DISSERTATION

HEART RATE VARIABILITY (HRV) TRAINING LEADS TO IMPROVEMENTS IN MEASURES OF EMPLOYEE MENTAL AND PHYSICAL HEALTH DURING COVID-19 PANDEMIC, WITH IMPLICATIONS FOR THEORY BUILDING AND HRD

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ABSTRACT

HEART RATE VARIABILITY (HRV) TRAINING LEADS TO IMPROVEMENTS IN MEASURES OF EMPLOYEE MENTAL AND PHYSICAL HEALTH DURING COVID-19 PANDEMIC, WITH IMPLICATIONS FOR THEORY BUILDING AND HRD

Data indicated that work-related stress could cost organizations financially, with losses associated with decreased productivity, healthcare costs and organizational dysfunction. Excessive stress in the workplace can cause significant costs to the employee as measured by declines in psychological and physiological health. Stress induced health symptoms and corresponding costs to the organization may be exacerbated by the COVID-19 Pandemic. These disruptions can affect organizational functioning as well the system's ability to dynamically respond to opportunities, challenges and organizational goals all of which can further increase employee stress and associated health outcomes. Human resource development professionals are in a position to offer interventions to help employees and organizational systems adjust to these new demands. Heart rate variability (HRV) training as a workplace wellness intervention to reduce stress for impacted employees has emerged as a promising line of research and applied work, with data supporting improved physical/mental health, learning and development and organizational outcomes.

The purpose of this study was to investigate the effects of a HRV training intervention on measures of employee health and organizational outcomes during the COVID-19 pandemic. Empirical data collection for this inquiry was operationalized with a quantitative, between-groups, experimental research design to test the effects of a HRV self-regulation training on participants who were randomly assigned to active treatment groups and non-participant groups

(wait-list control). Participants were assessed on psychological and physiological health and organizational outcomes by analyzing results of the POQA-R4 survey. The study population (N = 147) consisted of employees at a large, multi-national, independent public company in the multi-utilities industry. Data analyses concluded that three of this study's five hypotheses were upheld. Hypotheses related to *emotional stress* (moderate effect size), *physical stress* (moderate effect size) and *emotional vitality* (borderline moderate effect size) were upheld. The findings associated with mental and physical stress were consistent with previous literature, while organizational results were more ambiguous.

Based on these findings, recommendations for future research, application, theory building and implications for HRD were offered. Specific recommendations included further refinement of conceptual/theoretical frames, measurement variables and assessment tools. Recommendations for practice focused on providing evidenced based wellness interventions (such as HRV self-regulation training), and reinforcing the organizational culture to support a range of wellness needs and to strengthen social systems, which serve as protective and mediating factors in times of stress. These recommendations may position HRD professionals as agile and dynamic leaders who implement organizational wellness to both support business objectives while reinforcing a culture of care.

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DEDICATION

This research is dedicated to all the participants who took part in this collaboration. You are the embodiment of heartfelt leadership. Additionally, I dedicate this to all HRD and organizational leaders who demonstrate the heart and courage to advocate for wellbeing initiatives in support of improved business outcomes and organization wellness for all community members.

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CHAPTER ONE: INTRODUCTION

This chapter introduces the costs associated with stress in the work place while introducing heart rate variability self-regulation in organizations as the research topic for this inquiry. Additionally, the purpose of the research along with the corresponding research question are provided including definitions of key terms.

Introduction

With the cost of many common and preventable diseases reaching more than $1 trillion annually and threatening to reach $6 trillion worldwide by 2050, the need for effective change initiatives is vital for the health of those impacted by many of these often times containable diseases, but also for business and national and international economies (DeVol et al., 2007). Specifically, a systematic review of the costs of work-related stress estimated that the included cost of illness ranged from $221.13 million to $187 billion. The authors noted that the range was attributed to differing definitions of work-related stress, types of costs, and measures of productivity and that the estimates reported are likely conservative because of the inclusion criteria for their analysis (Hassard et al., 2018). The authors calculated that losses associated with productivity contributed to 70-90% and healthcare costs contributing to 10-30% of cost of illness due to work-related stress (Hassard et al., 2018).

To mitigate the damaging outcomes associated with the rise of disease, many organizations are offering workplace wellness initiatives for employees. In fact, in 2019 large employers (classified as those with 200 employees or more) offered such programming, with benefits supporting approximately 63 million covered employees (Pollitz & Rae, 2020). The Kaiser Family Foundation Employer Benefits Survey noted that despite the increase in

workplace wellness offerings (from 41 million covered employees in 2008), additional evidence was recommended to support improved health and wellness outcomes (Kaiser Family Foundation, 2020).

The Centers for Disease Control and Prevention (CDC, 2020) noted that individual employees can experience a range of physiological and psychological symptoms due to organizational stress. Physiological symptoms of stress may include feeling tired, overwhelmed or burned out, trouble sleeping and concentrating, as well as psychological symptoms of anxiety, nervousness, irritation, anger, depression and denial. How one copes with such stressors could impact personal well-being as well as the well-being of other members of both work and social systems, and that these symptoms may be exacerbated by the COVID-19 Pandemic (CDC, 2020).

The disruptions associated with the COVID-19 pandemic can impact organizational functioning as well the system's ability to dynamically respond to opportunities, challenges and organizational goals (Arora & Suri, 2020), all of which can further increase employee stress and associated health outcomes. It was argued that human resource development (HRD) professionals are uniquely positioned to offer interventions to help employees adjust to some of the new challenges associated with the COVID-19 pandemic, which may include "nontraditional" interventions to support employees experiencing increased stress levels associated with remote work and changing work demands (Hammer, 2021). How leaders respond to these changes can affect employee confidence and organizational performance. Among findings for "personal best leadership practices" to support employees while meeting business needs is to encourage, integrate and strengthen qualities of the heart (Dirani et al., 2020).

Heart Rate Variability

In light of research that calls for creative and novel approaches to workplace wellness initiatives, an emerging field of intervention shows promising results in organizational stress reduction. Heart rate variability (HRV) is defined as, "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para 1). The foundations of HRV self-regulation are rooted in an interconnected and systems approach referred to as psychophysiological coherence.

Psychophysiological coherence is a model that emphasizes the bi-directional interactions between the brain and the body, which are influenced by heart rhythms and the neural networks associated with cognition and emotion. Optimal performance of these systems can help to facilitate improvements in physiological and psychological health, cognition, emotional self-regulation, social functioning and wellness (Elbers & McCraty, 2020).

McCraty (2017) explained that while there are different types of coherence, all types share common characteristics such as "harmonious relationship, correlations and connections between the various parts of a system" (p. 1). When two or more systems operate from similar frequencies, they can become *entrained.* Entrainment may be observed physiologically when the cardiovascular, respiratory, heart rhythms and blood pressure all perform in an optimal and synchronized way and can be measured via HRV. Social coherence is characterized by harmonious relations between team members or groups who share common objectives, interests and goals (McCraty, 2017). Social coherence includes variables such as the above mentioned physiological synchronization as well as quantity and quality of positive emotions, cooperation and coordinated action among members of a group.

Research has indicated that improved coherence, as measured by HRV, is associated with improvement in the following psychological outcomes: depression (Kemp et al., 2010), anxiety (Miu et al., 2009), autonomic nervous system function (Thayer et al., 2009), executive function, cognitive performance, and sustained attention (Albinet et al., 2010). Improved HRV has been associated with improvements in the following physiological outcomes: cardiac health (Buccelletti et al., 2009), hypertension (Lehrer et al., 2003), DHEA and cortisol (McCraty et al., 1998), cholesterol, blood pressure, triglycerides (McCraty, 2015), pulmonary function (Lehrer et al., 2004), glycemic measures (McCraty et al., 2000), binge eating (Godfrey et al., 2018) and applied exercise physiology assessment and performance (Makivić et al., 2013).

HRV coherence interventions have demonstrated efficacy in improving employee health in a range of organizational settings and functions including the following: organizational leadership (Ruderman & Clerkin, 2015), industry (Low & McCraty, 2018b), special forces police officers and non-special forces officers (Andersen et al., 2015), first responders (McCraty & Atkinson, 2012; Ramey et al., 2017), healthcare (Buchanan & Reilly, 2019; King et al., 2017; Linden et al., 2010; Pipe et al., 2012), and first responders (Ramey et al., 2017).

Given the heart's ability to impact such a range of psychophysiological outcomes, this field of research demonstrates a need for further inquiry related to the influence of such interventions on organizational stress and performance in the current pandemic work environment. Such an approach could help to shift the workplace intervention paradigm to one of disease prevention and treatment to one where workforce populations have the tools to successfully thrive within their organizations. While this research shows promising results, additional inquiry for expanded populations, measuring a range of outcomes is needed.

Problem Statement

On one hand, the cost of organizational stress can be harmful to the individual employee's physiological and psychological heath. Additionally, organizational stress can generate significant costs to the organization in the form of absenteeism, organizational dysfunction, healthcare costs and productivity. On the other hand, there is growing evidence related to the efficacy of workplace wellness interventions, and increased use of such programs in the workplace. Furthermore, there is a growing body of evidence, which indicates that stress management interventions specifically targeting HRV self-regulation can produce healthier and more productive employees. Therefore, there is a need to investigate if HRV self-regulation interventions can also positively impact performance at the individual and organizational levels.

Significance of the Problem

The National Institute for Occupational Safety and Health's (2021) website defined job stress as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker" (para. 8). Job stress is caused by an interaction of worker characteristics and working conditions (Sauter et al., 1999). Despite the cause, the effects of employee stress not only increase the risk of the individual developing both physiological and psychological disorders but can also lead to measurable costs to the organization (Colligan & Higgins, 2006; Kaiser Family Foundation, 2020). The modern workplace is strife with challenges that may impact the health and wellbeing of the workforce. A competitive global marketplace, stronger demands on productivity, job insecurity, excessive work hours, retraining to keep pace with changes in technology, decreasing benefits, decreases in quality social interaction, porous work/life boundaries all contribute to organizational stress **(**Matheny et al., 2000). The COVID-19 pandemic has

contributed to organizational stress. Additional pandemic related stressors may include: virus exposure while at work, managing personal and family care during work, concerns about work performance, uncertainty about the future of the workplace, job insecurity, communication and technical challenges, new workspaces and/or schedule changes (CDC, 2020).

Chronic stress can lead to a number of physiological and psychological health consequences as well as negatively affect organizational outcomes. The American Psychological Association (APA, 2018) stated that while our bodies are equipped to handle moderate amounts of stress, when stress becomes ongoing and chronic, it can produce damaging outcomes for all physiological systems in the body. The musculoskeletal system responds to stress by tensing the muscles that guards against the threat of injury. When muscle tension becomes chronic it can lead to stress related disorders including headaches, muscle tension in the shoulders, neck, head, lower back and upper extremities (which is especially linked to job stress; APA, 2018).

The respiratory system supplies oxygen to cells while removing waste in the form of carbon dioxide from the body. Stress can influence the respiratory system in the form of short or rapid breathing because of constrictions of the airway between the nose and lungs, thus limiting proper respiratory function (APA, 2018).

The heart and blood vessels comprise two parts of the cardiovascular system whose function is to oxygenate to the organs and the body. Acute stress facilitates stronger heart contractions resulting in the release of stress hormones such as adrenaline and cortisol while elevating blood pressure to supply large muscles with blood. When the body is in a chronic stress response and does not recover from the flight or fight response, it can lead to long-term problems for the cardiovascular system such as hypertension, heart attack, or stroke (APA, 2018).

The endocrine system initiates a series of responses involving the hypothalamic-pituitary-adrenal (HPA) axis when faced with threat or stress. This response elevates a number of hormones including the release of glucocorticoids (including cortisol, commonly referred to as the “stress hormone”). Elevated stress hormones can lead to a number of disorders including chronic fatigue, metabolic syndrome and immune disorder (APA, 2018).

The gastrointestinal system is comprised of a complex neurological system which communicates with the brain. Stress can impede this brain-gut network, leading to gut dysregulation in the form of pain, bloating, and gut bacteria disruption. These disruptions negatively impact gut and brain health including cognition, affect and mood (APA, 2018).

Both the male and female reproductive systems are influenced by stress. Excess cortisol can influence a number of reproductive functions. These functions may include menstruation, sexual desire, pregnancy, premenstrual syndrome, menopause, reproduction and diseases of the reproductive systems (APA, 2018).

The nervous system, comprised of several subsystems, includes the central division (brain and spinal cord) and peripheral division (autonomic and somatic nervous systems). When the body experiences and recovers from stress the two branches of the autonomic nervous system initiate the flight or fight response in order to address the threat and when the stressor passes, returns the body to homeostasis. During the flight or fight response the body releases hormones and initiates physiological responses (increased heart rate and respiration, dilated blood vessels, digestive function releases glucose into the blood stream). If the stress response remains chronic it leads to long-term drains on several physiological and psychological system, which can lead to impaired functioning of the nervous system (APA, 2018).

Of note to this inquiry, a systematic review investigating the relationship between autonomic nervous system function (as measured by heart rate variability) on levels of stress and burnout, demonstrated evidence to support a negative relationship between job stress and heart rate variability (De Looff et al., 2018). The authors summarized that in response to a stressor, the autonomic nervous system influences brain function, blood flow, heart rate, respiration, hormonal and muscular responses (De Looff et al., 2018). This evidence highlights the damaging effects of organizational stress that can lead to costly physiological outcomes for workers and subsequently their employers.

In addition to the strain stress puts on a number of physiological systems, stress also influences psychological health. Stress can negatively influence emotional health in a number of ways, including cognition/executive functions, emotional processing/regulation and mood (APA, 2018). The Centers for Disease Control and Prevention (2020) noted that the COVID-19 pandemic has influenced work environments and the associated emotional response of employees can lead to increased stress levels, decreased well-being and the well-being of work and home communities. It is important to recognize the ways stress may manifest in order to build resilience and seek support. Some psychological symptoms of stress include feelings of anger, denial, uncertainty, nervousness, anxiety, overwhelm/burn out, depression, lack of motivation and trouble concentrating (CDC, 2020).

A recent systematic review found that during the pandemic the rates of mental illness in the general population were: stress (29.6%), anxiety (31.9) and depression (33.7%; Salari et al., 2020), with clinical levels of depression, anxiety and PTSD higher than pre-COVID-19 levels (Prout et al., 2020). The APA's (2020) report, *Stress in America 2020: A National Mental Health Crisis,* stated, "We are facing a national mental health crisis that could yield serious health and

social consequences for years to come" (p. 1). The report included statistics on the impact of stress in worker populations. The report stated that 64% of working adults say work is a source of stress, and 56% say job stability is stressor, up from 50% in 2019. Among employed adults, 68% say their employment has been negatively impacted by the pandemic and that the most common work-related stressors include having hours cut (19%), balancing work/home responsibilities (14%), and declining productivity (14%; APA, 2020).

Stress can negatively influence a range of physical and mental health outcomes for workers, while also impacting organizational functioning and costs (Dale et al., 2019). Specific organizational outcomes associated with stress may include loss of productivity, absenteeism and turnover. Additionally, worker health can increase healthcare costs for the organization (Dale et al., 2019). Organizational stress can influence an employee's sense of control and subsequent work performance, and over time may increase intention to quit (Adiguzel & Kucukoglu, 2019). A recent study investigated the impact of COVID-19 health anxiety (CovH anxiety) which includes "feelings of fear and apprehension about having or contracting COVID-19" (Trougakos et al., 2020, p. 1) on critical work. The authors observed a significant relationship between CovH anxiety and critical work (goal progress) and health (somatic complaints from emotion suppression and lack of psychological need fulfillment; Trougakos et al., 2020).

