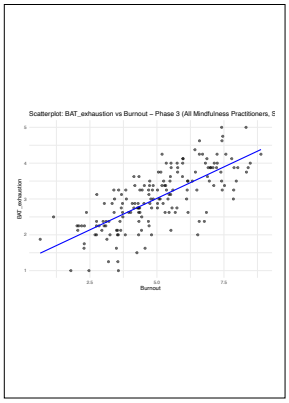
count
Residuals


lot of Residuals: reflection – Phase 3 (All Mindfulness Practitioners, Stress
Sample Quantiles
Theoretical Quantiles


Scatterplot: BAT_exhaustion vs AttentionalControl – Phase 3 (All Mindfulness Pract
BAT_exhaustion
AttentionalControl


Scatterplot: BAT_exhaustion vs Rumination – Phase 3 (All Mindfulness Practitioner
BAT_exhaustion
Rumination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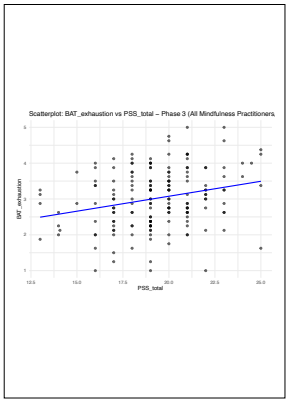
Burnout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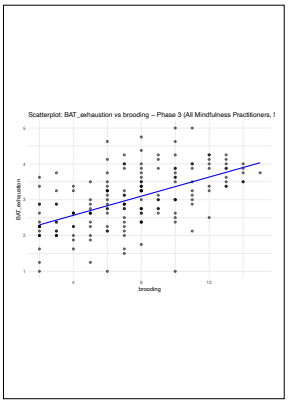
PSS_total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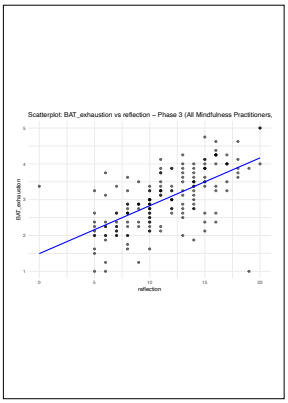
brooding


Scatterplot: BAT_exhaustion vs reflection – Phase 3 (All Mindfulness Practitioners,
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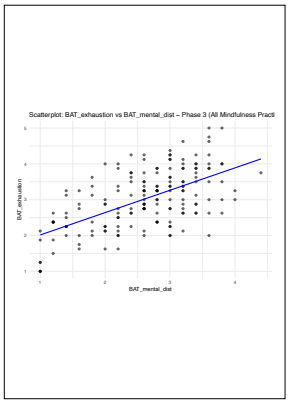
reflection


Scatterplot: BAT_exhaustion vs BAT_mental_dist – Phase 3 (All Mindfulness Practi
BAT_exhaustion
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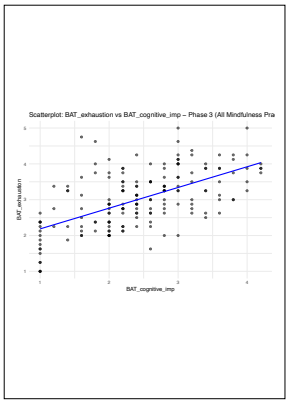
Scatterplot: BAT_exhaustion vs BAT_cognitive_imp – Phase 3 (All Mindfulness Pra
BAT_exhaustion
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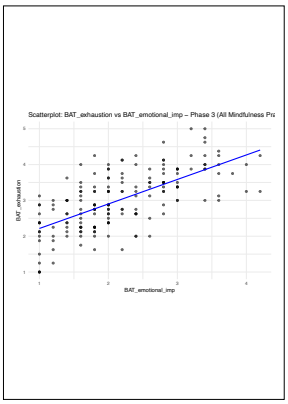
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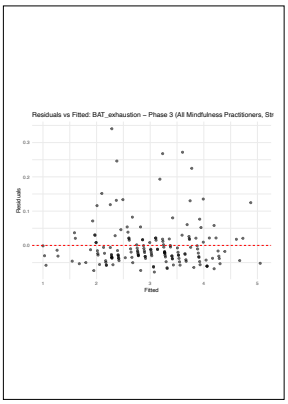
BAT_emotional_imp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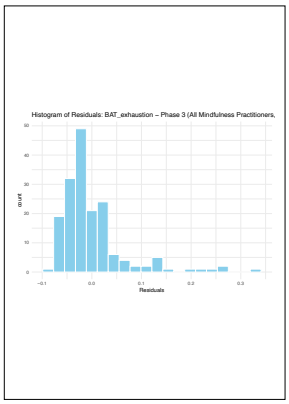
Fitted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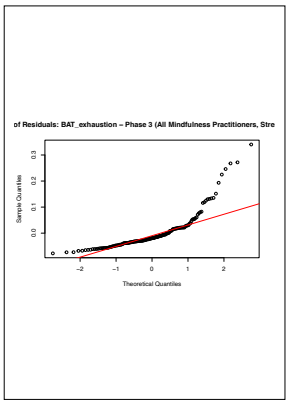
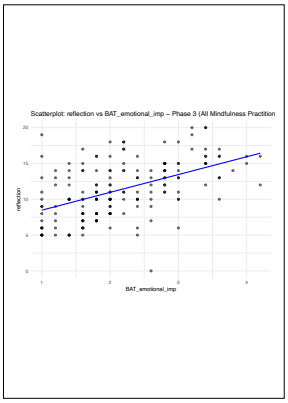
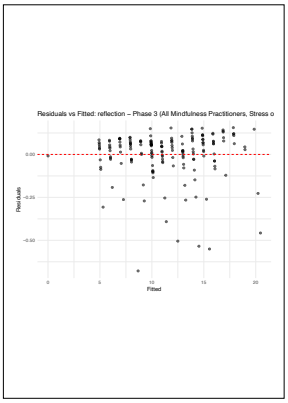
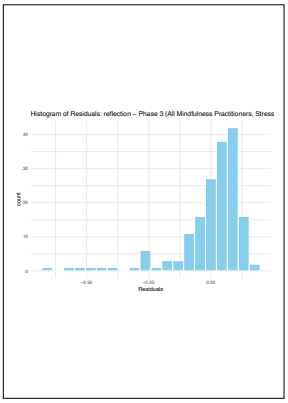
Residuals


of Residuals: BAT_exhaustion – Phase 3 (All Mindfulness Practitioners, Stre
Sample Quantiles
Theoretical Quantiles


Scatterplot: reflection vs BAT_emotional_imp – Phase 3 (All Mindfulness Practition
reflection
BAT_emotional_imp


Residuals vs Fitted: reflection – Phase 3 (All Mindfulness Practitioners, Stress o
Residuals
Fitted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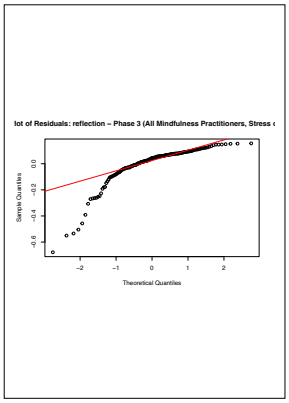
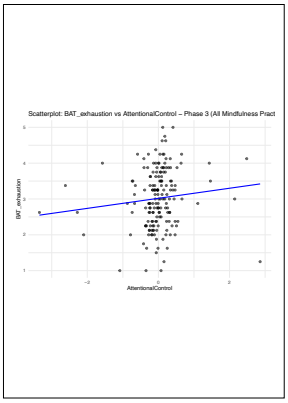
count
Residuals


lot of Residuals: reflection – Phase 3 (All Mindfulness Practitioners, Stress
Sample Quantiles
Theoretical Quantiles