Given the personal and organizational costs associated with the rise in preventable diseases, it is essential to investigate optimal intervention options. Specifically targeting stress reduction initiatives may mitigate employee and organizational costs associated with the consequences related to declines in workplace wellness including productivity, biopsychosocial declines, healthcare costs, retention and absenteeism. While it is difficult to

estimate the magnitude of the financial costs associated with these declines in productivity and worker health, some estimates exceed over 100 billion dollars of financial burden associated with organizational stress (Hassard et al., 2018). Research indicates that the magnitude of these burdens necessitates further research to help inform interventions, mitigation and even policy (Hassard et al., 2018).

Purpose of the Study

There were several goals associated with this study. The first goal was to review the research domains and data associated with HRV self-regulation interventions. The purpose of this analysis was to understand the scope and outcomes associated with HRV self-regulation interventions. Second, this project analyzed and consolidated the key conceptual frames associated with HRV self-regulation. The goal of this analysis was to identify, critically analyze and contribute to theory building for HRV self-regulation in the workplace while also contributing to the field of Human Resources Development. Third, this project investigated the effects of HRV self-regulation training on physiological health, psychological health, and organizational outcomes for employees in a large (over 200 employees), for-profit organization, thus contributing to the literature and practice of stress reduction in the workplace, workplace wellness and resiliency.

Research Questions

The following research questions framed the scope and outcomes of this project:

- *Research Question 1 (RQ1):* What are the research domains associated with HRV self-regulation?
- *Research Question 2 (RQ2):* What empirical evidence is associated with HRV self-regulation?

The following research questions framed the critical analysis of conceptual frames and theory building content for this project:

- *Research Question 3 (RQ3):* What are the key conceptual and/or theoretical frames underlying the espoused benefits of the HRV intervention?
- *Research Question 4 (RQ4):* How do these conceptual frames inform HRV self-regulation theory building and contribute to the field of HRD?

To measure the effects of the HRV self-regulation intervention, the following research question was asked:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?

Definitions of Key Terms

The following definitions were used for this study:

- *Allostasis*: The adaptive processes that maintain homeostasis through the production of mediators such as adrenalin, cortisol and other chemical messengers (McEwen, 2005, p. 315).
- *Coherence* is an optimal state in which the heart, mind and emotions are in sync and balanced.
- *Coherent sine wave pattern* is observed in heart rhythm variability patterns and is defined as "an ordered or constructive distribution of power content within a single waveform; autocoherence (e.g. sine wave)" (McCraty, 2015, p. 24).

- *Emotion Regulation:* How we try to influence which emotions we have, when we have them, and how we experience and express these emotions (Gross, 2008, p. 497).
- *Frequency-domain measures*: Frequency-domain measures consist of four components: ultra-low frequency (ULF), very-flow frequency (VLF), low-frequency (LF) and high-frequency (HF) and reflect the different HRV rhythms operating at various frequency ranges (Shaffer & Ginsberg, 2017).
- *Heart intelligence*: The flow of higher awareness and the intuition we experience when the mind and emotions are brought into synchronistic alignment with the energetic heart" (McCraty, 2015, p. 51).
- *Hearth rate variability (HRV)*: A measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para 1).
- *High-frequency band:* The high frequency (HF) band (0.15-0.40Hz) is referred to the respiratory band as it is associated with heart rate variations due to the respiratory cycle (respiratory sinus arrhythmia) and is generally recorded over a minimum of 1 minute time recording (Shaffer & Ginsberg, 2017).
- *Job stress:* The National Institute for Occupational Safety and Health define job stress as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker. Job stress can lead to poor health and even injury" (Sauter et al., 1999, p. 6).
- *Low-frequency band:* The low frequency (LF) band has been referred to as the baroreceptor (short term blood pressure regulation) range and is measured between 0.04

and 0.15 hertz and recorded over at least a two-minute time period (Shaffer & Ginsberg, 2017).

- *Normalized coherence:* Normalized coherence reflects the stability and degree of coherence in the HRV pattern. Thus, a coherent HRV pattern is observed as "a stable regular repeating rhythm resembling a sine wave at a single frequency between 0.032 - 0.26 Hz (2 -15 cycles per minute). Normalized coherence is calculated by "measuring the power spectral density (PSD) around the largest peak in the coherence range and dividing it by the PSD total power. Normalized coherence ranges from 0 – 100" (HeartMath® Inc., 2019).
- *Person-environment fit:* Positioning organizational learning and performance as a complex interaction of the person and their environment, P-E fit recognizes the roles of appraisal, personal attributes, resources and the environment and as key variables in the health and performance of employees and systems.
- *Physiological coherence* is a state in which the cardiovascular, immune, hormonal and nervous systems function in a state of energetic coordination (McCraty, 2015).
- *Positive adaption:* Behaviorally manifested social competence, or success at meeting stage-salient developmental tasks (Luthar & Cicchetti, 2000, p. 858).
- *Private corporations:* Been organized to make a profit (Inc. Editorial & Inc. Staff, 1999).
- *Resilience*: The capacity to prepare for, recover from and adapt in the face of stress, adversity, trauma or challenge (McCraty, 2015, p. 8).
- *Rewards*: Rewards are defined as money, esteem, career opportunities, and security which are defined by the processes of appraisal and coping (Mark & Smith, 2008).

- *RMSD:* "The root mean square of successive differences between normal heartbeats" (McCraty, 2015, p. 22).
- *SDNN:* The standard deviation of the normal-to-normal (NN) sinus-initiated interbeat-intervals measured in milliseconds" (McCraty, 2015, p. 21).
- *SDNN Index*: "The mean of the standard deviations of all the NN intervals for each 5-minute segment" (McCraty, 2015, p. 21).
- *Social coherence:* the harmonious alignment between couples or pairs, family units, small groups, or larger organizations in which a network of relationships exists among individuals who share common interests and objectives (McCraty, 2017)
- *Stress:* Stress occurs when an individual perceives that the demands of an external situation are beyond his or her perceived ability to cope with them (Lazarus, 1966).
- *Time domain measures of HRV*: The amount of variability in measurements of the interbeat interval (IBI), which is the time period between successive heartbeats. These values may be expressed in original units or as the natural logarithm (Ln) of original units to achieve a more normal distribution (Shaffer & Ginsberg, 2017, p. 2).
- *Very-low-frequency band:* "The power in the HRV power spectrum range between 0.0033 and 0.04 hertz which equates to rhythms or modulations with periods that occur between 25 and 300 seconds" (McCraty, 2015, p. 19).
- *Workplace stress:* The National Institute for Occupational Safety and Health define job stress as "the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker. Job stress can lead to poor health and even injury (Sauter et al., 1999, p. 6).

- *Workplace wellness:* "A corporate set of strategic and tactical actions that seek to optimize worker health and business performance through the collective efforts of employees, families, employers, communities, and society-at-large" (International Association for Worksite Health Promotion [IAWHP], 2009).

CHAPTER TWO: REVIEW OF THE LITERATURE

This purpose of this literature review is to summarize and critically analyze the research domains and key conceptual frames related to heart rate variability self-regulation as an intervention for organizational stress. Hearth rate variability (HRV) is defined as "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para 1).

Research Purpose

A systematic review found that the financial burden associated with work-related stress in 2014 ranged from $221.13 million to $187 billion (based off national and pan-European analyses; Hassard et al., 2018). The authors reported that the negative impact on productivity contributed to most of the costs associated with workplace stress (70-90%), with healthcare and medical costs contributing to the remaining 10-30%. At the employee level, stress has contributed to several health outcomes: "hypertension, silent myocardial ischemia, sudden cardiac death, coronary disease, cardiac arrhythmia, sleep disorders, metabolic syndrome, diabetes, neurogenerative diseases, fatigue and many other disorders" (McCraty, 2015, p. 8). Evidence suggests that organizational stress contributes to a significant financial burden to the organization as well as several health outcomes for worker populations, thus demonstrating the need for evidenced based interventions.

To mitigate the damaging effects of stress to the organization and its employees, the Institute of HeartMath® founded their non-profit research institution to study stress, health and performance and have offered The Resilience Advantage™ training intervention, which leverages the science of heart rate variability (HRV) and specifically one's ability to self-regulate

emotions. This intervention claims to improve a number of biopsychosocial outcomes for employees and for organizations. While HRV is an established measure of stress and performance its application and associated empirical research in the workplace are an emerging field of study and practice. Given the costs associated with organizational stress to both the organization and individual, there is a need for additional inquiry.

To ground this research inquiry in the appropriate knowledge bases, a literature review was conducted. The two primary purposes informing this review include: (a) to review HRV research domains and critically analyze key research findings specific to HRV interventions in the workplace and (b) to critically analyze key conceptual frameworks specific to HRV self-regulation in the workplace.

Research Questions

The following research questions framed this literature review: what are the research domains associated with HRV? What types of empirical evidence are associated with HRV? What does the empirical data related to HRV training interventions in the workplace suggest about its application in research and practice? What are the espoused benefits and values associated with a HRV intervention in the workplace? What are the key conceptual and/or theoretical frames underling the espoused benefits of the HRV intervention? How do the key conceptual and theoretical fames associated with HRV apply to components of theory building and the field of human resource development (HRD)?

Methods

HRV is a broad and multifaceted construct with applications in a wide range of research and applied disciplines. Empirical evidence supporting HRV appears in the literature in multiple domains including physiological and psychological health, learning, performance and

organizations. An empirical literature search and review was conducted to identify the key findings related to HRV interventions in the workplace. The initial search identified that HRV in the workplace is studied as both an independent and dependent variable (for example, as a depended variable measuring stress levels in participants). To more closely align with the aims of the current research inquiry, a more thorough investigation of HRV and/or HeartMath® training interventions as an independent variable was conducted. Additionally, a brief review of the research domains of HRV not specifically associated with organizational outcomes provides context to the construct of HRV as a whole.

This first review of the literature was informed by Callahan's (2010) recommendations which included the following methods and resources: Google Scholar, Primo, Research Gate and the HeartMath® online research database were tools utilized to locate relevant literature in the 2008 – 2018 timeframe. Search key words included combinations of the following terms: "HRV", "training", "heart rate variability", "workplace stress", "organizational stress", "performance", and "HeartMath". Additionally, reference lists and relevant citations within key articles were reviewed to locate additional empirical research.

The second literature review was conducted to identify and critically analyze the key conceptual frames informing this research. Rocco and Plakhotnik (2009) explained that conceptual frameworks ground research in applicable knowledge bases when theory may not be guiding the research. Thus, "the goal of a conceptual framework is to categorize and describe concepts relevant to the study and map relationships among them" (Rocco & Plakhotnik, 2009, p. 221). Additionally, Callahan (2014) explained that to enhance decision making based on evidence, it is important to synthesize existing literature.

Callahan (2010) explained that when conducting conceptual framework literature reviews, it is not the author's goal to conduct a comprehensive and detailed search of the literature, rather the aim is to "present carefully selected literature consistent with the premise of the manuscript" (p. 302). Callahan (2010) further explained that the author does not claim "that the broad scope of a body of literature has been explored and new findings are emerging from that analysis" (p. 302), instead the author constructs arguments with thoughtful selection of concepts and theories (Callahan, 2010). As such, additional details regarding the selection of conceptual and theoretical frameworks are included in subsequent sections.

This literature review consists of a brief review of HRV in health (physiological and psychological), and education, followed by a more thorough review and critical analysis of HRV in organizational outcomes, with particular attention paid to HRV training interventions as an independent variable. Next, a critical analysis of the empirical findings related to HRV as a training intervention in the workplace are offered. Finally, the key theoretical frames associated with HRV self-regulation interventions in the workplace are identified and analyzed with implications for theory building and the field of HRD.

HRV Empirical Research

HRV has been studied as a variable in a range of health, learning and performance studies. Below is a brief review of physiological and psychological outcomes associated with HRV including research on the efficacy of HRV self-regulation on stress reduction, health, wellness, learning and performance. A review of HRV measurement and analyses can be found in Appendix A.

Physiological

HRV is a measure of the time intervals between each heartbeat, which vary on a beat-to-beat basis (Buccelletti et al., 2009). Clinical research has indicated that the application of self-regulation techniques targeting improvements in HRV demonstrate efficacy for improvements in symptomology in a range of conditions including: "hypertension, arrhythmias, autoimmune disorders, environmental sensitivity, sleep disorders, drug and alcohol addiction . . . heart failure, chronic pain, fibromyalgia, chronic fatigue" (McCraty, 2015, p. 53). McCraty (2015) argued that due to the ease of learning and application as well as high compliance rates, interventions which include HRV self-regulation techniques not only demonstrate strong results, but are also adaptable to a range of populations.

It has been hypothesized that HRV data includes information about several regulatory systems acting on the cardiovascular system which may contain predictive qualities associated with diseases including myocardial infarction (or heart attack). As one of the leading public health concerns in the world, hypertension and its treatment are of vital importance (Buccelletti et al., 2009). Thus, a meta-analysis on the association between the variables was conducted and found that disrupted HRV was associated with an increase in averse cardiac outcomes. The authors concluded that HRV analysis is an effective and efficient way to assess cardiac risk (Buccelletti et al., 2009).

Additionally, research on the role of HRV in neurological function such as attention deficit hyperactivity disorder (ADHD) as well as performance in trained athletes have demonstrated efficacy. A pilot study investigated the use of HRV training and biofeedback in two populations: clinical and optimal performance (athletes) to measure the impact on production of sensorimotor rhythm (SMR) which has been linked to improvements in focus and relaxation

(Reid et al., 2013). Each sample of twenty trained athletes and twenty participants with clinical diagnoses such as anxiety or ADHD were measured with electroencephalogram (EEG), which measure electrical activity of the brain, at baseline and during HRV training. Results indicated significant increases in SMR during HRV training compared to baseline. These results suggested that increased HRV may lead to increased production of SMR (Reid et al., 2013).

Additional research has demonstrated efficacy for the application of HRV interventions on a range of physiological health outcomes. For example, one study indicated that teaching participants to self-regulate their HRV coherence levels (see subsequent sections for more details) produced significant reductions in cortisol (a stress hormone) and increases in DHEA (a naturally occurring hormone associated with vitality and wellbeing; McCraty et al., 1998).

Additionally, a pilot study investigating the effects of teaching HRV self-regulation to two worker populations (utility line workers and online travel) demonstrated significant decreases in measures of "organizational stress (life pressures, relational tensions, work-related stress), emotional stress (anxiety, depression, anger) and stress symptoms (fatigue, sleep, headaches, etc.), and significant increases in emotional vitality" (McCraty, 2015, p. 56). Worker populations with metabolic syndrome demonstrated significant reductions in total cholesterol and LDL cholesterol (utility workers). The travel employees demonstrated significant reductions in systolic and diastolic blood pressure and triglycerides (McCraty, 2015).

Paul Lehrer, a psychophysiologist, has studied the relationship between physiological coherence or "resonance" and baroreflex gain (where suboptimal baroreflex measures can be predicative of cardiac complications). A controlled study with an experimental group consisting of healthy adults found that ten sessions of HRV biofeedback training demonstrated lasting

positive impact on baroreflex gain and pulmonary function. The authors recommended HRV training as a treatment for pulmonary and cardiovascular disease (Lehrer et al., 2003).

Similarly, in a controlled study involving asthma patients, Lehrer et al. (2004) investigated the use of HRV biofeedback on pulmonary function. The study found that HRV biofeedback training indicated efficacy in the treatment of asthma and may lead to decreased usage and dependency on steroid medication. The authors recommended further research to support their findings.

Additionally, in a randomized control trial, patients who demonstrated medically unexplained physical symptoms (MUPS) and associated distress were assigned to a treatment group which received psychophysiological treatment including HRV interventions. Results demonstrated significant improvement in the severity and frequency of physical symptoms in the treatment group as compared to the control, as well as improvements in self-report measures of depressive symptoms (Katsamanis Karavidas et al., 2011).

To research the impact of stress management in elderly patients with congestive heart failure (CHF), subjects were assigned to a control or experimental group consisting of eight training sessions (over ten weeks) of an adapted HeartMath® (HRV) training curriculum (Luskin et al., 2002). Results indicated significant improvements in the treatment vs. control group in measures of "depression, stress management, optimism, anxiety, emotional distress" (p. 168), as well as functional capacity and HRV. The authors concluded that the program is an effective and cost-efficient tool to enhance medical treatment for CHF (Luskin et al., 2002).