Scatterplot: BAT_exhaustion vs AttentionalControl – Phase 3 (All Mindfulness Pract
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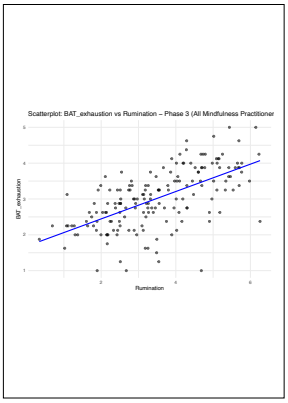
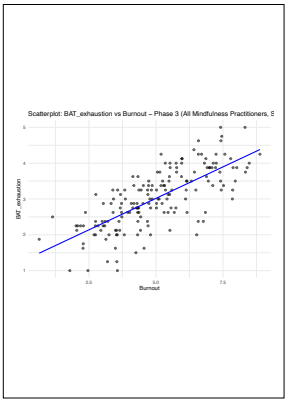
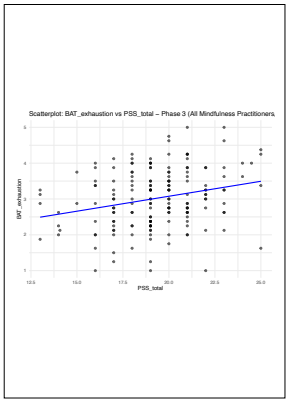
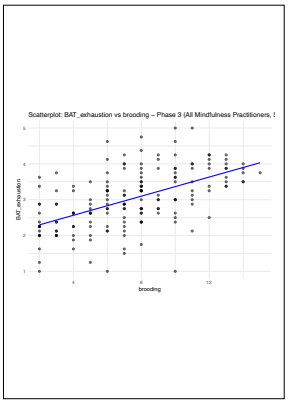
AttentionalControl


Scatterplot: BAT_exhaustion vs Rumination – Phase 3 (All Mindfulness Practitioner
BAT_exhaustion
Rumination


Scatterplot: BAT_exhaustion vs Burnout – Phase 3 (All Mindfulness Practitioners, S
BAT_exhaustion
Burnout


Scatterplot: BAT_exhaustion vs PSS_total – Phase 3 (All Mindfulness Practitioners,
BAT_exhaustion
PSS_total


Scatterplot: BAT_exhaustion vs brooding – Phase 3 (All Mindfulness Practitioners, I
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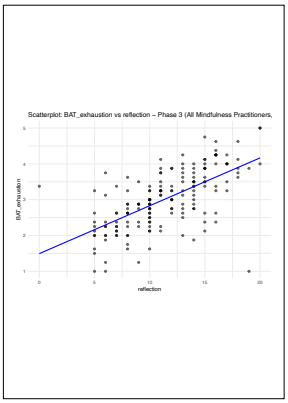
brooding


Scatterplot: BAT_exhaustion vs reflection – Phase 3 (All Mindfulness Practitioners,
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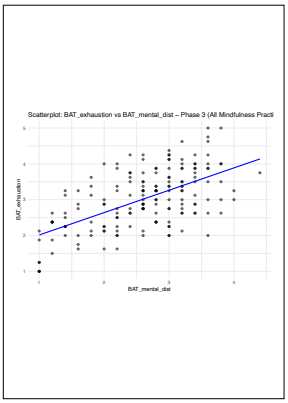
Scatterplot: BAT_exhaustion vs BAT_mental_dist – Phase 3 (All Mindfulness Practi
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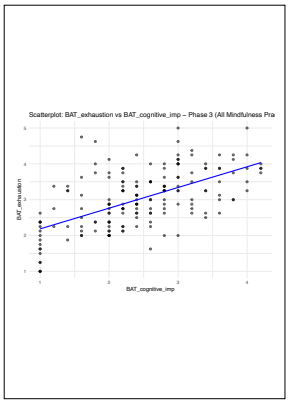
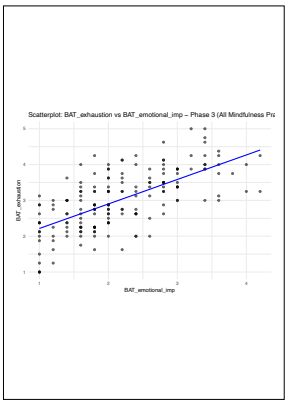
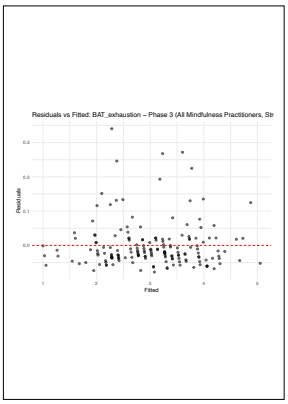
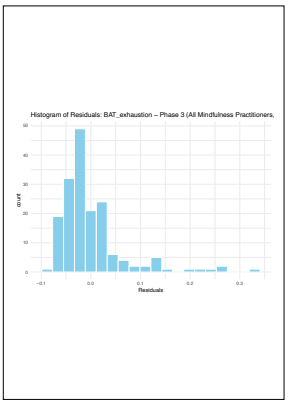
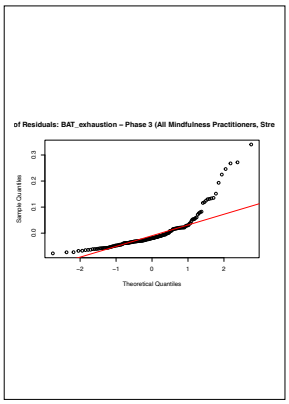
BAT_mental_dist

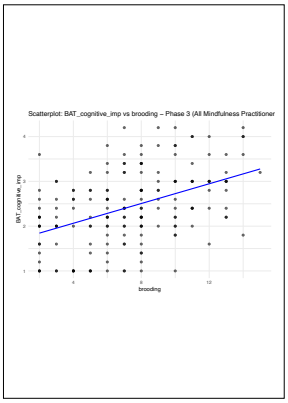

Scatterplot: BAT_exhaustion vs BAT_cognitive_imp – Phase 3 (All Mindfulness Pra
BAT_exhaustion
BAT_cognitive_imp


Scatterplot: BAT_exhaustion vs BAT_emotional_imp – Phase 3 (All Mindfulness Pra
BAT_exhaustion
BAT_emotional_imp

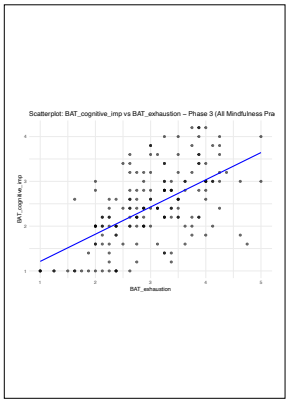

Residuals vs Fitted: BAT_exhaustion – Phase 3 (All Mindfulness Practitioners, Str
Residuals
Fitted


Histogram of Residuals: BAT_exhaustion – Phase 3 (All Mindfulness Practitioners,
count
Residuals


of Residuals: BAT_exhaustion – Phase 3 (All Mindfulness Practitioners, Stre
Sample Quantiles
Theoretical Quantiles


Scatterplot: BAT_cognitive_imp vs brooding – Phase 3 (All Mindfulness Practitioner
BAT_cognitive_imp
brooding


Scatterplot: BAT_cognitive_imp vs reflection – Phase 3 (All Mindfulness Practitione
BAT_cognitive_imp
reflection