A pilot study (McCraty et al., 2000) designed to measure the impacts of a HeartMath® stress reduction and emotional self-regulation program on patients with Type 1 or Type 2 diabetes was conducted. Outcomes consisted of psychological, quality of life and hematologic

(blood) measures. Results indicated a significant improvement in self-report measures of psychological symptoms including negative emotions (anxiety, depression, anger, and distress) and significant increases in peacefulness, social support and vitality. Significant decreases in somatic measures of sleeplessness and fatigue were reported as well as improvements in quality of life and reductions in sensitivity to daily life stressors. Additionally, "regression analysis revealed a significant relationship between self-reported practice of the techniques learned in the program and the change in HbA1c levels in patients with Type 2 diabetes. Increased practice was associated with reductions in HbA1c" (p. 1). The authors concluded that the HeartMath® training intervention demonstrated efficacy in the treatment of health, quality of life and glycemic measures in populations with diabetes. They suggested further research to support these findings (McCraty et al., 2000).

Additionally, a 2018 study by Godfrey et al. investigated the association between binge eating severity, autonomic nervous system (ANS) function and HRV. Binge eating is hypothesized to be comprised of two measures: overeating (OE) and loss of control (LOC) with a link to poor emotional self-regulation in relation to negative affect. The study measured changes in HRV in a population with obesity, LOC and OE. HRV was measured at rest and with a mental stressor. Results indicated an association between increased severity in LOC and OE which were related to decreases in autonomic nervous system (ANS) flexibility as measured by HRV (Godfrey et al., 2018). The authors concluded that "findings support that ANS activity is associated with LOC and OE, that HRV may be a feasible marker of emotion regulation in this population" (Godfrey et al., 2018, p. 78).

Physiological Outcomes Summary

The studies reviewed above represent a small sample of the literature on HRV and health outcomes. Results demonstrate that HRV is predictive of several health variables and data on participants' ability to improve HRV measures has demonstrated efficacy in mediating physiological conditions. Specifically, researchers have demonstrated that HRV analysis is an effective and efficient way to assess cardiac risk (Buccelletti et al., 2009). A controlled study on the impact of HRV training on elderly patients with congestive heart failure (CHF), indicated significant improvements in the treatment vs. control group in psychological measures as well as functional capacity. These findings support the use of the intervention as effective and cost-efficient in the treatment of CHF (Luskin et al., 2002).

Additionally, a study investigating the impact of HRV training on sensorimotor rhythm (SMR; which has been linked to improvements in focus and relaxation) in two populations: trained athletes and those with clinical diagnoses (anxiety, ADHD) demonstrated significant increases in SMR (Reid et al., 2013). Another study which taught participants to self-regulate HRV coherence levels demonstrated significant increases in DHEA (vitality/wellbeing hormone) and reductions in cortisol (stress hormone; McCraty et al., 1998). A study on the impact of HRV training on worker populations found significant reductions in total cholesterol and LDL cholesterol in participants with metabolic syndrome as well as reductions in systolic/diastolic blood pressure and triglycerides (McCraty, 2015).

Findings from several studies on HRV and physiological outcomes demonstrated significant improvements in pulmonary function and in baroreflex gains, which have shown to be predictors of cardiac complications (Lehrer et al., 2003). Additionally, Lehrer et al. (2004) found that HRV training improved pulmonary function and dependence on steroid medication in

asthma patients. HRV training also demonstrated significant improvements in physical and depressive symptoms in populations with medically unexplained physical symptoms (MUPS; Katsamanis Karavidas et al., 2011).

A pilot study on HRV self-regulation in a sample of participants with Type 1 or Type 2 diabetes demonstrated efficacy in health, quality of life and glycemic measures (McCraty et al., 2000). Additionally, researchers found evidence to support an association between HRV, loss of control and overeating in an obese sample with a history of binge eating (Godfrey et al., 2018). Research on HRV and exercise physiology (see Appendix B) highlights the physiological and psychological interplay in several athletics and fitness related outcomes. Specifically, data supports the use of HRV interventions and assessment in relation to recovery, intensity, training loads and psychological and physiological performance.

These finding support the use of HRV interventions as an effective, efficient and inexpensive tool for improving a range of health outcomes. Data demonstrates significant associations between HRV and the following measures: assessment of cardiac risk, hypertension, sensorimotor rhythm, DHEA, cortisol, cholesterol, blood pressure, triglycerides, pulmonary function, baroreflex gains, MUPS, CHF, glycemic measures, binge eating and applied exercise physiology assessment and performance.

Psychological

In addition to strong evidence supporting physiological etiology, HRV also demonstrates high efficacy in the treatment of psychological conditions and executive function. McCraty (2015) summarizes that evidence supports the application of HRV interventions for the following conditions: “anger, anxiety disorders, depression, PTSD, ADD/ADHD, eating disorders” (McCraty, 2015, p. 53).

Depression “is a common mood disorder that can result in significant discomfort as well as interpersonal and functional disability” (Katsamanis Karavidas et al., 2007, p. 19). Evidence suggests that autonomic nervous system function is negatively impacted in depression, specifically in changes in heart rate and reductions in HRV, which can also contribute to cardiovascular disease. In their study to investigate the impact of HRV biofeedback to treat depression, the authors found that HRV biofeedback as an adjunctive protocol for the treatment of depression was associated with acute increases and some chronic increases in HRV. These findings indicated that improvements in cardiac function as well depressive symptoms (Katsamanis Karavidas et al., 2007) are associated with HRV regulation.

In a meta-analysis (Kemp et al., 2010) of the impact of depression and antidepressant treatment on HRV, the authors explained that depression is associated with increases in cardiac events but that many studies focus on populations with cardiovascular disease, thus indicating a need to study the impact of depression and antidepressant treatment on populations without cardiovascular disease (Kemp et al., 2010). The analyses found that participants with depression had lower HRV than healthy control subjects. Additionally, they found that tricyclic medication decreased HRV while serotonin reuptake inhibitors did not impact HRV. The authors concluded that, “antidepressant medications might not have HRV-mediated cardioprotective effects” (Kemp et al., 2010, p. 1067). These findings indicate a need for healthcare providers to recognize the role depression and subsequent treatments have on cardiac health (Kemp et al., 2010).

Pop-Jordanova (2009) explained that HRV, and specifically the relationship of beat-to-beat variations to the autonomic nervous system, may provide psychophysiological data on “arousal, emotional state and stress level” (Pop-Jordanova, 2009, p. 248). Thus, an investigation with participants consisting of schoolchildren with mental health diagnoses such as (anxious-

phobic, somatoform, obsessive-compulsive, attention deficit hyperactivity and conduct disorders) took part in 15 sessions of HeartMath® training. Results demonstrated that almost all participants improved HRV measures as well as corresponding improvements in their clinical diagnoses. It was further specified that the highest improvements were found with conduct disorder and anxiety and the lowest for ADHD (Pop-Jordanova, 2009).

Similarly, a study measured variations in HRV variables in participants with extreme scores of trait anxiety. Electrocardiograms measured several outcomes associated with HRV during times of mental stress and relaxation. The authors concluded that trait anxiety is a significant risk factor for anxiety disorders and cardiac disease, which are also associated with disturbances in the autonomic nervous system (Miu et al., 2009).

Executive Function

In their summary on the role of HRV and executive function, Thayer et al. (2009) explained that executive function is needed for humans to "function adequately" (p. 146). Specifically, goal-directed behavior is informed by human's ability to plan, direct and control behavior. "The aspects of executive control involve selecting, maintaining, updating, and rerouting information" (Thayer et al., p. 146), while filtering out information which is not useful. A key feature of executive function includes one's ability to maintain this filter and focus across time, which highlights attention and focus as variables in executive function. "Thus, both sustained attention and working memory are core elements of executive functions" (p. 146).

Thayer et al. hypothesized that HRV is related to cognitive performance and executive function by way of a complex interaction involving neural structures associated with cognition, affect, the autonomic nervous system and HRV (Thayer et al., 2009). Thus, they conducted a complex review of the impact of HRV on performance (executive and non-executive function

under threatening and non-threatening conditions), cognitive performance in police shooting and naval navigation simulations, and with anxiety patients. The analysis found "an important relationship among cognitive performances, HRV, and prefrontal neural function" (Thayer et al., 2009, p. 141). The authors concluded that their findings have implications for physiological and psychological outcomes and suggested further research to refine the relationship between HRV and executive function.

A study investigating the impact of physical training, HRV and executive function in older populations found a significant relationship among the variables (Albinet et al., 2010). Specifically, the analysis included sedentary men and women from 65-78 years old who were assigned to two groups: aerobic exercise group or a stretching group. Resting HRV and executive function were both measured pre and post intervention. The results indicated that the aerobic training group (not the stretching group) improved on measures of HRV and measures of executive function. These data support aerobic training as a protective factor for both brain and cardiac health and highlight the interaction between cognition, HRV and exercise in the elderly population (Albinet et al., 2010).

Additional research on the role of HRV and cognitive function, specifically the role of a subtle threat cue on IQ test performance, supports the relationship between variables (Elliot et al., 2011). In this study, participants took an IQ test and briefly viewed a subtle threat cue (color red) or a control color. Measures of HRV were taken pre and post IQ test. Results indicated that participants who viewed the subtle threat cue demonstrated decreases in HRV which were associated with poorer performances on the IQ test. The authors explained that these results support the interaction between HRV and related ability to emotionally regulate and cognitive performance (Elliot et al., 2011).

To investigate the relationship between cognitive performance and HRV as a function of fitness levels, research was conducted on two participant populations consisting of high and low-fit groups (Luque-Casado et al., 2013). Each group's HRV measures were taken under three performance variables: duration discrimination (a psychophysical task where participants are tasked with discriminating the time between two visual stimuli), temporal orienting task (designed to measure "participants' ability to build-up expectancies about the moment when a particular event would occur;" (Luque-Casado et al., 2013, p. 3), and psychomotor vigilance (designed to measure sustained/vigilant attention by calculating reaction time to visual stimuli presented at random intervals). Data indicated that the lowest measures of HRV were observed during the duration discrimination task. Additionally, decreases in HRV were measured as a function of time on task only in the low-fit group and the high-fit group had faster reaction times in the psychomotor vigilance task. The authors concluded that there was evidence to support a relationship between HRV and cognitive processing and that the main benefit of higher fitness levels was associated with sustained attention (Luque-Casado et al., 2013).

Psychological Outcomes Summary

The studies reviewed above represent a small sample of the empirical data on the relationship between HRV functionality on measure of psychological health and executive function. Specifically, data indicate an association between HRV regulation and improved depressive symptoms as well as cardiac function (Katsamanis Karavidas et al., 2007). Further, based on their data on the association between HRV, antidepressant medication and depression, researchers (Kemp et al., 2010) recommend that healthcare providers monitor this interaction in their treatment protocols for both mental and cardiac health.

Research (Pop-Jordanova, 2009) on pediatric populations with clinical mental health diagnoses, demonstrated a strong relationship between improved measure of HRV regulation and corresponding improvements in clinical diagnoses, particularly in those participants with conduct disorder and anxiety. Additional research indicates that HRV regulation allowed participants to improve measures of trait anxiety which is linked to suboptimal autonomic nervous system function and HRV (Miu et al., 2009).

Researchers hypothesize a strong correlation between HRV, executive function and associated cognitive performance. It is explained that this complex interaction involves cognitive neural structures, affect, the ANS and HRV (Thayer et al., 2009). Additional research demonstrates a strong correlation between executive function and HRV in elderly populations (Albinet et al., 2010). Further, research supports a significant relationship between HRV, fitness levels and cognitive processing (specifically sustained attention; Luque-Casado et al., 2013).

In summary, data support the interaction between HRV and related ability to regulate outcomes, which leads to improvements in several psychological, executive function and cognitive performance domains. Specific outcomes reviewed in this analysis demonstrate the benefits of HRV regulation in the following outcomes: depression, cardiac health, pediatric mental health, anxiety, autonomic nervous system function, executive function, cognitive performance, fitness and sustained attention.

Education

While concepts like social and emotional intelligence are beginning to enter the public lexicon in relation to success in schools, the traditional focus on educational development has been on improving cognitive aptitude in learners (McCraty, 2015). As previously reviewed, evidence suggests there is an association between executive function, cognitive performance and

emotions. Thus, the emotional component on learning outcomes has generated an interest in investigating the interaction between emotions, HRV regulation and school outcomes. Below is a sample of such research.

Sponsored by the U.S. Department of Education, The TestEdge National Demonstration Study (TENDS), a quasi-experimental, randomized controlled study, was a collaboration between the HeartMath® Institute and Claremont University designed to test the efficacy of the TestEdge (HRV/emotional self-regulation) program on student stress, test anxiety, emotional wellbeing, psychosocial functioning and academic performance in public school children (consisting of 980, 10th grade students; Bradley et al., 2007). The study consisted of quantitative, qualitative and physiological outcome variables and was designed to measure the impact of the TestEdge intervention on stress and test anxiety.

Pre-intervention analyses showed that 61% of the students reported having test anxiety with 26% reporting high levels most of the time (which was twice as high for females). Students with high levels of test anxiety scored an average of 15 points lower on standardized test scores (math and language arts). Additionally, a regression analysis found that Affective Mood explained close to twice the variance in standardized test scores, while positive feelings and prosocial behavior had a positive effect on scores. Strong negative feelings and antisocial behavior had a negative impact on performance. Based on these findings and additional data, the authors explained that test anxiety may contribute to a concerning source of test bias (Bradley et al., 2007).

The physiological data collection consisted of monitoring students' HRV data during a stress inducing situation (Stroop color-word conflict test). The control group was directed to use their own methods for completing the test while the intervention group for the pretest were

instructed to use their usual methods for preparing for a challenging test, and posttest were instructed to use one of the TestEdge techniques. Data indicated that the experimental group was able to self-initiate a coherent state (see subsequent sections for details) prior to taking the exam and that this contributed to a significant reduction in test anxiety and improved emotional disposition. Additionally, these students also demonstrated increased HRV and HRV coherence during the resting baseline period (post-intervention) without being instructed to use TestEdge tools. These data suggest that with consistent use and practice of the TestEdge tools, students had created a more adaptive baseline level of psychophysiological functioning.

Qualitative data consisted of classroom observations before, during, and after the TestEdge intervention and were compared to the control school. It was observed that more positive changes took place in the experimental school compared to the control. Additionally, students in the experimental school demonstrated lower levels of fear, frustration and impulsivity with increases in "engagement in class activities, emotional bonding, humor, persistence, and empathetic listening and understanding" (Bradley et al., 2007, p. xix). Coupled with additional data from student drawing analyses as well as findings from the secondary study consisting of case studies from classrooms representing various states and grade levels, the researchers concluded that there is strong evidence to support the efficacy of the TestEdge intervention. They explained that students recognized psychophysiological, academic and social gains as a result of participation (Bradley et al., 2007).

Additional research supports the efficacy of emotional/HRV self-regulation in schools. A recent study (Connolly, 2009) measured emotional stability, relationships and wellbeing with the Strengths and Difficulties Questionnaire (SDQ) in a population of seven schools (three primary and four post-primary) who participated in HeartMath® and "Journey to my Safe Place"

trainings. The primary school students measured significant reductions in "emotional problems (51%); conduct problems (43%); hyperactivity (40%); and a significant improvement in relating to peers (50%;" McCraty, 2015, p. 73). The "post primary students had significant reductions in "hyperactivity (12%), emotional problems (9%) and conduct problems (9%), and they showed (27%) improvement in relating to peers" (McCraty, 2015, p. 73).

Similarly, a quasi-experimental study was conducted in Salt Lake City and was comprised of preschool students with lower socioeconomic and ethnic minority designations, using an age-appropriate HRV/emotional self-regulation intervention called Early HeartSmarts (EHS; Bradley et al., 2012). Students were measured on four areas of development (physical, cognitive, social/emotional and language development) using The Creative Curriculum Assessment (TCCA). Results demonstrated significant improvement in each of the four psychosocial development categories while analyses of covariance "found a strong, consistent pattern of large, significant differences on the development measures favoring preschool children who received the EHS program over those in the control group" (Bradley et al., 2012, p. 36).

Similar trainings have also demonstrated efficacy with college students. Researchers explained that there is strong evidence to support a negative relationship between school burnout and physiological and cognitive functioning, thus the researchers initiated a study to investigate the use of HRV self-regulation and physiological and cognitive functioning (measures of negative affect and cognition; May et al., 2019). A sample of American college students (N = 90) was assigned to three groups: HRV self-regulation training, high intensity interval training (HIIT) and a control group. Results indicated a significant reduction in the HRV training group on measures of school burnout and improved mathematical performance, which were not observed in the HIIT group. Additionally, the HRV training group saw reductions in measures of

blood pressure while the HIIT group did not. Finally, cardiovascular fitness measured as V02max improved for the HIIT group but not for either of the other groups, while both experimental groups saw decreased heartrate as compared to the control group. All groups decreased measures of cardiac sympathovagal tone. The authors concluded that these results support the use of HRV interventions in decreasing symptoms of burnout and improved measures of cardiac health (May et al., 2019).

Education Summary

A U.S. Department of Education sponsored study investigated the use of The TestEdge National Demonstration Study (TENDS), to test the efficacy of HRV/emotional self-regulation in a sample of 10th grade, public school children on measures of stress and test anxiety. Quantitative and qualitative data led the researchers to conclude that subjects recognized psychophysiological, academic and social benefits as a result of participation (Bradley et al., 2007). Additionally, HRV training outcomes were measured in a sample of primary and post-primary students on measures of emotional stability, relationships and wellbeing (Connolly, 2009). Both populations measured significant reductions in some measures of emotional problems and a significant improvement in relating to peers (Connolly, 2009).

Preschool aged children given the Early HeartSmarts (EHS) intervention demonstrated significant improvement in four psychosocial development categories (physical, cognitive, social/emotional and language development; Bradley et al., 2012). Additionally, college students were assigned to either an exercise or HRV self-regulation group with data demonstrating significant improvement on measures of school burnout and improved mathematical performance leading the authors to conclude that HRV self-regulation can support both cardiac health and school burnout (May et al., 2019). This small sample of research on HRV in education

has demonstrated significant improvements in measures of: test anxiety, emotional disposition, engagement, bonding, humor, persistence, empathetic listening and understanding, emotional problems, conduct problems, hyperactivity, relating to peers, physical, development (cognitive, social/emotional and language), school burnout, school performance cardiac health and psychophysiological functioning.

Organizations

It is estimated that in the U.S. the cost of stress on workers contributes to significant health problems, absenteeism and declines in job performance totaling an estimated $300 billion in costs per year (McCraty, 2015). Stressful working conditions can lead to emotional and physiological strain on worker populations, which subsequently negatively impacts social interactions with team members and ultimately impacts organizational functioning. Thus, the need to provide solutions which allow individuals to emotional self-regulate which can lead to not only improved levels of individual coherence but improvements in social and team coherence as well (McCraty, 2015).

McCraty (2015) summarized that significant improvements in health outcomes, communication, productivity, satisfaction, and innovative problem solving have been measured for a range of industries (hospitals, military, first responders, corporations) using HRV/HeartMath® interventions. In order to align with the aims of the current research, the following studies have been selected for more in-depth review and analyses. Inclusion criteria included: (a) private corporations. Defined as having "been organized to make a profit" (Inc. Editorial & Inc. Staff, 1999); (b) studies using HeartMath® and/or HRV interventions as an independent variable; and (c) published in a peer reviewed journal.

Research Study 1: Effects of an HRV Intervention on Psychological, Endocrine, and Physiological Outcomes on Workers During Organizational Downsizing

Citing the expanding body of research on the impact of organizational downsizing and subsequent increases in stress on workers' health, safety and wellbeing, the authors sought to investigate the efficacy of a cardiac coherence (HRV) training on psychological (anxiety, perceived stress, wellbeing and sleep), endocrine (cortisol, salivary alpha-amylase – a digestive enzyme associated with mental stress), and physiological (sleep, HRV) outcomes (Trousselard et al., 2014). The organization, which was undergoing downsizing and organizational restructuring, was a research laboratory with 160 employees. Nine male subjects (the sample size was noted as a limitation along with the non-experimental design and duration of the effects) were recruited via mail with the following inclusion criteria: male, not undergoing treatment, no practiced stress intervention since the announcement of the organizational restructuring. The subsequent sample consisted of nine male volunteers.

Psychological assessments were completed three times (pre-intervention/baseline, middle intervention and at the conclusion of the intervention) and included the following assessment tools: Spielberger State-Trait-Anxiety Inventory (with very good internal consistency: Chronbach's alpha = .80 to .92), the Cohen perceived stress scale (Chronbach's alpha = .84), the Buguet sleep questionnaire (self-report sleep questionnaire on measures of restoration quality and ease of falling asleep, no internal reliability measures reported), and the activation-deactivation adjective check list (AD-ACL) which assesses transitory arousal states comprised of two bipolar dimensions titled energetic-arousal and tense-arousal with corresponding sub-factors. "The reliability of the AD-ACL scale was estimated as .92 based on communality results from a

factor analysis" (p. 80). Demographic data and the trait anxiety questionnaire were completed only at baseline (Trousselard et al., 2014).

Physiological measures consisted of sleep variables and measures of HRV. Sleep was measured using two portable Actiwave monitors (miniature monitors worn discreetly on the body) which are reported to be as reliable as sleep laboratories in collecting ECG (electroactivity of the heart), EEG (electroactivity of the brain), EOG (movements of the eyes during sleep), and EMG (electrical activity produced by skeletal muscles) data. Data were recorded when the subject went to bed at 22h00. When the subject returned to the lab at 8h00 the monitors were removed and analyzed both at baseline and at the conclusion of the intervention. HRV data were recorded using an Actiwave cardio designed for collecting electrocardiogram (heartbeats) recordings. HRV analyses were conducted using a validated computer program and by an HRV analysis expert (who was not involved in experimental sessions) and consisted of several validated measures of HRV including measures of temporal sleep. An additional Actiwave module was used to assess EEG recordings for established sleep recordings (Trousselard et al., 2014).

Endocrine measures consisted of cortisol, salivary enzyme alpha-amylase (psychological stress marker) and salivary chromogranin A (psychosomatic stress marker). To account for circadian variations, the latter two enzymes were assessed between 15h30 and 1800 under controlled eating, drinking, and smoking conditions. Cortisol measurements were collected at baseline, mid-training and at the conclusion of the intervention by way of a "12h-night-cortisol excretion . . . and were calculated according to the diuresis and the creatinine excretion rates" (p. 81). All endocrine samples were analyzed in duplicate (Trousselard et al., 2014).

The HRV training intervention was called Cardiac Coherence Training (CCT) offered by the Institute of HeartMath® with outcomes targeting stress management in the face of workplace restructuring and job insecurity. The three-month protocol consisted of ten individual training sessions with topics including (a) risk factors (interpretation, health and wellness), (b) Freeze Frame: emotional refocusing and stress reduction, and (c) power tools for inner quality: fostering a culture of care for improved job satisfaction. Additionally, a range of techniques and tools were incorporated to improve individual wellbeing and to "bring about a positive change in the surrounding organizational culture within which employees work" (Trousselard et al., 2014, p. 81).

The authors conducted a series of statistical analyses including ANOVAs located in Table C.1 (see Appendix C) and based on the results, concluded that the HRV intervention did appear to help participants mitigate their stress response during the organizational restructuring. Specifically, they noted decreases in perceived stress, increases in wellbeing and improvements in sleep quality. Not included in Table C.1 are additional outcomes which showed that the effects were strongest for those demonstrating higher levels of trait anxiety in several variables. Further, they observed that sleep, particularly REM-sleep was a key variable in improvements. The authors concluded that the data indicated that more research is needed while these findings indicate that the intervention was effective, efficient and financially accessible for similar populations, specifically those with high levels of trait anxiety.

Research Study 2: Effects of an HRV Program on Physiological, Psychological, and Workplace Measures in a Sample of Employees With Hypertension

Hypertension and associated increases in high blood pressure are risk factors for "coronary heart disease, heart attacks, strokes, kidney disease, and vascular complications"

(McCraty et al., 2003). Thus, research on the impact of an organizational stress reduction intervention on measures of blood pressure, emotional health and work-related outcomes in a sample of hypertensive employees was conducted (McCraty et al., 2003). A randomized, wait-list control trial consisted of 36 participants, both male and female, at a global information technology company who were diagnosed with hypertension by their physicians. Additional inclusion criteria were: "taking antihypertensive medication on a regular schedule or must have had at least 1 of the 4 baseline BP readings (average of 3 successive measurements) in the range of 90–105 mm Hg diastolic or 140–179 mm Hg systolic" (McCraty et al., 2003, p. 357).

The intervention consisted of 16 hours of training (one full day and two half days) where participants were taught techniques designed to self-regulate their HRV by initiating physiological coherence. Programming targeted improving outcomes related to regulating sympathetic nervous system arousal including improved affect and performance and decreased stress. The intervention included technology which provided in-the-moment HRV feedback, which was designed to assist participants in self-initiating improved coherence levels and were available for use by treatment participants at work and on the weekends. At the conclusion of the intervention, participants were instructed to practice program-related techniques daily (McCraty et al., 2003).

Outcome variables were blood pressure, emotional health and workplace variables which were measured both before and three months after the intervention. Baseline blood pressure measurements were taken by nurses who were blinded to the experimental and control conditions and were measured once a week for four consecutive weeks. Blood pressure readings consisted of three readings per visit (taken at 2-minute intervals) which were averaged to produce the final reading. Baseline psychometric data were taken at one of two measurement sessions using the

Personal and Organizational Quality Assessment (POQA) "which provides a broad-based assessment of emotional health, psychosocial functioning, and work performance-related outcomes and the Brief Symptom Inventory (BSI) . . . a clinically valid measure of key indices of psychological distress" (McCraty et al., 2003, p. 358).

Post intervention blood pressure measurements were taken in two sessions (1 week apart), three-months post intervention, using the same protocol to collect baseline data. Psychometric data were collected at the first of these two data collection sessions. ANCOVA's were conducted for blood pressure measurements to adjust for the following covariates: "age, gender, body mass index, and medication status" (p. 360), and psychological outcomes where the "post-intervention score for each scale as the outcome variable and its baseline score as the covariate" were assessed (p. 360). Finally, a correlational analysis was conducted to measure "change scores for pre–post psychological and BP outcomes" (McCraty et al., 2003, p. 360).

Results indicate that three months after treatment participants saw significant reductions in systolic blood pressure and improvements in emotional health, decreased measures of stress, depression, psychological distress, increases in peacefulness and positive outlook, and increases in workplace satisfaction and value of contribution (see Table C.1 in Appendix C for details). The authors concluded that stress reduction and its impact on HRV, physiological and psychological measures can lead to improvements in health and productivity in workers (McCraty et al., 2003).

Research Study 3: Effects of a HeartMath® Program on Physiological, Psychological, and Workplace Measures in a Sample of Three Levels of Telecommunications Employees

While it is recognized that some degree of stress helps to promote optimal performance in the workplace, levels of sub-optimal stress are on the rise and often result in significant costs to

both the individual worker as well as the organization. The authors (Barrios-Choplin et al., 1997) explained that some research has hypothesized that an individual's experience of stress is rooted in how stress is perceived and communicated (see subsequent sections for details). Thus, one's perception and reaction to stress will determine if a stress response is activated, while inefficient communication with others can contribute to the negative emotional responses to stress. This model posits that improving interpretive style and communication in response to stress in the workplace will subsequently improve psychological and physiological outcomes for workers (Barrios-Choplin et al., 1997).

Three levels of employees (n = 48) at Motorola (a telecommunications company), including executives (group 1, n = 9), software engineers (group 2, n = 9), and factory workers (group 3, n = 30) were selected to participate in the inner quality management (IQM) program provided by HeartMath®. The IQM training intervention consisted of four primary training modules including:

> (1) Freeze-Frame (changing interpretive styles to affect mood and stress); (2) Intuitive Communication (enhancing communication and goal clarity); (3) Power Tools for Inner Quality (creating a caring culture and job satisfaction); and (4) Quantum Management (operationalizing the above tools day to day; p. 195).

The training intervention was delivered in one day and participants were instructed to practice the techniques associated with the intervention for six months.

Psychological assessments were conducted pre-intervention for each of the three groups using the Personal Opinion Survey (POS), which included 58 items representing 12 constructs. POS post-intervention assessments were conducted at 6 months for groups 1 & 2 and at 3 months for group 3 because of time restrictions of the organization (Barrios-Choplin et al., 1997). Blood pressure readings were taken a total of four times by a medical technologist on each of the POS assessment days. The first measurement was taken upon arrival, the second after sitting for five

minutes thinking neutral thoughts, the third after sitting for five minutes thinking stressful thoughts and the fourth after five minutes of practicing stress reduction techniques (which were self-generated for pre-assessment and post-assessment consisted of tools learning in the IQM training intervention; Barrios-Choplin et al., 1997).

Electrocardiogram (ECG) was used to assess HRV. Both physiological measures were recorded at the same time as the surveys for groups 1 and 2, while physiological measures were not assessed post intervention for group 3 "as the factory workers were not made available by management at the needed time" (Barrios-Choplin et al., 1997, p. 196). Due to the different assessment times of the groups, the authors combined data for groups 1 and 2 and were analyzed after six months while group 3 was analyzed at three months. A p-value of <0.05 was considered significant (see Table C.1 for details).

The authors further explained that one of the most significant findings related to results that all the formerly hypertensive employees were able to (to some degree) reverse their hypertensive designation as a result of the IQM intervention. Psychologically, the data indicated that participants were able to decrease their levels of tension and anxiety, while physiologically, data indicated that participants decreased levels of stress with improved measures of autonomic nervous system functioning. These data lead the authors to conclude that despite limitations such as the lack of a control group and the possible presence of confounding variables, the intervention shows efficacy as a cost-effective tool to improve worker wellbeing and productivity. The authors specified that "the self-management intervention illustrates the profound impact that stress can have on our physiology and work performance" (p. 200) and concluded that the results may indicate that individual self-management capacity may be stronger than previously thought (Barrios-Choplin et al., 1997).

Organizational Outcomes Summary

Like previous findings, interventions targeting improvements in HRV and self-regulation demonstrate efficacy in workplace populations targeting improvements in psychophysiological outcomes. Specifically, research conducted on a sample of laboratory workers undergoing an organizational restructuring found that an HRV training intervention demonstrated efficacy in mitigating harmful stress, improved wellbeing and sleep quality. The authors noted that results were strongest for those with higher levels of trait anxiety (Trousselard et al., 2014).

Similarly, a randomized wait-list control trial of an HRV intervention on a sample of workers with diagnosed hypertension demonstrated efficacy in improving systolic blood pressure, improved emotional health, decreased stress, depression and psychological distress and increases in peacefulness, positive outlook, workplace satisfaction and value of contribution. The authors concluded that the intervention positively impacted stress, HRV and psychophysiological outcomes leading to improvements in the health and productivity of the worker population (McCraty et al., 2003).

To test the efficacy of a training intervention designed to improve employee's perception and reaction to stress as well as workplace communication was conducted on three levels of employees at a telecommunications company. Data indicated that of the employees who matched criteria for hypertension, all were able to reverse the designation at the conclusion of the intervention. Additional data indicated efficacy for psychological outcomes related to tension and anxiety and physiological outcomes related to improved autonomic nervous system functioning (Barrios-Choplin et al., 1997). Overall, data indicate strong psychological and physiological benefits to individual workers and improvements to workplace outcomes for the organizations.