Scatterplot: BAT_cognitive_imp vs BAT_exhaustion – Phase 3 (All Mindfulness Pra
BAT_cognitive_imp
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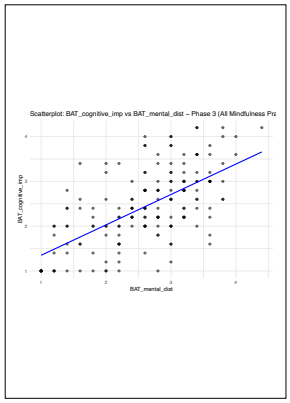
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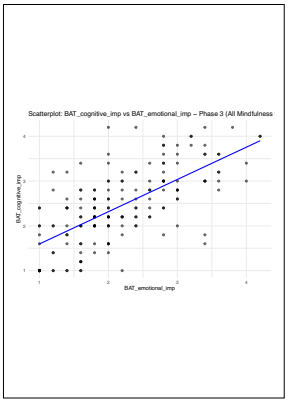
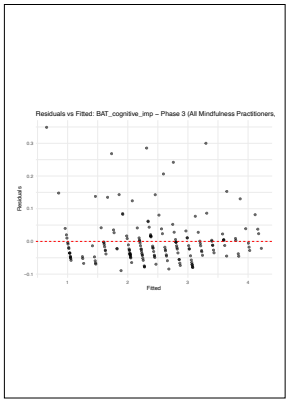
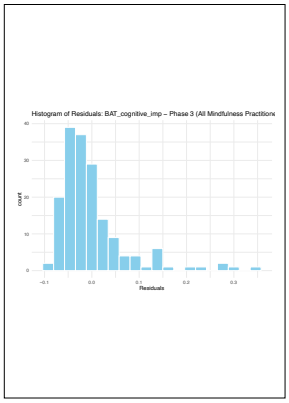
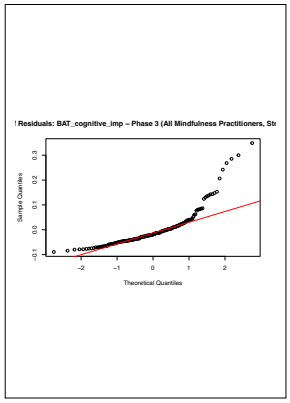
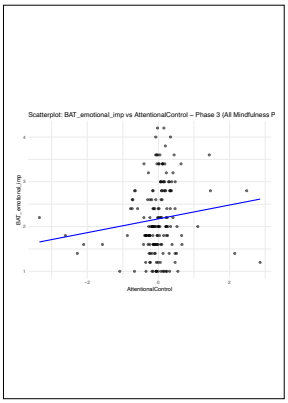
BAT_cognitive_imp
BAT_mental_dist

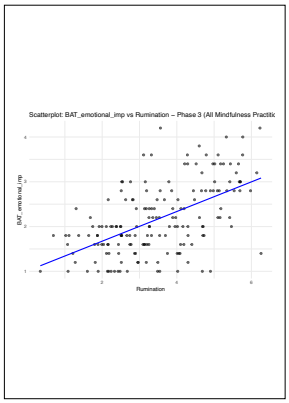

Scatterplot: BAT_cognitive_imp vs BAT_emotional_imp – Phase 3 (All Mindfulness
BAT_cognitive_imp
BAT_emotional_imp


Residuals vs Fitted: BAT_cognitive_imp – Phase 3 (All Mindfulness Practitioners,
Residuals
Fitted


Histogram of Residuals: BAT_cognitive_imp – Phase 3 (All Mindfulness Practitione
count
Residuals


Residuals: BAT_cognitive_imp – Phase 3 (All Mindfulness Practitioners, Str
Sample Quantiles
Theoretical Quantiles


Scatterplot: BAT_emotional_imp vs AttentionalControl – Phase 3 (All Mindfulness P
BAT_emotional_imp
AttentionalControl


Scatterplot: BAT_emotional_imp vs Rumination – Phase 3 (All Mindfulness Practitic
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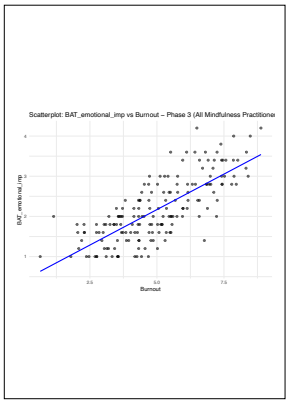
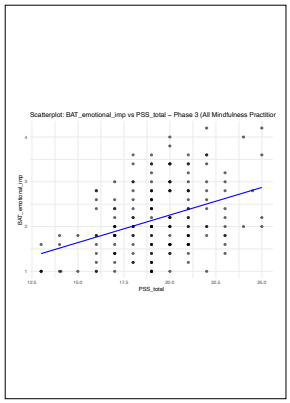
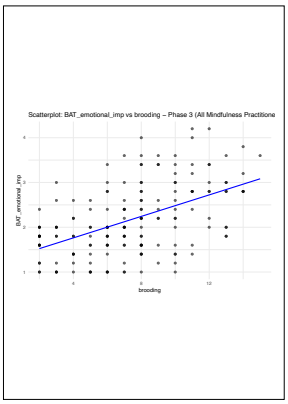
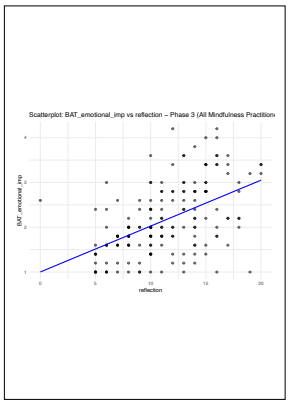
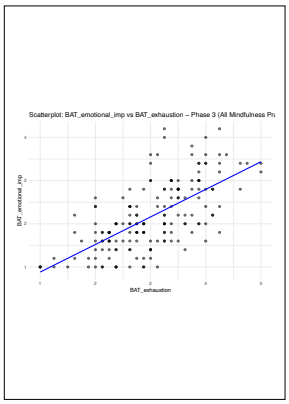
Rumination

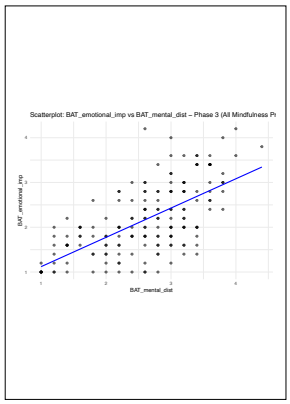

Scatterplot: BAT_emotional_imp vs Burnout – Phase 3 (All Mindfulness Practitione
BAT_emotional_imp
Burnout

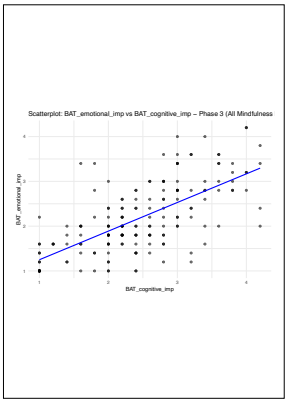

Scatterplot: BAT_emotional_imp vs PSS_total – Phase 3 (All Mindfulness Practitior
BAT_emotional_imp
PSS_total

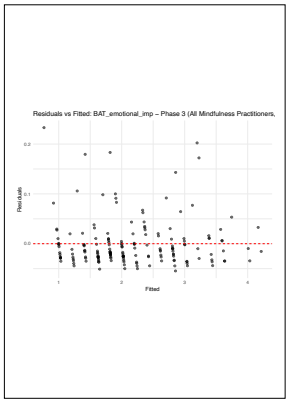

Scatterplot: BAT_emotional_imp vs brooding – Phase 3 (All Mindfulness Practitione
BAT_emotional_imp
brooding

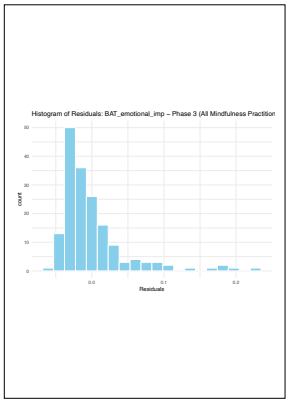

Scatterplot: BAT_emotional_imp vs reflection – Phase 3 (All Mindfulness Practition
BAT_emotional_imp
reflection

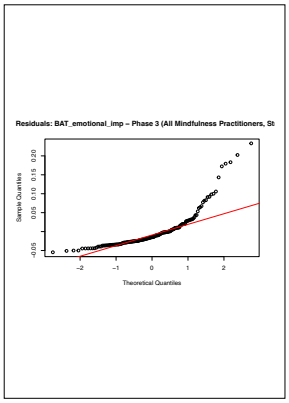

Scatterplot: BAT_emotional_imp vs BAT_exhaustion – Phase 3 (All Mindfulness Pra
BAT_emotional_imp
BAT_exhaustion