The low cost and efficiency of the interventions demonstrated additional value to organizations sponsoring such interventions.

Critical Analysis: Empirical Evidence of HRV in the Workplace

Table C.1 provides a summary of empirical data for the HRV in the workplace studies selected for this review. Further analysis illustrates where the outcome variables among studies intersect. Specifically, study 1 did not observe any changes in HRV post intervention while study 3 did observe improvements in some HRV variables. Additionally, study 3 reported large changes to both systolic and diastolic blood pressure while study 2 only observed significant improvements in systolic blood pressure.

Psychological data indicated that improvements in perceived stress/stress symptoms were observed by study 1 and study 2 while physical wellbeing in study 1 and physical stress were observed in study 3. Additionally, workplace satisfaction data observed in study 2 aligned with job satisfaction improvements observed by study 3.

While each study did identify additional psychological and physiological improvements as a result of the interventions, the remainder of the measurement variables did not significantly overlap, which may indicate challenges associated with construct validity. Based on these data additional research is necessary to further refine and align underlying mechanisms, constructs and subsequent expected outcomes of HRV training in the workplace.

This review illustrates that empirical data in a wide range of domains support both the etiology and efficacy of HRV in relation to wellbeing interventions and diagnoses. Specifically, research in support of psychological and physiological improvements for adult, child, clinical and worker populations have demonstrated improvements in health, academic, workplace and

performance domains. Given the accessibility, efficiency and effectiveness of HRV interventions in the workplace, additional research is recommended.

Conceptual Frames

Despite strong evidence supporting biopsychosocial outcomes for employees and organizations, the conceptual frames for HRV self-regulation interventions were challenging to identify. What follows is an introduction to the leading HRV training intervention, an analysis of the espoused benefits of the intervention, followed by the identification, review and critical analysis of the key theoretical frames supporting HRV in the workplace. Finally, implications for HRD are offered.

HeartMath®

HeartMath® is a leading research organization on HRV. Founded in 1991, this non-profit organization studies the links between stress, health, performance and the role of brain/heart functioning. Over the past 26 years, HeartMath® has been involved in over 300 independent, peer reviewed studies and has collaborated with a range of organizations, including schools, non-profits, corporations and humanitarian organizations. The training intervention specific to this inquiry, HeartMath®'s "The Resilience Advantage™", has produced the following outcomes:

> increased situational awareness in relationships, meetings and projects; enhanced ability to focus, process information and solve problems; heightened creativity and innovation; increased ability to handle challenging clients and situations; increased access to intuition for fast, effective decision-making on complex issues; increased regenerative sleep; increased vitality and resilience; reduced stress, worry and fatigue. (HeartMath®, 2018)

The Resilience Advantage™ training is comprised of six, one-hour long training modules which target experiential learning in the following areas: resilience, stress, the science of the heart, depleting and renewing emotions, self-regulation, physiological and psychological coherence, intuition, and relational energetics.

The Resilience Advantage™ relies both on the science of HRV and specifically one's ability to self-regulate emotions. McCraty (2015) explains that the key mechanisms associated with one's capacity for emotional self-regulation targets a balance between both the emotional and cognitive systems. The physiological functioning of these systems is informed by the heart's neural system which sends information to the brain's subcortical (emotional) and cortical (cognitive) regions. This afferent (ascending) information from the heart to the brain is conveyed in the heart's rhythms (HRV) which are impacted by emotional states. These emotional patterns can be either coherent (regenerative emotions) or incoherent (depleting emotions) and impact the information sent to the cortex, a key brain region associated with executive function and emotional self-regulation. HeartMath®'s training intervention teaches participants to intentionally activate a positive or regenerative emotion, thus increasing one's ability to emotionally self-regulate.

With over 300 peer reviewed and independent studies supporting the tools provided by HeartMath®, the organization claims that their HRV interventions in the workplace leads to improvements in the employee experience including, "improved workplace communication, satisfaction, productivity, lower health-care costs, innovative problem-solving and reduced employee turnover" (HeartMath®, 2018). Evidence suggests that these improvements lead to both social and financial gains for the organization (McCraty, 2015).

To measure the impacts of The Resilience Advantage™ training intervention, HeartMath® offers an assessment which targets measures of personal and organizational quality. Specifically, the POQA-R4, Personal and Organizational Quality Assessment-Revised 4 Scale measures the following variables that comprise the assessment's conceptual frames:

1. emotional vitality (emotional buoyancy, emotional contentment),

2. organizational Stress (pressures of life, relational tension, intention to quit),
3. emotional stress scale: anxiety/depression, anger/resentment, and
4. physical stress (fatigue, health symptoms).

Contained within the assessment is a diagram which illustrates the effects of organizational stress as well as the effects of the HeartMath® Intervention. The effect of organizational stress initiates a feedback loop where organizational stress influences emotions by inducing negative affect, while decreasing positive emotions, which in turn decreasing health, well-being, job involvement and performance. The effects of the HeartMath® training intervention is illustrated with another feedback loop where the training intervention introduces stress management tools which elicit positive emotions while decreasing negative emotions, while subsequently increasing health, well-being, job involvement and performance thus reducing original organizational stress levels (Barrios-Choplin & Atkinson, 2004)

A wide range of claims are made regarding the espoused benefits of The Resilience Advantage™ training intervention. These claims are located in a number of print and digital marketing materials, in *The Science of the Heart (*McCraty, 2015), as well as the HeartMath® website. A sample of these claims include: “tools which are suitable for all ages and cultures, reduced stress, improved personal stability, creativity, insight and fulfillment” (McCraty, 2015, p. iii); “improved health, personal effectiveness, highly practical, evidence based, greater fulfillment” (McCraty, 2015, p. 1). Additionally, claims related to organizational outcomes include: “improved communication and cooperation, improvements in emotional and physiological stress” (McCraty, 2015, p. 81), “increases in ability to self-manage and self-regulate, improvements in ability to reach group objectives, improved workplace satisfaction, increases in innovative problem solving, reductions in employee turnover, social and financial

benefits to the organization" (McCraty, 2015, p. 82). A recent flyer advertising a free information session to organizational leaders makes the following claims: improved patient and staff outcomes and satisfaction, reduced turnover costs, reduced sick leave liabilities, improved team performance, reduced stress, improved resilience and improved decision making (HeartMath®, 2018).

To consolidate the concepts located in the POQA-R4 assessment tool as well as espoused benefits from HeartMath® academic and marketing material a thematic analysis was applied using the process outlined by Braun and Clarke (2006):

- *Phase 1: familiarize yourself with your data:* Immerse yourself with the data via repeated readings in an active way, searching for patterns and meanings.
- *Phase 2: generate initial codes:* Begin to identify themes in the data which are interesting and begin to provide meaning to the output.
- *Phase 3: search for themes:* After data has been initially coded, analyze codes at the broader level of themes.
- *Phase 4: review themes:* Review themes to ensure that data within themes is coherent and that themes are distinguishable from each other.
- *Phase 5: define and name themes:* Identify what is interesting about the theme and apply a meaningful and accurate name.
- *Phase 6: produce the report:* Final analysis of the data which produces interesting and accurate account of the story the data tells.

The following themes related to the espoused benefits of The Resilience Advantage™ training intervention were constructed as a result of the thematic analysis:

1. *Improve emotional self-regulation:* Emotional self-regulation is the foundational skillset and benefit associated with The Resilience Advantage™ training intervention. Specific claims indicate that these tools are highly practical for a range of participants and generate increases in ability to self-manage and self-regulate.
2. *Decrease stress:* A strong focus on decreases in both physiological and psychological stress indicate that participants should see improvements in overall health and emotional wellbeing.
3. *Increase resilience:* Improvements in personal stability, increased positive emotions, creativity, insight, fulfillment, and personal effectiveness, all point to the benefits associated with the broader claim of improved resilience.
4. *Improve organizational outcomes:* Decreased stress, improvements in self-regulation capacity and improved resilience at the individual level lead to improvements at the team and organizational level. Specific benefits include: improved communication, cooperation, ability to reach group objectives, innovative problem solving, employee satisfaction and health outcomes, which all lead to measurable social and financial benefits to the organization.

Drawing from the themes generated from the thematic analysis and integrating them with those from the POQA-R4 produces the key conceptual frames for this analysis: (a) stress, (b) organizational stress, (c) emotional self-regulation, and (d) resilience. The following is a literature review and critical analysis of each of the conceptual frames. The analysis is followed by applying methods of theory building to more fully integrate the conceptual frames and to advance the theoretical foundations related to HRV in the workplace. Finally, implications for the field of human resource development (HRD) are discussed.

Conceptual Frames: Stress, Organizational stress, Resilience and Emotional Self-Regulation

The review of the conceptual frames starts with the biological and psychological foundations of stress; followed by a review of organizational stress highlighted by research on predictive variables to best inform intervention building; then the construct of resilience is examined which emphasizes the dynamic and multidisciplinary nature of the construct; and finally a review of emotional self-regulation, its utility, key variables informing the construct which may inform optimal interventions targeting capacity building and protective factors. Additionally, the science of the heart and specifically coherence capacity building informing physiological, psychological and community outcomes is reviewed and integrated into each section.

Stress

Early conceptualizations of stress have been traced back to scientific works conducted by Galileo Galilei (1633), Hooke (1679), Young (1807), and Cauchy (1822) which focused on physical mechanics, including variables such as tension strengths, springs, elasticity, force, stress and strain (Dato, n.d.). These ideas later gave way to the first biological references to stress when Cannon (1929) introduced the physiological concept of homeostasis, which built upon the work of Claude Bernard (1878), who theorized about the milieu intérieur or the body's inner world, which strives to maintain order and a consistent internal environment. Bernard's work evolved to recognize that the purpose of the body's internal processes are to maintain consistency and a state of equilibrium in response to any outside influences (Goldstein, 2008). In his lectures titled *Phenomena of Life Common to Animals and Vegetables* (translated by Hoff et al.) he described this process by saying:

> The constancy of the internal environment is the condition for free and independent life…. All the vital mechanisms, however varied they might be, always have one purpose, that of maintaining the integrity of the conditions of life within the internal environment. (Bernard, 1974)

While, basic to the modern understanding of physiological functioning, at the time these views were revolutionary for the foundation of medical philosophies (Goldstein, 2008).

Homeostasis. Building on Bernard's work on the inner world, psychologist James Cannon introduced the concept of homeostasis or "steady state" (Cannon, 1932) which refers to "the stability of the inner world" (Goldstein, 2008, p. 6). According to Cannon, the brain produces a series of key internal variables which serve as goal values for the organism to maintain. Initially these variables were physiological but were later expanded to include psychological variables (Goldstein, 2010). If internal or external stimuli, including events such as "exposure to cold, hypotensive hemorrhage, traumatic pain, insulin-induced hypoglycemia, or emotional distress" (Goldstein & Kopin, 2007, pp. 109–110) disrupt the inner stability or goal values, the endocrine and nervous systems initiate a range of responses which prompt both emotional and behavioral action in the organism with the goal of returning the body's systems to homeostasis (Goldstein, 2008).

Fight or Flight. The adrenal glands play a primary role in the body's response to both external and internal stimuli, which could disrupt the organism's ability to remain in a state of homeostasis. These acute responses to threats and the corresponding adrenal response are referred to as the "flight or fight" response. This response activates both the sympathetic arm of the autonomic nervous system as well as the adrenal glands to release epinephrine/adrenaline. These simultaneous reactions are referred to the sympathoadrenal activation, which restore homeostasis in the organism (Goldstein, 2010).

These adrenal responses incite a number of physiological and psychological mechanisms to assist the organism to return to inner stability. Cannon asserted that the body's adrenal response to both "fight" and "flight" were the same. These adrenal responses include: increasing blood flow by the relaxation of blood vessels, providing metabolic fuel to muscles under conditions of exertion while removing waste products of muscle metabolism, mitigating blood loss by stimulating clotting, releasing glucose – a metabolic fuel into the bloodstream, stimulating respiration, removing excess potassium ion content from trauma-induced cell destruction, and psychologically – increasing emotional responses and inciting energetic effects or "reservoirs of power". Criticisms of Cannon's explanation of the adrenal response cite the lack of differentiation associated with physiological, chemical, psychological and behavioral responses initiated from either the fight/flight response or the physiological/psychological threat to the organism. This limitation stems from measuring just one variable (adrenaline), which does not allow for patterns associated with other variables to be observed (Goldstein, 2008).

Stress Response Theory. Hans Selye's work on stress also recognized the physiological responses associated with stress to the organism. Like Bernard, he stated that stress is the "the nonspecific response of the body to any demand made upon it" (Selye, 1976, p. 137) or, more simply "the rate of wear and tear in the body" (Selye, 1956, p. 3). Selye's work recognized that all stress was not bad and that living organisms need stress to actualize our internal drives. He stated that "Indeed, complete freedom from stress is death!" (Selye, 1976, p. 137). He clarified that stress is a constant which "speeds up the intensity of life" and explains that a "painful blow and a passionate kiss can be equally stressful" (Selye, 1976, p. 137). This distinction recognizes that stress is not a state to be avoided, but necessary for the organism to survive and thrive. To mitigate the negative connotations associated with the term stress, Selye, proposed the terms

distress and eustress, where pleasurable experiences and their associated psychological states are termed eustress and unpleasant psychological states such as fear and anxiety produced negative states and were labeled distress.

While Selye's research provided valuable insights on the physiology of stress, researchers have noted areas for criticism. The generalizability of the stress response as uniform contradicts data related to specificity of responses and differences between organisms (Lazarus & Folkman, 1987). Additionally, the conceptualization of stress as an "outcome" and only recognizable once the stress response was initiated limits the prospective nature of identifying causes of stress (Hobfoll, 1989).

General Adaptation Syndrome. While conducting research on stress reactions in rats, Selye (1950) observed that despite the specific type of noxious agent (including excessive cold temperatures, physical exertions, and injected toxins) given to the rats, the organisms would respond in a predicable way to return to homeostasis. This process was labeled the general adaption syndrome (GAS) and is comprised of three stages (Burgess, 2017):

1. *Alarm reaction stage:* This initial stage is governed by the sympathetic branch of the autonomic nervous system, which initiates a series of physiological responses. These responses start with a distress signal sent to the hypothalamus which releases glucocorticoids. These hormones subsequently release stress hormones including cortisol and adrenaline. The physiological responses associated with these hormones include boosts of energy, increased heartrate, blood pressure and blood sugars all of which are designed to initiate action in the organism. This reaction is commonly referred to as the "fight or flight" response.

2. *Resistance stage:* The second stage of the GAS is initiated by the parasympathetic branch of the autonomic nervous system which sets off a series of physiological changes designed to return the organism to homeostasis. These physiological responses include reductions in cortisol and the return of the heartrate and blood pressure to normal levels. If the stressful situation is resolved, then the body will return to homeostasis. If the stressful situation is not resolved, the body will remain in a state of alert and will continue to produce the stress hormones. During this prolonged stress response, the person may become irritable and have difficulty concentrating.
3. *Exhaustion stage:* The final stage of the GAS is reached when the body remains in a prolonged state of resistance. The body is unable to recover from the initial alarm reaction stage, thus depleting internal resources, which may lead to the development of stress related health conditions. Once the exhaustion stage is reached, the body is no longer able to fight stress and may experience symptoms including anxiety, depression, fatigue and feelings of defeat.

While Selye is largely recognized as the first to conceptualize the stress response, there are criticisms to his General Adaption Syndrome. The first notes the emphasis placed on the biological response to stress while underplaying the psychological components. As Selye's work focused primarily on animals, critics note that there is a wide variance of psychological processes and responses to stressful situations including appraisal of the threat, mediation of the stress process, motivational deficits and emotional distress (Cassidy, 1999). The second criticism notes the lack of individual differentiation in stress responses while focusing on the commonalities associated with the stress response. Critics note that the model does not account

for differences in psychological and physiological makeup of the organism as well as cognitive and emotional appraisal of the stressor (Cassidy, 1999).

Response Specificity. Mason (1972) raised a criticism of Selye's general adaption syndrome noting the model's non-specificity of the stressor and stress response. Mason observed that each of the stressors in Selye's experiments shared common characteristics, specifically related to the emotional meaning of the experience: that they were new, provoked uncertainty and were unfamiliar to the animal. These observations demonstrated that helplessness, uncertainty and lack of control were key features of the animal's experience (Krohne, 2001). Mason (1975) made the distinction between Selye's physiological stress response and the human stress response whose primary characteristic is cognitive mediation (Krohne, 2001) which later informed Lazarus' work on cognitive mediation theory that explains the relationship between emotion, cognition and stress.

Stimulus Based Stress Model. Building on Mason's stress specificity, Holmes and Rahe (1967) argued that adverse life and social events and specifically the amount and duration of change needed to become socially readjusted is associated with stress related illness. Subsequently they developed the social readjustment rating scale that measures "the intensity and length of time necessary to accommodate to a life event, *regardless of the desirability of the event"* (Holmes & Rahe, 1967, p. 213, emphasis in original). The survey was administered to 394 participants who rated 43 life events (Life Change Unit), where marriage was given a rating of 500 and a measure where all other events were evaluated as requiring more or less readjustment. The study concluded that there were high correlations between groups (gender, age, religion, education – except white and black participants), and as such there is consensus about life events and stress.

Hobfoll (1989) wrote about the utility of the findings noting that objective measures of life events and their impact on the stress response is useful. Generally recognized as a valuable tool for measuring stressful events and predicting the onset of stress related illness, critics also recognize generalizability challenges noting that different cultures may perceive stressful events differently (Mindtools). Regardless of these criticisms, these findings reinforce the importance of specificity and appraisal in the stress response.

Allostatic Load. McEwen (2005) proposed a novel term to add clarity to the broad and sometimes vague concept of stress. Allostasis refers to the body's ability to initiate a number of physiological responses in order to maintain homeostasis. McEwen (2005) defined allostasis as "the adaptive processes that maintain homeostasis through the production of mediators such as adrenalin, cortisol and other chemical messengers" (p. 315). If the process of allostasis continues for a long period of time, it can lead to what McEwen (2005) referred to as allostatic overload which is "the wear and tear on the body and brain that result from being stressed out" (p. 315). McEwen's (2005) framework provided clarity on the protective physiological responses to stress and the detrimental effects of being in a chronic stress response.

More specifically, the concept of allostasis draws from literature related to the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) pathway which both contribute to the neuroendocrine response to a stressor. These pathways contribute to over 90% of the body's processes (McCraty, 2015). While both systems promote a healthy stress response, problems arise with chronic over or underuse. Specifically, allostatic load refers to an overburdened ANS and HPA, which leads to one or both pathways failing to turn on or off. Subsequently the body's neurobiological system is chronically stressed or underperforming (McEwen, 2005). These physiological responses contribute to several pathologies including

those of the "mind", specifically, mood, attention, arousal and cognitive function. Physiological outcomes of allostatic load include atherosclerosis, heart disease, stroke, abdominal obesity, loss of minerals from bone and immunosuppression. Additionally, allostatic load can impact brain function including pathways associated with the hippocampus (emotion, memory, ANS) and amygdala (emotions; McEwen, 2005). McEwen (2005) argued that the concept of allostatic load leads to a need to more effectively utilize the adaptive qualities associated with the stress response while minimizing the effects of chronic stimulation, and the subsequent pathologies associated with being "stressed out".

Some critics (Romero et al., 2009) note that while one of the aims of introducing the term allostasis was to bring clarity to the vague field of stress, that in fact, allostasis is closely related to the term homeostasis and adds more confusion to the terminology related to stress. Additionally, critics point to the fact that there is a range of variables so complex that allostatic load does not recognize the overarching complexity of stress (e.g., Romero et al., 2009). Despite these criticisms, Lovallo (2015) noted that the concept of allostasis has proved useful in the study of stress since the 1990's. Lovallo explained that both researchers and practitioners find efficacy in the concept of allostatic load as they allow for a useful frame to describe the costs associated with chronic stress and to design research and to summarize findings.

Stress and the Heart. Building on research which challenges assumptions related to the heart primarily responding to commands sent from the brain, psychophysiologists now recognize the dynamic and two-way paths of communication between the heart and the brain (McCraty, 2015). Referencing the intrinsic cardiac nervous system, researchers demonstrate the four primary dynamic processes where the heart communicates *to* the brain: "neurologically (through the transmission of nerve impulses), biochemically (via hormones and neurotransmitters),

biophysically (through pressure waves) and energetically (through electromagnetic field interactions" (McCraty, 2015, p .3). The information the heart sends to the brain impacts the stress response, emotion regulation, resilience and several performance outcomes (McCraty, 2015).

McCraty (2015) summarized the role stress and both positive and negative emotions have on health outcomes. McCraty described stress as "emotional unease, the experience of which ranges from low-grade feelings of emotional unrest to intense inner turmoil" (p. 8). McCraty explained that external events as well as internal cognition, attitudes and feelings such as anger, anxiety, judgement, overwhelm as well as typical day-to-day experiences can lead to the experience of stress. Summarizing research on stress and the heart, McCraty lists a number of pathologies associated with stress and negative emotional arousal: "hypertension, silent myocardial ischemia, sudden cardiac death, coronary disease, cardiac arrhythmia, sleep disorders, metabolic syndrome, diabetes, neurogenerative diseases, fatigue and many other disorders" (p. 8). McCraty further explained that it is the act of experiencing emotion rather than simply the cognitive process of thinking about a past emotion which produces the physiological changes in the stress response.

Conversely, regenerative emotions can also produce a range of valuable outcomes, including meaning-making, motivation, social connectivity, courage to act and to protect who and what we find valuable. Further, positive emotions are also linked to several regenerative health outcomes and associated physiological responses. Such outcomes include: better health, improved heart function, and longevity (McCraty, 2015).

Heart Rate Variability. Heart rate variability (HRV) is defined as "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method

for gauging human health and resiliency" (HeartMath® Institute, 2015, para.1). The role of HRV in health was first detected in the 1960's when it was observed that fetal complications were associated with changes in heart rate and specifically reduced HRV even before changes in heart rate were observed. Subsequent research observed a correlation between reduced HRV in patients with diabetes and associated neurological dysfunction in the autonomic nervous system. Additionally, it has been shown that reduced HRV indicates a higher death rate post heart attack (myocardial infarction) than any other predictive factor (Thomas et al., 1997).

HRV naturally declines with age and age adjusted values can be used in risk prediction and health. Specifically, age adjusted HRV is shown to be a strong and independent predictor of patients with coronary artery disease and all-cause mortality. Additionally, low levels of age adjusted HRV have been shown to be a strong and independent predictor of negative health outcomes in healthy individuals (Dekker et al., 1997).

Normal variability in heart rate is generated from both afferent (ascending) and efferent (descending) neural activity in the two branches of the ANS. These coordinated actions along with physiological, mechanical and hormonal outputs act to maintain optimal cardiac parameters. This variability allows for adjustments to be made in response to internal and external challenges. Specifically, the vagal nerve and both branches of the ANS (sympathetic which speeds up the heart rate and parasympathetic which slows heart rate) remain active even while the individual is at rest. Thus, heart rate variability is an indicator of balance between the two branches. As HR increases there is less time between heartbeats for variability to occur, so HRV decreases, while at lower HRs there is more time between heartbeats, so variability naturally increases. This pattern of increased and decreased heart-rate is the basis of the heart's rhythms (McCraty, 2015).

For example, in a healthy individual, the heart rate would be higher during the day when responding to challenge and lower at night during rest or sleep. Deficits in these physiological self-regulatory functions are strong indicators of risk for a number of health outcomes including "depression, irritable bowel, hypoglycemia, fibromyalgia, panic disorder, hypertension, sleep disorder, chemical sensitivity, asthma, premenstrual syndrome, fatigue, anxiety, dizziness, migraine, nausea, arrhythmia (McCraty, 2015, p. 22). Additionally, HRV is an indicator of behavioral, cognitive (specifically executive function) and emotional flexibility and it has been hypothesized that this correlation to disease represents a limited ability of the individual to self-regulate in each domain (McCraty, 2015).

Coherence. From a human systems perspective, for the system to have optimal functioning there must be a quality of global coherence among subsystems such as physical, mental, emotional and social. This means that each subsystem is operating autonomously and in a coordinated way within the larger system. This does not mean that each unit is operating simultaneously, rather all are performing unique functions in way that is both complex and synchronized (McCraty, 2015). Thus, the term physiological coherence refers to:

> the degree of order, harmony and stability in the various rhythmic activities within living systems over any given time period. This harmonious order signifies a coherent system, whose efficient or optimal function is directly related to the ease and flow in life processes. (McCraty, 2015, p. 26)

An incoherent system is characterized by irregular and unsynchronized subsystems and results in an inefficient and stressful operating system.

Heart or cardiac coherence can be measured in an HRV analysis where a balance of both branches of the autonomic nervous system result in improved heart-brain communication and "entrainment" among a range of physiological systems. This coherent state is characterized by

efficient processing and the ability to activate the body's natural regenerative processes (McCraty, 2015).

McCraty (2015) explained that commonly labeled "positive emotions" reflect a range of internal functions which entrain themselves in a coherent way and is referred to as psychological coherence. The domains of coherence can include thoughts, speech, emotional composure and a range of physiological responses that are represented in heart rhythm variability patterns. These patterns are described as either coherent or incoherent. A coherent sine wave pattern is observed in heart rhythm variability patterns and is defined as "an ordered or constructive distribution of power content within a single waveform; autocoherence (e.g., sine wave)" (McCraty, 2015, p. 24). "Positive emotions not only 'feel better,' they actually tend to increase synchronization of the body's systems, thereby enhancing energy and enabling us to function with greater efficiency and effectiveness" (McCraty, 2015, p. 26). Empirical research has resulted in a 75% accuracy rate in the researcher's ability to correctly identify emotional state from HRV pattern recognition" (Bradley & Pribram, 1998).

While these coherence states are naturally occurring, sustained coherence is relatively uncommon. Thus, leading toward research and interventions which allow individuals to activate a state of coherence in a proactive way which includes actively initiating a positive emotion (McCraty, 2015). This dynamic approach targets the individual's ability to physiologically and psychologically self-regulate which can be measured in HRV patterns.

Transactional Theory of Stress and Coping. Research related to the role of the heart in the stress response and subsequent efforts to mitigate and prevent the damaging effects of depleting emotions while leveraging the benefits of regenerative emotions highlights the bi-directional nature of heart-brain communication and the resulting biological, neurological,

biophysical and energetic responses. Like previous stress models, Lazarus and Cohen (1977) recognized that key variables in the stress response included how the organism responds to demands made on the internal and external resources and the resulting efforts to return to balance or homeostasis. They also recognized that meaning and appraisal of the event played a role in the stress response. Building on these variables they argued that environment was a key factor in the stress response and informed one's options for mediation and resolving the negative outcomes (both psychological and physiological) of the stress response. Thus, Lazarus (1966) offered the following definition: "stress occurs when an individual perceives that the demands of an external situation are beyond his or her perceived ability to cope with them".

Lazarus and Cohen (1977) argued that, in fact, environment was a key variable in psychological stress and further explained that environmental conditions were directly related the stress response. Specifically, environmental factors (current and past) both limit and provide for the tools needed to resolve the stressful situation. Thus, they oriented the study of stress as a complex interaction between the person and environment.

Lazarus and Cohen (1997) explained that the term environment includes a wide range of meaning. They specified that environment could include:

> (roads, bodies of water, societal changes, the density of population in a city) to those that are very immediate (e.g., the actions of an employer, a crowded room, the physical layout of one's house); it sometimes even includes things traditionally considered to be within the individual (e.g., disruption of the "internal physiological environment" or the secretion of stress hormones) or the mind (e.g., the way an event is interpreted or dealt with). (p. 90)

Given the range of variables associated with stress, the authors proposed that the stress response is more generally a relationship between the person and their environment, essentially a transactional relationship.

Lazarus (1966) proposed the transactional model which highlighted the relationship between the individual and the environment and the role of appraisal in the coping process. Appraisal refers to the cognitive appraisal of the situation as excessive in relation to available resources. Subsequently, the transactional theory of stress and coping was developed by Lazarus and colleagues over years of research (Folkman et al., 1986).

The appraisal process consists of two phases: primary appraisal and secondary appraisal. In *primary appraisal* the person assesses what is at stake in the situation. They evaluate the possibility of outcomes in a number of areas: "Is there harm or benefit with respect to commitments, values, or goals? Is the health or well-being of a loved one at risk? Is there potential harm or benefit to self-esteem" (Folkman et al., 1986, p. 993)?

Evaluating resources to identify if the individual can overcome/prevent harm or add value to their circumstances is *secondary appraisal.* Appraisal options may include, "altering the situation, accepting it, seeking more information, or holding back from acting impulsively and in a counterproductive way" (Folkman et al., 1986, p. 993). Next, the two levels of appraisal allow the individual to assess if the *person-environment transaction* is significant to wellbeing, whether it be threatening (harm/loss oriented) or challenging (possibility/benefit oriented).

Folkman et al (1986) explain that *coping* has three primary features: (a) process oriented (thinking and behavior in the stressful situation), (b) contextual (appraisal of demands and available resources, and (c) efforts oriented (non-value laden with an emphasis on ability to mitigate stress). They cited previous research which provides evidence for the notion that successful coping consists of two factors: *emotions-focused coping* or regulating stressful emotions and *problem-focused coping* or altering stress inducing person-environment factors.

Problem focused coping relies on behavior to mitigate stress. Specific actions which illustrate problem focused coping include: "Confrontative Coping, Planful Problem-Solving, and Seeking Social Support" (Baqutayan, 2015, p. 482). Emotion based coping strategies include: "Self-Control, Seeking Social Support, Distancing, Positive Appraisal, Accepting Responsibility, and Escape/Avoidance" (Baqutayan, 2015, p. 482). When both methods are employed, coping then functions by behaviors to resolve the problem and emotional self-regulation (Baqutayan, 2015).

Lazarus and Folkman (1987) explained that the coping process can produce several short-term or immediate, as well as long-term outcomes. Short term outcomes include resolution, or whether or not the situation was resolved, as well as the quality of the resolution (improved, stayed the same or worse). They explained that the affect or reported emotions impacted how individuals rated the quality of the resolution. Long-term outcomes included three categories: (a) physical health (health status, somatic health), (b) subject well-being (affect and psychological symptoms), and (c) social functioning.

Baqutayan (2015) recognized there are many variables in the study of stress and how those variables are interrelated, is still not clear. Baqutayan specified that stress and coping mechanisms do go together and that the optimal method for resolving stress does depend on the specifics of the stressors and the needs of the individual. Criticisms of the transactional theory of stress and coping point to the prominence of the role of perception as opposed to environmental variables (Hobfoll,1989). Hobfoll (1989) recognized that both approaches do overlap. In order to address these issues, further study was recommended (Baqutayan, 2015).

Stress Summary. With its early roots in physical mechanics, stress has been an evolving field of study. The physiological reactions associated with stress in the body was introduced by

Bernard's (1878) work on the *inner world* and corresponding efforts for the organism to maintain a consistent internal environment. Building on Bernard's work, James Cannon (1929) introduced the concept of homeostasis and documented the brain processes associated with *goal values* the organism tries to maintain during a stressful event. Cannon also documented the physiology of stress, specifically the role of the adrenal glands with his work on *flight or flight* in the stress response. Based on his experiments with rats, Selye (1950) offered the *General Adaption Syndrome* which documents the three primary processes associated with the stress response: alarm, resistance and exhaustion.