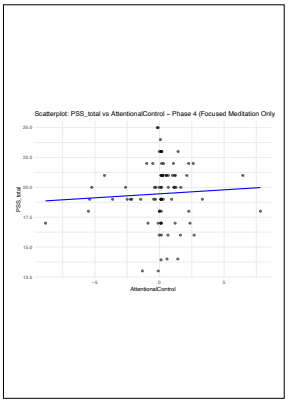

Scatterplot: BAT_emotional_imp vs BAT_mental_dist – Phase 3 (All Mindfulness Pra
BAT_emotional_imp
BAT_mental_dist

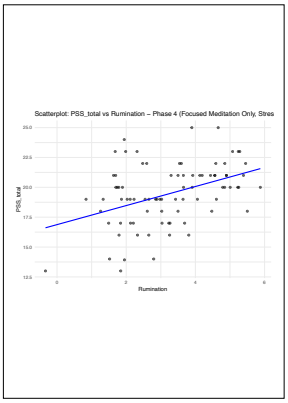

Scatterplot: BAT_emotional_imp vs BAT_cognitive_imp – Phase 3 (All Mindfulness
BAT_emotional_imp
BAT_cognitive_imp

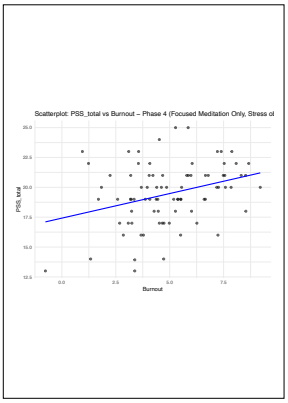

Residuals vs Fitted: BAT_emotional_imp – Phase 3 (All Mindfulness Practitioners,
Residuals
Fitted

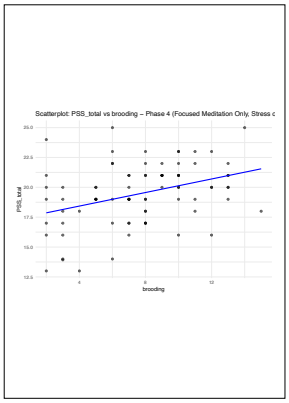

Histogram of Residuals: BAT_emotional_imp – Phase 3 (All Mindfulness Practitior
count
Residuals

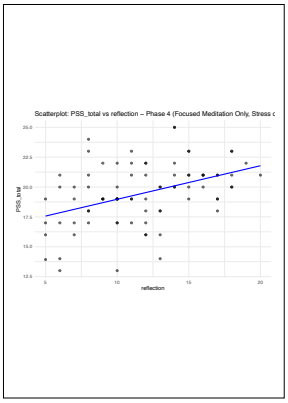

Residuals: BAT_emotional_imp – Phase 3 (All Mindfulness Practitioners, St
Sample Quantiles
Theoretical Quantiles

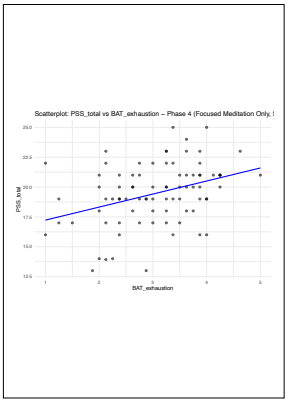

Scatterplot: PSS_total vs AttentionalControl – Phase 4 (Focused Meditation Only
PSS_total
AttentionalControl

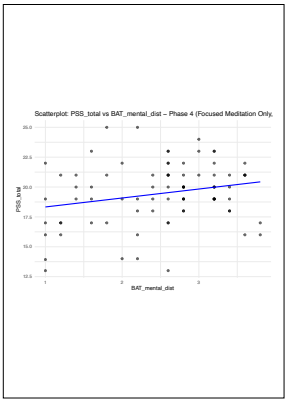

Scatterplot: PSS_total vs Rumination – Phase 4 (Focused Meditation Only, Stres
PSS_total
Rumination


Scatterplot: PSS_total vs Burnout – Phase 4 (Focused Meditation Only, Stress ol
PSS_total
Burnout


Scatterplot: PSS_total vs brooding – Phase 4 (Focused Meditation Only, Stress
PSS_total
brooding


Scatterplot: PSS_total vs reflection – Phase 4 (Focused Meditation Only, Stress
PSS_total
reflection


Scatterplot: PSS_total vs BAT_exhaustion – Phase 4 (Focused Meditation Only,
PSS_total
BAT_exhaustion


Scatterplot: PSS_total vs BAT_mental_dist – Phase 4 (Focused Meditation Only,
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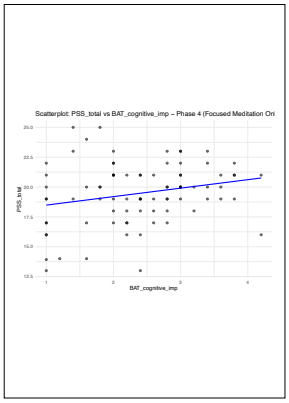
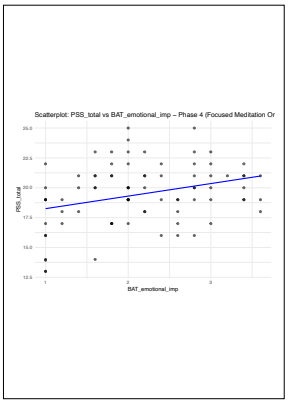
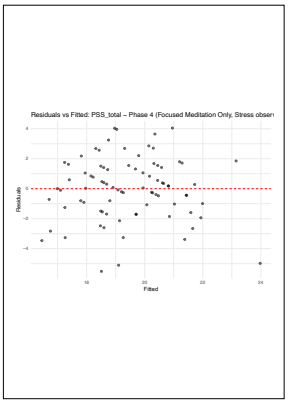
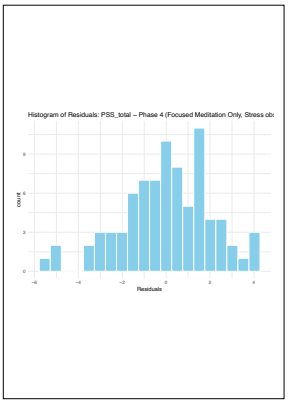
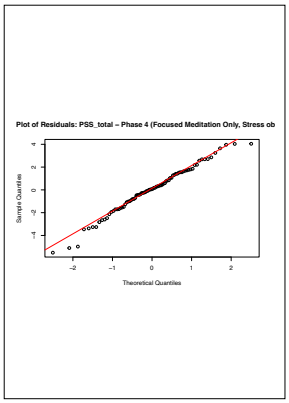
BAT_mental_dist

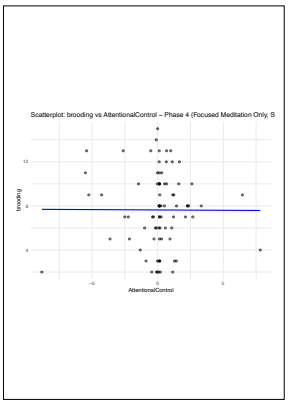

Scatterplot: PSS_total vs BAT_cognitive_imp – Phase 4 (Focused Meditation Onl
PSS_total
BAT_cognitive_imp


Scatterplot: PSS_total vs BAT_emotional_imp – Phase 4 (Focused Meditation Or
PSS_total
BAT_emotional_imp


Residuals vs Fitted: PSS_total – Phase 4 (Focused Meditation Only, Stress obser
Residuals
Fitted


Histogram of Residuals: PSS_total – Phase 4 (Focused Meditation Only, Stress ob
count
Residuals


Plot of Residuals: PSS_total – Phase 4 (Focused Meditation Only, Stress ob
Sample Quantiles
Theoretical Quantiles