Mason (1972) introduced the concept of *response specificity* when he raised a criticism of Selye's (1950) general adaption syndrome noting the model's non-specificity of the stressor and stress response. Holmes and Rahe (1967) offered the *stimulus based stress model* and argued that adverse life and social events and specifically the amount and duration of change needed to become socially readjusted is associated with stress related illness. Later, McEwen (2005) offered the term *allostasis* which refers the body's ability to initiate several physiological responses in order to maintain homeostasis and coined *allostatic load* referencing the chronic demands on the HPA axis and ANS in the stress response leading to individuals becoming "stressed out". Research (McCraty, 2015) focusing on the science of the heart demonstrates the bi-directional nature of heart-brain communication and the role emotions play in both mitigating depleting emotions and leveraging the regenerative nature of renewing emotions. Finally the Transactional Theory of Stress and Coping (Folkman et al., 1986) argued that environment was a key factor in psychological stress and oriented the study of stress as a complex interaction between the person and environment.

Despite all these contributions to field of stress, researchers and practitioners recognize that there is much work to be done in the study of stress. Emotions can initiate, and in some instances sustain, biological, neurological, biophysical, energetic and environmental responses and their subsequent impacts on a range of physiological, psychological and community outcomes.

Organizational stress

Utilizing Mark and Smith's (2008) review, what follows is a critical analysis of models of stress in the workplace that help to conceptualize the aims of this study. This construct has a focus on predictive variables of organizational stress and the impact such stress has on both personal and organizational outcomes.

Person-Environment Fit Model. French (1973) developed the person-environment fit model that linked health outcomes to an individual's work environment. This model was built upon the transactional model previously reviewed by Lazarus (1993). Lewin's (1951) previous research also contributed to the person-environment fit model that recognized the interaction between personal attributes and the work environment and their impact on stress related variables such as health, behavior and strain.

Mark and Smith (2008) explained that these health outcomes are a result of the degree of to which a person and their work environment are suited. For a healthy match the employee's skills, abilities, resources and attitude align with those of the job. Further, the work environment should align with worker attributes such as their needs and potential. If there is a mis-match between the person and the environment (either subjective or objective) the result could lead to negative health issues. Mark and Smith referenced Lazarus' support of the model as it was a

forward-looking approach to job stress and satisfaction but recognized challenges with the model as it represents the person-environment fit as static, rather than changing and dynamic.

Job Characteristics Model. Hackman and Oldham (1976) identified the key variables that allow individuals to be intrinsically motivated to effectively perform on the job. The three variables were (a) psychological – referring to the internal psychological states which allow the worker to be motivated to perform including experienced meaningfulness, and responsibility and knowledge of outcomes; (b) job characteristics – which allow for optimal psychological states including skill variety, task identity, task significance, autonomy, and feedback; and (c) personal attributes – which indicate how optimally an individual will respond to the complexity and challenges of the job.

The corresponding Job Diagnostics Survey (Hackman & Oldham, 1976) was tested in seven organizations with samples consisting of 658 employees, which represented 62 different jobs with strong results supporting the model's validity. Despite these scores, Kompier (2003) summarized some of the limitations of the model specifically noting some of the challenges associated with the validity of self-report measures as opposed to more objective measures (specifically related to job control). Additionally, criticisms related to the direction of causation of job characteristics, which may, in fact, be reciprocal. Despite these limitations, Kompier recognized the utility of the model for predicting outcomes as well job satisfaction.

Vitamin Model. Building upon the theme of environmental influences, the vitamin model (Warr, 1987) used an analogy to describe the non-linear relationship of nine environmental variables on mental health. War explained that environmental "vitamins" have the potential to be harmful at too low or too high dosages. Warr specified that the environmental influences include, "opportunity for control, opportunity for skill use, externally generated goals,

variety, environmental clarity, availability of money, physical security, opportunity for interpersonal contact, and valued social position" (Warr, 1987, p. 401). The mental health outcomes consisted of "affective well-being, competence, autonomy, aspiration, and integrated functioning" (Warr, 1987, p. 401).

Mark and Smith (2008) explained that some job characteristics such as salary, safety and task significance also represented a positive linear relationship on health until they reach a threshold where increases in the vitamin neither positively or negatively impact health. Additionally, some vitamins (such as job expectations, self-sufficiency, community, feedback and skill utilization and variety) demonstrate a non-linear relationship where adequate amounts are needed in order to be beneficial, but negative outcomes are observed with too high or low of a dosage.

De Jonge and Schaufeli (1998) argued for the utility of the model specifically citing that previous models over-conceptualize linear relationships and that the vitamin model recognizes the curvilinear nature of job characteristics and mental health. Despite these observations, Mark and Smith (2008), in their review of evaluations of the vitamin model, noted that while interesting conceptually, evidence is limited and evaluation of its efficacy has not yet been demonstrated.

Michigan Model. The trauma associated with the Second World War initiated a new interest in mental health. Thus, the University of Michigan's Institute for Social Research (ISR) launched the "Mental Health and Social Environment" program to focus on the workplace growth of the 1960's and its impact on the American experience. Led by French and Kahn, initial interests focused on health in the workplace (Althaus et al., 2013).

Psychologist Kurt Lewin and his work on field theory prompted French and Kahn (1962) to develop a model that included environmental variables. They viewed the industrial or organizational environment to produce both positive and negative outcomes and explained that "we view the industrial environment not only as a source of pressures and conflicts which interfere with mental health, but also as a source of support conducive to mental health" (French & Kahn, 1962, p. 1). The model integrated appraisal as a variable and recognized that how the employee perceives the objective environment will form their subjective assessment of the environment. This assessment will impact stress, and subsequent physiological and psychological outcomes. The model also integrated characteristics of the individual such as values and personality as well as their social environment including family and social groups, which can impact the subjective assessment and subsequent stress levels (Althaus et al., 2013).

Janssen et al. (1999) recognized the value of the Michigan model when they commented that such models contribute to understanding of the relationship of work, experiences, stress and associated outcomes as well as recognizing the contributions to research and application. The authors critiqued the Michigan model by pointing out that the global frameworks do not lend to specific hypothesis testing, making contradictory evidence difficult to obtain as some relationships will always be found.

Person-Environment Fit (P-E Fit). Building upon the objective and subjective nature of environment conceptualized by the ISR and specifically the Michigan model, the ISR conceptualized a new model distinct from previous work. The person-environment fit (P-E fit) model (French & Kahn, 1962) also drew from Lewin (1951) which recognized the interaction of individual, environment and subsequent behavior and health outcomes. The P-E Fit model illustrated that a mismatch between the person (capabilities and goals), the environment

(demands, resources) can have both objective and subjective realities, thus the degree of the lack of fit will have varying levels of impact on health (Althaus et al., 2013).

In his detailed analysis of the P-E Fit Model, Caplan (1987), of the University of Michigan, offered views on limitations and direction for further refinement of the model. Limitations point to methodological challenges related to obtaining objective measures of employees' abilities and skills as well as needs, demands and resources of the environment. Caplan suggested the development of scales that demonstrate that there is not contamination between the personal and environmental variables would provide value. If such improvements were made, Caplan argued that social science research will be able to address a range of both basic and applied inquires.

Demand Control Support Model. The demand control support model positioned organizational stress as an interaction between job demands and job decision latitude (Karasek, 1979). Karasek (1979) argued that this new conceptualization resolved some of the ambiguity related to variables in the workplace that cause mental strain (which is linked to health outcomes such as depression, fatigue and cardiovascular disease) and job dissatisfaction. The primary premise of the model explained that strain is caused when one has low decision making authority or "decision latitude" coupled with heavy job demands. Similar to the vitamin model, the demand control support model recognized the complex nature of the interaction of a number of variables related to decision latitude and job demands and the subsequent job strain outcomes. The utility of the model points to reducing strain for a range of workers by redesigning work to improve decision latitude while maintaining outcomes which are a result of the job demands.

Karasek (1979) specified that high strain situations (high demand and low job control) were more likely to incite the negative outcomes of strain. Challenge situations produced the

lowest levels of illness and were observed with moderate to high levels of stress and high levels of job control – thus demonstrating that high control can mitigate high levels of demand.

Mark and Smith (2008) summarized evaluations of the model by noting that it is a strongly influential model of organizational stress. Criticisms point to the limited number of variables considered, and the individual differences in responses to stressors.

Cox's Transactional Model of Occupational Stress. Cox and Griffiths (1995) differentiated the role of interactional and structural approaches to organizational stress. They specified that interactional models focus primarily on the processes associated with the stress response including interactions between stressors, populations and outcomes. Transactional models focus on the subjective processes associated with the stress response and include such variables as environment, appraisal and emotional processes. Transactional models recognize that individual differences may exist in resources available for coping, the variation in subjective appraisal, personality characteristics and locus of control.

Cox and Griffiths (1995) argued for the relationship between psychological stress and physiological injury in the workplace. They specified that work design, management of work and social variables can incite both psychological and physical harm. They acknowledged that existing models of occupational stress recognize the impact of stress on psychological and physiological outcomes, but argued that little research has target occupational injuries and accidents. This observation prompted the National Institute of Occupational Safety and Health (NIOSH, 1996) to recognize that psychosocial factors influences worker's safety and health and specifically contribute to jobs stress and psychological strain.

Effort-Reward Imbalance Model. Building upon the person-environment fit model and the demand-control model, Siegrist (1996) introduced the effort-reward imbalance model of

organizational stress, which specifically measured cardiovascular health. Siegrist argued that stressful events were an exchange between a number of "high cost" and "low gain" conditions. In an effort to predict cardiac events in the workplace, a number of variables were studied. Worker variables were categorized as low status control (lack of promotion and job insecurity) and effort – which consisted of extrinsic (work pressure) and intrinsic (coping, need for control). Cardiovascular outcomes were measured as hypertension and atherogenic lipids. Siegrist concluded that averse cardiovascular health is associated with high-cost/low gain workplace environments.

Mark and Smith (2008) summarized support and criticisms of effort-reward imbalance model. They explained that the model has strong measures of validity, but lacks differentiators related to individual variations related to intrinsic effort and perceptions of stress.

Demand-Skill-Support Model. In an effort to simplify the complexity related to work and worker health van Veldhoven et al. (2005), conducted an empirical study to best model the relationship between a range of work characteristics and employee health outcomes in the most parsimonious manner possible. As a result, the Demand Skill Support model was proposed, heavily drawing from the foundational variables presented in the demand control support model. The demand skill support model was built from an investigation of 37,291 Dutch employees to identify the relationship of seven work related variables and three outcome variables. The work variables consisted of "pace and amount of work, physical effort, skill, task autonomy, quality of social relationships with colleagues, quality of relationships with supervisor, and job security, with the outcome variables of work-related fatigue, task satisfaction, and organizational commitment" (Mark & Smith, 2008, p. 14). Data demonstrated the best fit to include the following variables: physical demands, time demands, skill utilization and quality of social

relationships. These variables comprise the Demand Skill Support Model and indicate the best relational fit of work characteristics, health and wellbeing.

While recognizing the value of the large sample size, Mark and Smith (2008) summarized that like previous offerings, the model does not fully account for individual differences related to appraisal, stress reactions, the lack of integrating transactional qualities and the subjective nature of job characteristics. Mark and Smith (2008) also recognized the benefits associated with the parsimonious nature of the proposed model.

Demand Induced Strain Compensation Model. To refine valuable aspects of two leading models of job stress, specifically the demand control support model (Karasek, 1979) and the Effort Reward Imbalance model (Siegrist, 1996), De Jonge and Dormann (2003) combined the two models to leverage their strong theoretical contributions, novel insights and heuristic value. The result, the demand induced strain compensation model, recognizes a range of demands and resources and that the pairing of these demands and resources impact health outcomes and employee growth:

> emotional demands at work are most likely to be compensated for by emotional resources, cognitive demands by cognitive resources, and physical demands by physical resources . . . for example, if high behavioural demands are met with low behavioural resources, high cognitive demands with low cognitive resources, and high emotional demands with low emotional resources, then adverse health is likely to result. However, if high demands in each dimension are met with high resources, then motivation, learning and growth are likely to result. (Mark & Smith, 2008, p. 15)

De Jonge and Dormann (2003) explained that initial results are strong but do need additional empirical data to support the model. They recognized that a strength of the model is its ability to positively impact customized solutions in practice, especially among service workers.

Job Demand Resource Model. The Job Demand Resources Model (Demerouti et al., 2001) targeted job demands and job resources and their impact on burnout and resulting illness and organizational commitment. “Job demands refer to those physical, social, or organizational

aspects of the job that require sustained physical or mental effort and are therefore associated with physiological and psychological costs" (Demerouti et al., 2001). Job resources on the other hand, provide resources to mitigate negative health outcomes and refer to:

> Physical, psychological, social, or organizational aspects of the job that may do any of the following: (a) be functional in achieving work goals; (b) reduce job demands at the associated physiological and psychological costs; (c) stimulate personal growth and development. (Xanthopoulou et al., 2007, p. 122)

Results supported a relationship between job demands and exhaustion and lack of job resources with disengagement in three populations including human services, industry and transport. The authors concluded that the Job Demands Resource model is useful in efforts to reduce burnout and speficy that in order to reduce employee exhausion, job demands should be limited or reworked. Finally, they argued that improving job resources may lead to improvements in employee engagement. Mark and Smith (2008) recognized that this model contributes to the theoretical contributions of previous models and indicated that the addition of personal factors may be a useful direction for future research.

DRIVE Model: Demands, Resources, and Individual Effects Model. After critically analyzing several models of organizational stress, Mark and Smith (2008) offered the Demands Resources and Individual Effects model to mitigate some of the deficiencies of previous models. Specifically, the new model address challenges associated with finding the right balance between the limitations associated with the individual experiences of stress in the workplace, and transactional models that may have too much complexity in their process-oriented structure.

Drawing from a number of models, Mark (2008, in preparation) offered the demands, resources, and individual effects model (DRIVE) which included the following independent variables: job demands, social support, decision authority, skill discretion, extrinsic effort, intrinsic effort, rewards, 40 coping behaviors including categories for problem focused coping,

seeking advice, self-blame, wishful thinking, and escape/avoidance, attributional/explanatory styles and demographic variables of age and gender. Dependent variables were anxiety, depression and job satisfaction. Mark (2008) later refined the model to include a perceived job stress variable.

The final model was tested on populations of nurses and university employees consisting of close to 1,200 participants. Results suggest that workplace demands and resources showed strong predictability of health outcomes and perceived work stress. Positive and negative coping as well as personal demands and resources were strong predictors of health outcomes. The strongest predictors were intrinsic efforts on anxiety and depression and rewards and attributional behaviors on job satisfaction.

Mark and Smith (2008) recognized the need for more data to support the DRIVE model but argued that the model successfully integrates variables of job characteristics models and transactional models and successfully offers a middle ground highlighting the balance of simplicity and complexity. They argued that the model offers a useful tool for practical interventions specifically noting that adjusting one variable has the potential to impact others which could lead to simple or complex workplace interventions.

Social Coherence and the Heart. Building on the previously reviewed physiology of coherence where the human system reaches optimal functioning when it obtains a coherent state characterized by optimal functioning of subsystems (physical, mental, emotional and social), social coherences extends from the human organism to larger social organizations. Specifically, these organizations share common goals and can include couples, families, groups and organizations. “Social coherence is reflected as a stable, harmonious alignment of relationships that allow for the efficient flow and utilization of energy and communication required for

optimal collective cohesion and action" (McCraty, 2015, p. 28). Conceptually, social coherence is similar to physiological coherence, but now refers to optimal relationships between individuals rather than within the physiological functioning of the body. "In a coherent team, there is freedom for the individual members to do their part and thrive while maintaining cohesion and resonance within the group's intent and goals" (McCraty, 2015, p. 28).

Evidence suggests that a measurable energetic field allows for nonverbal communication among team members to take place (McCraty, 2015). Neuroscientist Pribram and Sociologist Bradley empirically developed the general theory of social communication which found that most groups create a "field" of emotional energetics which connects all members regardless of the size, formality, tenure of members, culture and length that the group has been formed. Their work targeted charisma as a key variable in social functioning and situated the study of social interaction with bonds among group members (Bradley, 1987). The researchers found that "most groups have a global organization and coherent network of emotional energetic relations interconnecting virtually all members into a single multilevel hierarchy" (McCraty, 2015, p. 28).