Scatterplot: brooding vs AttentionalControl – Phase 4 (Focused Meditation Only, S
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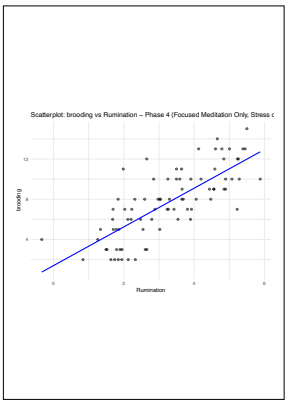
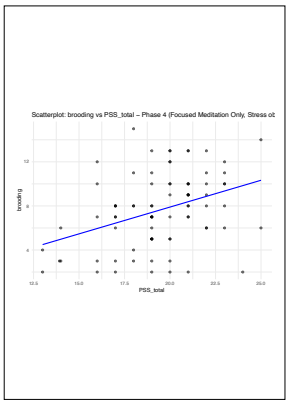
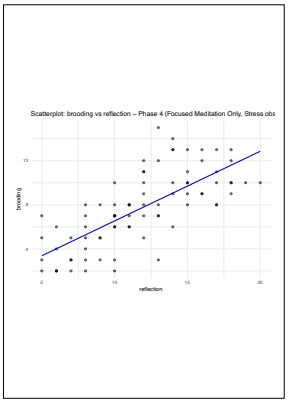
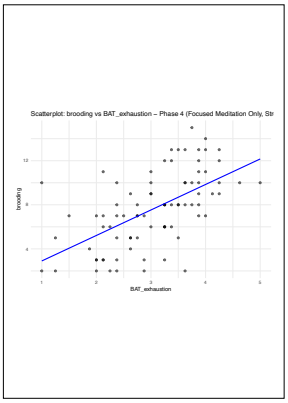
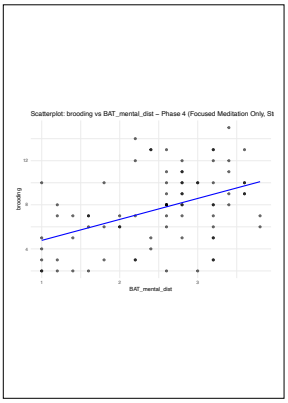

Scatterplot: brooding vs Rumination – Phase 4 (Focused Meditation Only, Stress
brooding
Rumination

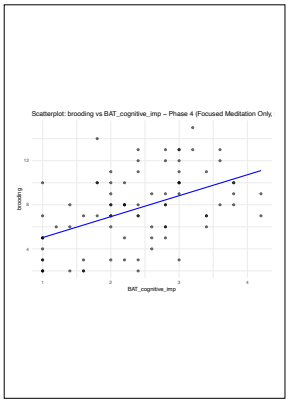

Scatterplot: brooding vs Burnout – Phase 4 (Focused Meditation Only, Stress obse
brooding
Burnout

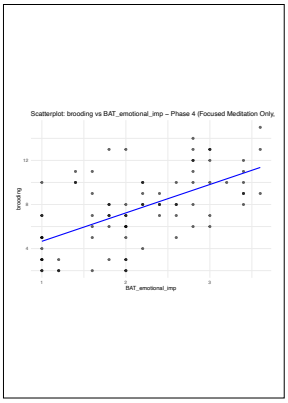

Scatterplot: brooding vs PSS_total – Phase 4 (Focused Meditation Only, Stress ob
brooding
PSS_total


Scatterplot: brooding vs reflection – Phase 4 (Focused Meditation Only, Stress obs
brooding
reflection


Scatterplot: brooding vs BAT_exhaustion – Phase 4 (Focused Meditation Only, Str
brooding
BAT_exhaustion


Scatterplot: brooding vs BAT_mental_dist – Phase 4 (Focused Meditation Only, St
brooding
BAT_mental_dist


Scatterplot: brooding vs BAT_cognitive_imp – Phase 4 (Focused Meditation Only,
brooding
BAT_cognitive_imp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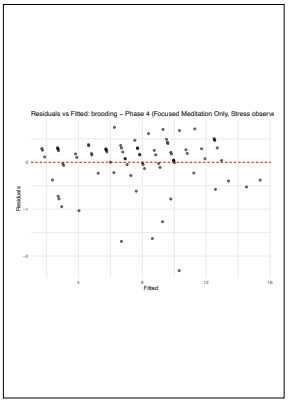
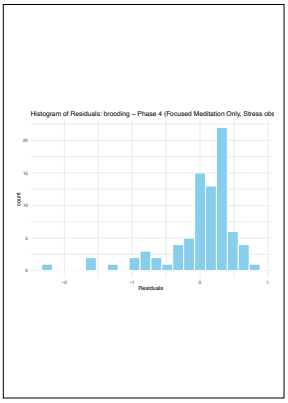
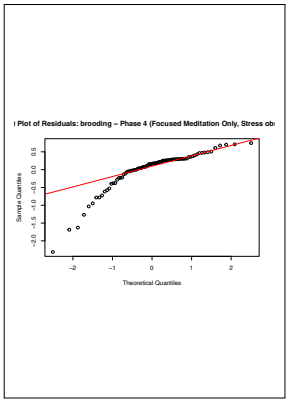
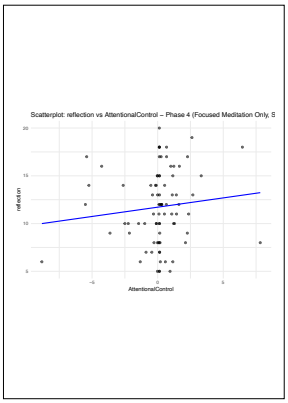
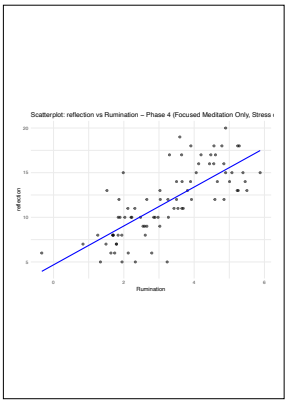
brooding
BAT_emotional_imp

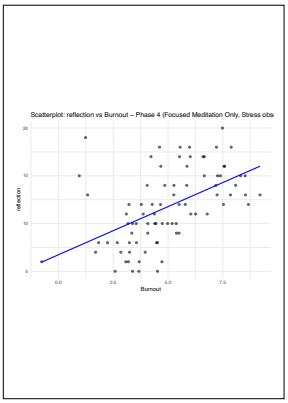

Residuals vs Fitted: brooding – Phase 4 (Focused Meditation Only, Stress observe
Residuals
Fitted

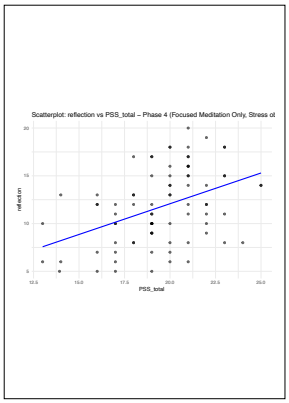

Histogram of Residuals: brooding – Phase 4 (Focused Meditation Only, Stress obs
count
Residuals

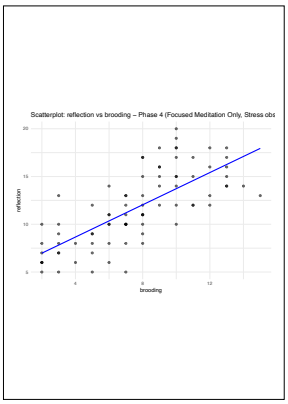

l Plot of Residuals: brooding – Phase 4 (Focused Meditation Only, Stress ob
Sample Quantiles
Theoretical Quantiles

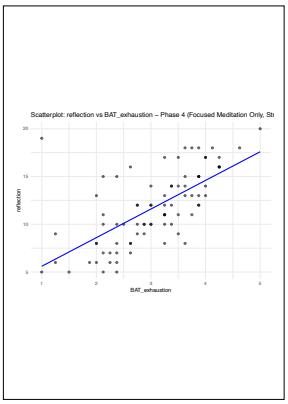

Scatterplot: reflection vs AttentionalControl – Phase 4 (Focused Meditation Only, S
reflection
AttentionalControl

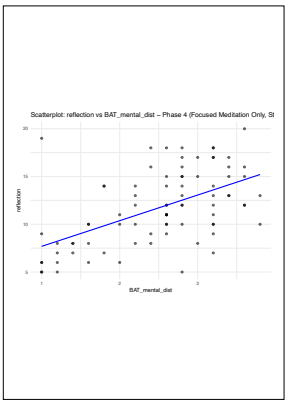

Scatterplot: reflection vs Rumination – Phase 4 (Focused Meditation Only, Stress
reflection
Rumination

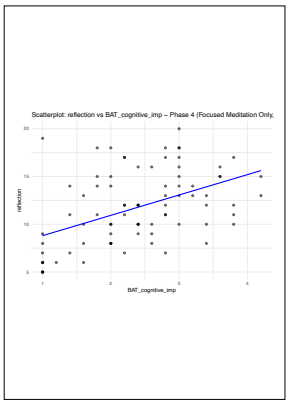

Scatterplot: reflection vs Burnout – Phase 4 (Focused Meditation Only, Stress obs
reflection
Burnout

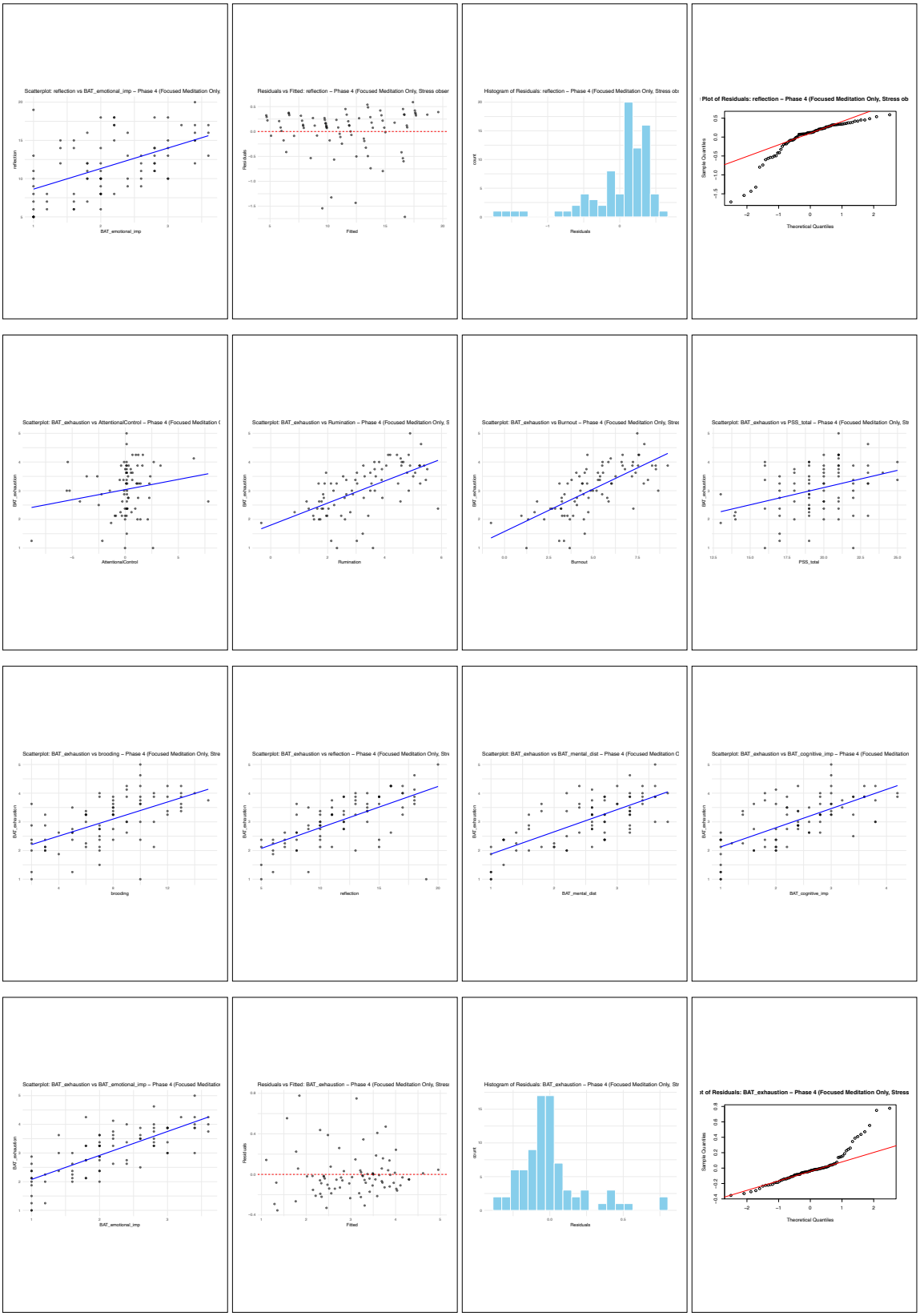

Scatterplot: reflection vs PSS_total – Phase 4 (Focused Meditation Only, Stress ob
reflection
PSS_total

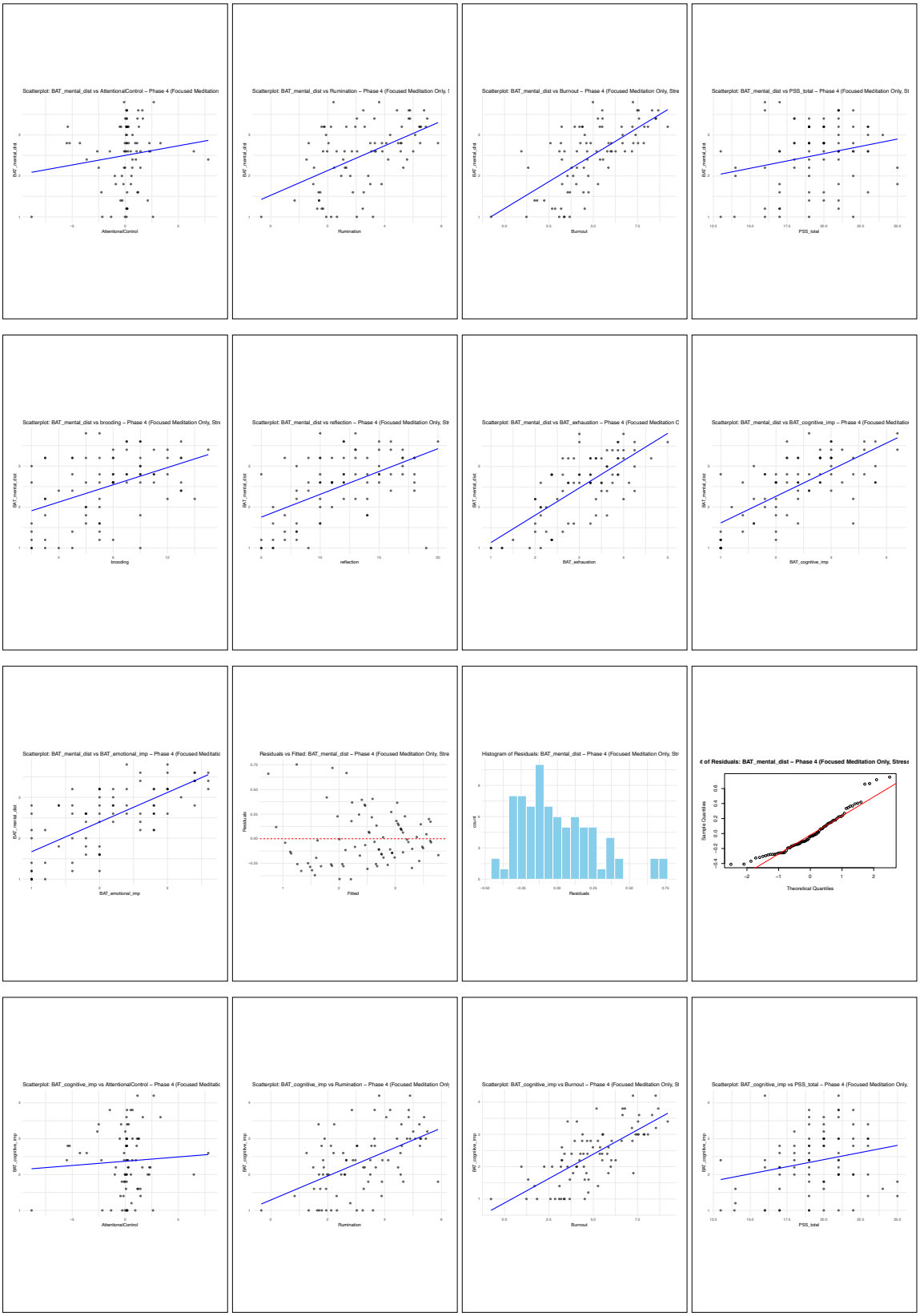

Scatterplot: reflection vs brooding – Phase 4 (Focused Meditation Only, Stress obs
reflection
brooding

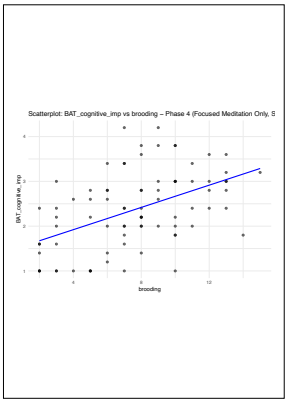

Scatterplot: reflection vs BAT_exhaustion – Phase 4 (Focused Meditation Only, Str
reflection
BAT_exhaustion

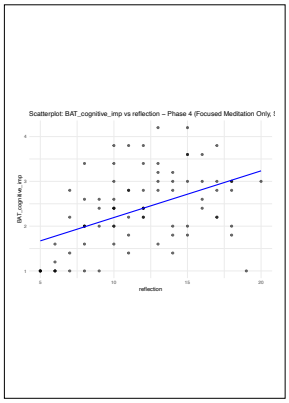

Scatterplot: reflection vs BAT_mental_dist – Phase 4 (Focused Meditation Only, St
reflection
BAT_mental_dist

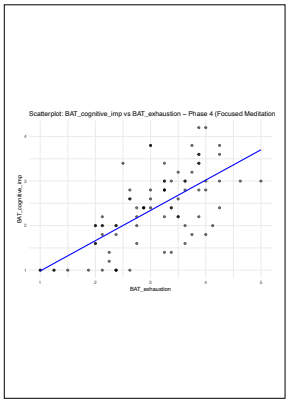

Scatterplot: reflection vs BAT_cognitive_imp – Phase 4 (Focused Meditation Only,
reflection
BAT_cognitive_imp

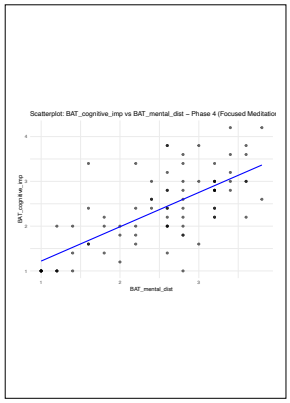

Scatterplot: reflection vs BAT_emotional_imp – Phase 4 (Focused Meditation Only
Residuals vs Fitted: reflection – Phase 4 (Focused Meditation Only, Stress obser
Histogram of Residuals: reflection – Phase 4 (Focused Meditation Only, Stress ob
Plot of Residuals: reflection – Phase 4 (Focused Meditation Only, Stress ob
Scatterplot: BAT_exhaustion vs AttentionalControl – Phase 4 (Focused Meditation (
Scatterplot: BAT_exhaustion vs Rumination – Phase 4 (Focused Meditation Only, S
Scatterplot: BAT_exhaustion vs Burnout – Phase 4 (Focused Meditation Only, Stres
Scatterplot: BAT_exhaustion vs PSS_total – Phase 4 (Focused Meditation Only, Str
Scatterplot: BAT_exhaustion vs brooding – Phase 4 (Focused Meditation Only, Stre
Scatterplot: BAT_exhaustion vs reflection – Phase 4 (Focused Meditation Only, Str
Scatterplot: BAT_exhaustion vs BAT_mental_dist – Phase 4 (Focused Meditation C
Scatterplot: BAT_exhaustion vs BAT_cognitive_imp – Phase 4 (Focused Meditation
Scatterplot: BAT_exhaustion vs BAT_emotional_imp – Phase 4 (Focused Meditation
Residuals vs Fitted: BAT_exhaustion – Phase 4 (Focused Meditation Only, Stress
Histogram of Residuals: BAT_exhaustion – Phase 4 (Focused Meditation Only, Str
t of Residuals: BAT_exhaustion – Phase 4 (Focused Meditation Only, Stress

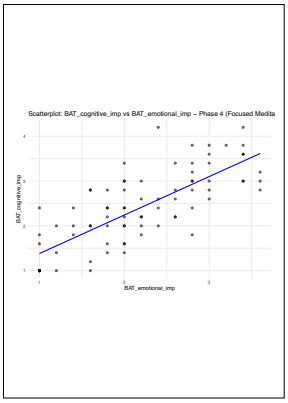

Scatterplot: BAT_mental_dist vs AttentionalControl – Phase 4 (Focused Meditation
Scatterplot: BAT_mental_dist vs Rumination – Phase 4 (Focused Meditation Only, I
Scatterplot: BAT_mental_dist vs Burnout – Phase 4 (Focused Meditation Only, Stre
Scatterplot: BAT_mental_dist vs PSS_total – Phase 4 (Focused Meditation Only, St
Scatterplot: BAT_mental_dist vs brooding – Phase 4 (Focused Meditation Only, Str
Scatterplot: BAT_mental_dist vs reflection – Phase 4 (Focused Meditation Only, Str
Scatterplot: BAT_mental_dist vs BAT_exhaustion – Phase 4 (Focused Meditation C
Scatterplot: BAT_mental_dist vs BAT_cognitive_imp – Phase 4 (Focused Meditatio
Scatterplot: BAT_mental_dist vs BAT_emotional_imp – Phase 4 (Focused Meditatio
Residuals vs Fitted: BAT_mental_dist – Phase 4 (Focused Meditation Only, Stre
Histogram of Residuals: BAT_mental_dist – Phase 4 (Focused Meditation Only, Str
t of Residuals: BAT_mental_dist – Phase 4 (Focused Meditation Only, Stress
Scatterplot: BAT_cognitive_imp vs AttentionalControl – Phase 4 (Focused Meditatio
Scatterplot: BAT_cognitive_imp vs Rumination – Phase 4 (Focused Meditation Onl
Scatterplot: BAT_cognitive_imp vs Burnout – Phase 4 (Focused Meditation Only, St
Scatterplot: BAT_cognitive_imp vs PSS_total – Phase 4 (Focused Meditation Only,

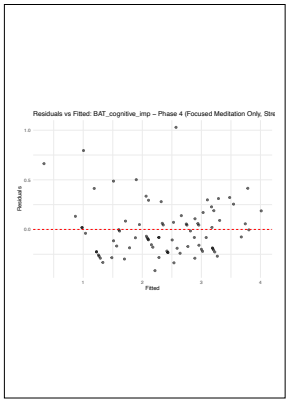

Scatterplot: BAT_cognitive_imp vs brooding – Phase 4 (Focused Meditation Only, S
BAT_cognitive_imp
brooding

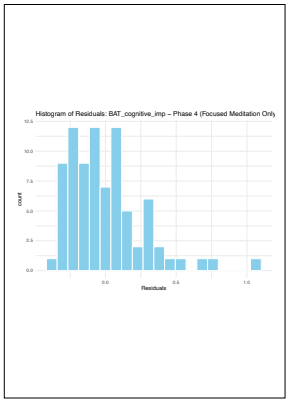

Scatterplot: BAT_cognitive_imp vs reflection – Phase 4 (Focused Meditation Only, I
BAT_cognitive_imp
reflection

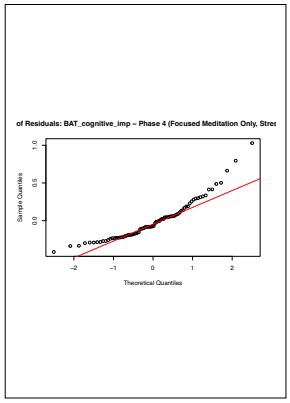

Scatterplot: BAT_cognitive_imp vs BAT_exhaustion – Phase 4 (Focused Meditation
BAT_cognitive_imp
BAT_exhaustion

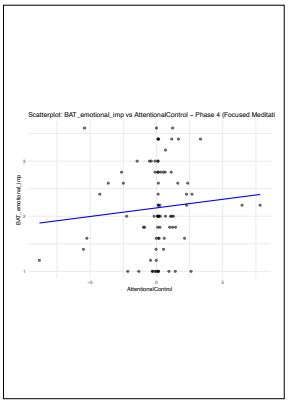

Scatterplot: BAT_cognitive_imp vs BAT_mental_dist – Phase 4 (Focused Meditatio
BAT_cognitive_imp
BAT_mental_dist

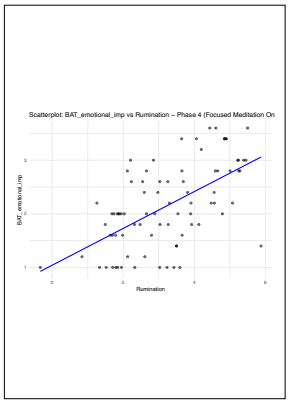

Scatterplot: BAT_cognitive_imp vs BAT_emotional_imp – Phase 4 (Focused Medita
BAT_cognitive_imp
BAT_emotional_imp

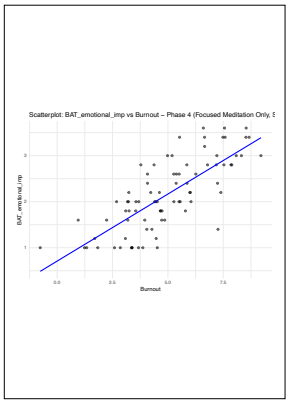

Residuals vs Fitted: BAT_cognitive_imp – Phase 4 (Focused Meditation Only, Stre
Residuals
Fitted

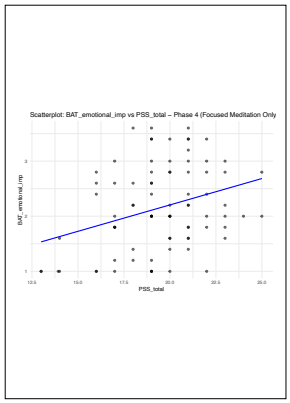

Histogram of Residuals: BAT_cognitive_imp – Phase 4 (Focused Meditation Only
count
Residuals


of Residuals: BAT_cognitive_imp – Phase 4 (Focused Meditation Only, Stres
Sample Quantiles
Theoretical Quantiles


Scatterplot: BAT_emotional_imp vs AttentionalControl – Phase 4 (Focused Meditati
BAT_emotional_imp
AttentionalControl


Scatterplot: BAT_emotional_imp vs Rumination – Phase 4 (Focused Meditation On
BAT_emotional_imp
Rumination


Scatterplot: BAT_emotional_imp vs Burnout – Phase 4 (Focused Meditation Only, S
BAT_emotional_imp
Burnout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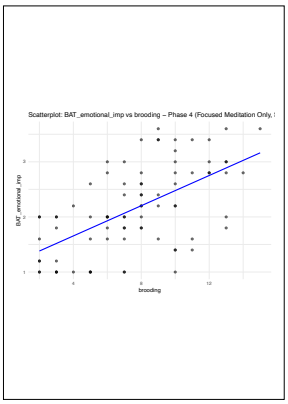
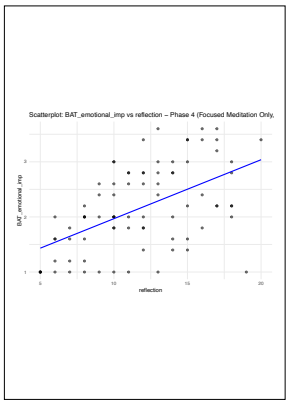
BAT_emotional_imp
PSS_total


Scatterplot: BAT_emotional_imp vs brooding – Phase 4 (Focused Meditation Only, I
BAT_emotional_imp
brooding


Scatterplot: BAT_emotional_imp vs reflection – Phase 4 (Focused Meditation Only,
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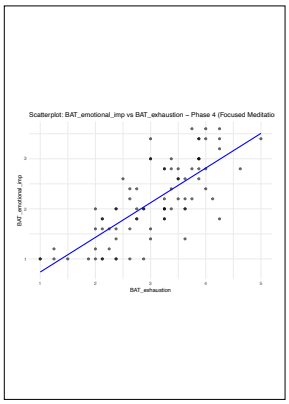
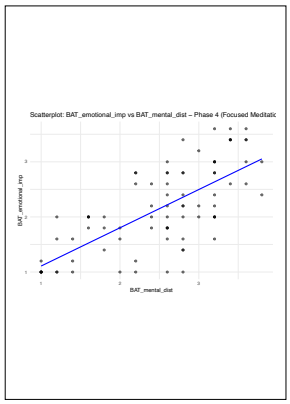
reflection


Scatterplot: BAT_emotional_imp vs BAT_exhaustion – Phase 4 (Focused Meditatio
BAT_emotional_imp
BAT_exhaustion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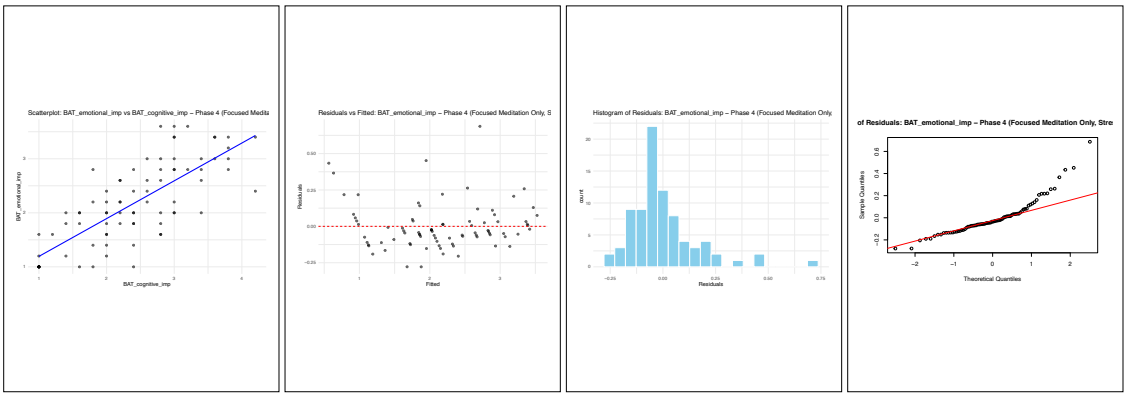
BAT_emotional_imp
BAT_mental_dist


Scatterplot: BAT_emotional_imp vs BAT_cognitive_imp – Phase 4 (Focused Medita
BAT_emotional_imp
BAT_cognitive_imp
Residuals vs Fitted: BAT_emotional_imp – Phase 4 (Focused Meditation Only, S
Residuals
Fitted
Histogram of Residuals: BAT_emotional_imp – Phase 4 (Focused Meditation Only
count
Residuals
of Residuals: BAT_emotional_imp – Phase 4 (Focused Meditation Only, Stre
Sample Quantiles
Theoretical Quantiles

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