High levels of social coherence benefit the organization as well as individual members of the group in several ways. Specific outcomes include improved performance, communication and collaboration (McCraty, 2015). Conversely, organizations with low individual and group levels of coherence result in several maladaptive outcomes. McCraty (2015) explained that when an individual is in an incoherent emotional (and physiological state) it can result in aligning more heavily with self-interest rather than those of the group, thus generating lower levels of social coherence. Additionally, stressful group dynamics can increase stress among individual members, which can contribute to increased errors, decreased efficiency and even increased violence and abuse (Hoel et al., 2001).

Organizational stress can impact functioning of both individuals of the group and larger system functioning (McCraty, 2015). Based on the physiology of coherence where and individual reaches an optimal balance of functioning in physical, mental and emotional subsystems, social coherences extends from the human organism to larger social organizations. Creating personal coherence allows the individual to actively mitigate the damaging effects of stress while generating a stronger field environment, which allows the social and organizational system to reach higher levels of performance (Bradley, 1987).

Organizational Stress Summary. Building on Lazarus' (1986) model which illustrated the transactional nature of stress, the person-environment fit Model (French & Kahn, 1962) highlighted the interaction of personal attributes, work environment and health outcomes. Additionally, the job characteristics model (Hackman & Oldham, 1976) highlighted three key variables (psychological, job characteristics and personal attributes) which determine job motivation and an individual's ability to respond to organizational stress.

Building on the theme of environmental influences, the vitamin model (Warr, 1987) used the vitamin analogy to explain the non-linear relationship of workplace environmental variables on health and explained that "vitamins" can be both useful in the right doses, yet harmful in too high or too low dosages. The Michigan model (French & Kahn, 1962) also focused on environmental variables in the role of predicting work factors and subsequent impact on health. This model highlighted the ability of environmental variables to both support or interfere with worker health. The Michigan model also integrated appraisal and employee perception and assessment of the work environment. Building upon the objective and subjective nature of environment, the person-environment fit (P-E Fit) model (Caplan & Van Harrison, 1982) recognized the interaction of the individual and environment and subsequent behavior and health

outcomes. The P-E Fit model illustrated that a mismatch between the person and the environment can have both objective and subjective realities and note that the degree of worker-environmental fit will impact health outcomes.

The demand control support model (Karasek, 1979) positioned organizational stress as an interaction between job demands and job decision latitude. The primary premise of the model explained that strain is caused when one has low decision-making authority or "decision latitude" coupled with heavy job demands. Cox and Griffiths (1995) argued for the relationship between psychological stress and physiological injury in the workplace. The effort-reward imbalance model of organizational stress (Siegrist, 1996) argued that stressful events were an exchange between a number of "high cost" and "low gain" conditions. Siegrist (1996) concluded that averse cardiovascular health is associated with high-cost/low gain workplace environments. Additional research on stress and the physiology of the heart illustrates the damaging effects stress can have on the individual and the organization. Additionally, coherence research extends to social settings and highlights the adaptive outcomes associated with high levels of individual and group coherences for the organization.

To simplify the complexity related to work and worker health, van Veldhoven et al. (2005) conducted an empirical study to best model the relationship between a range of work characteristics and employee health outcomes in the most parsimonious manner possible. They concluded that the key variables consisted of physical demands, time demands, skill utilization and quality of social relationships. As a result, the Demand Skill Support model was proposed. To further refine leading models of organizational stress, De Jonge and Dormann (2003) combined several models to create a more applied and parsimonious model. The result, the

demand induced strain compensation model was constructed. The model predicts health outcomes and employee growth from a range of demands and resources.

The Job Demand Resources Model (Demerouti et al., 2001) targeted job demands and job resources and their impact on burnout and resulting illness and organizational commitment. Results supported a relationship between job demands and exhaustion and lack of job resources with disengagement in three worker populations. The DRIVE (Demands Resources and Individual Effects) model (Mark & Smith, 2008) was offered as a resource to mitigate some of the deficiencies of previous models related to complexity and individual experiences of stress in the workplace. The resulting model allows practitioners to successfully adjust even one variable while building simple or complex workplace interventions.

Resilience

The study of resilience seeks to understand more about the qualities that allow some individuals, despite experiencing significant averse life circumstances, to survive and even thrive in the face of challenging conditions (Fletcher & Sarkar, 2013). The study of resilience dates to the 1800's and continues to the present (Jackson et al., 2007). While the construct has been given much attention, there is still relatively little agreement on how to clearly articulate and define the construct. Like Tusaie and Dyer's (2004) review of resilience, this analysis recognizes the dynamic, interactive and complex nature of the construct. Martin-Breen and Anderies (2011) explained that several disciplines, including psychology, ecology, political science, business administration, sociology, history, disaster planning, urban planning, and international development all incorporate the concept of resilience into their discipline. The authors recognized that this range of inquiry produces different methodologies, empirical data and application, which contributes to the complex nature of resilience as a construct.

Richardson (2002) explained that resilience theory is reflected in three primary "waves" of inquiry. The first wave is characterized by resilience qualities which were represented as protective factors and developmental assets that were observed in children in the face of adversity. The second wave conceptualized resilience as a process of disruption and resilience qualities need for reintegration. The third wave reflects the multidimensional nature of the construct and highlights the individual's motivation to evolve in the face of adversity with an emphasis on intervention building and application. This review mirrors these phases of resilience and begins by offering several definitions for resilience, describes key themes which inform the construct of resilience (adversity, childhood, vulnerability, trait, process, interpersonal and environment), and finally, models for resilience are briefly reviewed.

Definitions. Before reviewing specific definitions of resilience, it is important to note that data indicates that there are weak correlations on outcomes with definitions that combine numerous areas of resilience in their definitions. Thus, it is argued that definitions need to specify the domain of research and practice rather than rely on a global definition of the construct (Tusaie & Dyer, 2004). Indeed, Rutter (1999) recognized that the broad nature of the conceptualization of resilience is both necessary and appropriate.

In their review of the construct, Fletcher and Sarkar (2013) explained the term "resilience" has roots in science and mathematics and include variables such as strain, strength, elasticity, recovery, bending and bouncing back. When the concept is applied to humans, they recognized that the range of definitions is often informed by the subjects and historical and sociocultural boundaries of the specific inquiry.

When applied to humans, definitions of resilience cover a range of qualities related to the individual as well as circumstantial and resource-related components. Rutter (1985), in his work

on resilience and the predicative nature of adversity and mental health outcomes states that resilience is "the ability to bounce back or cope successfully despite substantial adversity". Similarly, Tugade and Fredrickson (2004) in their work on the impact of positive emotion on the study of resilience define psychological resilience as "effective coping and adaptation although faced with loss, hardship, or adversity" (p. 320). Note that both definitions highlight the role of adversity, coping and adaptation as foundational components to adversity, which aligns with Fletcher and Sarkar's (2013) assessment that that the two necessary elements for resilience are adversity and positive adaptation.

Bonanno (2004) challenged established beliefs that resilience is linked to recovery from adversity and notes that traditionally, the primary sample of subjects in the study of resilience comprised of those who suffered extreme loss and subsequently sought treatment for their distress. Instead, Bonanno argued that a large portion of the population also experiences trauma and/or loss yet can retain positive emotional affect and exhibit only minor levels of emotional distress and loss of function. Thus, Bonanno offers a definition of resilience which expands on the notion that resilience is founded in the "process of recovery" and highlights the range of unique pathways to resilience:

> The term recovery connotes a trajectory in which normal functioning temporarily gives way to threshold or subthreshold psychopathology (e.g., symptoms of depression or posttraumatic stress disorder [PTSD]), usually for a period of at least several months, and then gradually returns to pre-event levels. Full recovery may be relatively rapid or may take as long as one or two years. By contrast, resilience reflects the ability to maintain a stable equilibrium. (p. 20)

Providing separate definitions for recovery and resilience highlights the differences between coping mechanisms associated with pathologies of recovery as opposed to the resources associated with one's ability to remain at equilibrium in the face of adversity.

Some researchers focus their definitions of resilience on the traits or qualities of the individual who demonstrates high levels of resilience. To bring clarity to some of the ambiguity associated with the study of resilience, Polk (1997) reviewed 26 articles on resilience to provide qualities that define resilience. Subsequently, Polk defined resilience as "the ability to transform disaster into a growth experience and move forward" (p. 1). Additionally, Polk identified four distinct patterns of resilience:

1. *Dispositional pattern*: the pattern of physical and ego-related psychosocial attributes that contribute to the manifestation of resilience. Psychosocial attributes are characteristics reflective of personal competence and a sense of self, while physical attributes are the constitutional and genetic factors that enter into the development of resilience. These physical factors include intelligence, health, and temperament (p. 5).
2. *Relational pattern*: the characteristics of roles and relationships that influence resilience. This pattern includes both intrinsic and extrinsic aspects defined as the placement of value on both close confiding relationships as well as on a broader social network (p. 6).
3. *Situational pattern*: This pattern discloses resilience as a characteristic approach to situations or stressors and is manifested as cognitive appraisal skills, problem-solving ability, and attributes that indicate a capacity for action in facing a situation (p. 6).
4. *Philosophical pattern*: This pattern is manifested by personal beliefs. The belief that self-knowledge is valuable and reflection about oneself and events contribute to this pattern (p. 6).

Polk's patterns recognize a range of environmental, sociocultural, and dispositional and relational qualities associated with resilience. The benefit of articulating these patterns helps to bring clarity to the ambiguous nature of the construct that is reflected in the literature. Despite

this benefit, Polk recognizes that next steps to providing empirical evidence for this framework is the development of a theoretical construct and testing instruments.

Adversity. Despite Polk's emphasis on resilience as an ability to remain at equilibrium, much of the literature places a strong emphasis on the role of adversity in the conceptualization of resilience. Tusaie and Dyer (2004) summarized that early research on resilience focused on characteristics of the individual which allowed them to succeed in the face of adversity. Rutter's (1999) focus on positive adaptation in the face of adversity informs the construct of resilience. Coleman and Ganong (2002) in their research on resilience in children and families, argued that adversity is an antecedent to resilience. Researchers also note that there are differences in how people react to and appraise adverse events and as such, there are differences in how people perceive and react to events (Folkman et al., 1986).

Childhood. Resilience as a psychological concept originated from researchers who studied children who were able to thrive in the face of challenging early life situations. These children were categorized as "invulnerable" and later "resilient", thus a new line of research was initiated (Martin-Breen & Anderies, 2011). More specifically, resilience research focused on personality attributes that led to positive outcomes for children who faced adversities such as illness, trauma, poverty, abuse and neglect (Jackson et al., 2007).

This line of research represented a shift in the field of psychology, which had placed an emphasis on psychopathologies and their associated risk factors, to a focus on resilience factors that represent characteristics of the individual who could thrive in the face of challenge (Richardson, 2002). These qualities include self-esteem, supportive community, strong family relations, temperament and foresight. These variables represent a shift in research to a focus on identification of protective factors for overcoming adversity (Fletcher & Sarkar, 2013).

Rutter (1999) emphasized that the while the term resilience refers to resistance to psychosocial adversity, there is strong evidence to suggest that responses to adverse experiences vary significantly. Research on processes informing childhood responses to adversity need to accommodate for several methodological challenges. For instance, the variety of both protective and risk factors including vulnerability to stress, genetic and environmental influences, family dynamics, the role of new experiences, and cognitive and affective processing. Rutter explained that interventions need to be mindful of the complex interactions associated with these variables and how they might impact the individual, their environment and communities.

Vulnerability. When conceptualizing resilience, Rutter (1985) proposed a continuum with vulnerability and resilience representing two ends of a spectrum. Giordano (1997) described the interaction between vulnerability and resilience as a dynamic process and one where being able to effectively manage shifts between the two states will indicate one's ability to overcome adversity. Jackson et al. (2007) further explained that if one can successfully maintain equilibrium in the face of adversity that the resulting resilience will reduce vulnerability. Including vulnerability as a variable supporting the conceptualization of resilience reinforces the notion that building resilience while reducing vulnerability in the face of adversity is an active and dynamic process.

Stress. Tusaie and Dyer (2004) argued that the two foundational variables informing the construct of resilience are psychological coping and the physiology of stress. From a physiological perspective, when faced with adversity, humans have internal mechanisms to foster resilience and ultimately return to homeostasis (Jackson et al., 2007).

Drawing from psychological research on the interaction of stress and coping, it was observed that some individuals exhibited personal growth from their ability to cope with

adversity, thus informing the construct of resilience (Tusaie & Dyer, 2004). In their review of resilience, Fletcher and Sarkar (2013) recognized that when viewed from a stress-coping perspective, coping was a primary variable in overcoming adversity and subsequent resilience. Tusaie and Dyer (2004) further explain that like the field of psychoneuroimmunology, which studies the impact of the mind on health and disease, the area of inquiry is not on disease, rather the positive outcomes associated with overcoming adversity. Integrating stress as a variable into the complex construct of resilience highlights that overcoming adversity has both physiological and psychological roots aimed at first maintaining homeostasis and ultimately allowing the individual to experience personal growth in the face of adversity.

Traits. Several theories of resilience highlight the role of both physical and psychological characteristics which allow individuals to thrive in the face of adversity (Jackson et al., 2007). These trait-oriented theories of resilience recognize a range of characteristics which allow individuals to successfully adapt (Fletcher & Sarkar, 2013). Often referred to as protective factors, these traits are "influences that modify, ameliorate, or alter a person's response to some environmental hazard that predisposes to a maladaptive outcome" (Rutter, 1985, p. 600). Tusaie and Dyer (2004) further explained that it is not the challenging circumstances themselves but the way these adversities are perceived which influence one's ability to cope in the face of challenge.

Protective factors span a number of categories and include some of the following factors related to the individual: (a) cognitive factors (optimism, intelligence, creativity, humor, belief system, self-concept, confidence, curiosity); (b) competencies (coping strategies, social skills, educational abilities, intelligence, memory, resourcefulness, discipline, problem solving, flexibility); and (c) physical factors (stamina, physical attractiveness; Earvolino-Ramirez, 2007; Fletcher & Sarkar, 2013; Giordano, 1997; Jackson et al., 2007; Tusaie & Dyer, 2004). These

traits, along with influences from family, community and other external factors help individuals regulate behavior and promote resilience (Rutter, 1985).

Process. The evolution of the conceptualization of resilience originally focused on the role of personality traits and later evolved to recognize resilience as a process (Luthar et al., 2000). This shift allows for advances in the field's ability to empirically study resilience and construct applied interventions (Martin-Breen & Anderies, 2011). Rutter (1987) explained that while the presence of specific resilience traits or "protective factors" are strong predictors of resilience, he argued that "protective processes" are more valuable in the study and practice of enhancing resilience and preventing negative outcomes.

Luthar et al. (2000) summarized resilience as a process by offering the following definition: resilience is "a dynamic process encompassing positive adaptation within the context of significant adversity" (p. 543). They specified that two conditions must be present to satisfy the definition (a) exposure to significant threat or adversity, and (c) positive adaptation in the face of adversity despite risk to optimal development. Luthar and Cicchetti (2000) define positive adaptation as "behaviorally manifested social competence, or success at meeting stage-salient developmental tasks" (p. 858). The temporal and contextual elements indicated that protective factors and positive adaptation will vary from situation to situation and will not necessarily remain static throughout the course of a lifetime (Fletcher & Sarkar, 2013).

Interpersonal. Interpersonal relationships and social support are key variables in the study of resilience and protective factors (Tusaie & Dyer, 2004). Tusaie and Dyer (2004) summarized research on the role of social support and explained that interpersonal relationships impact several facets of resilience. Specifically, amount of social support as well as the process of maintaining such relationships are important, as the authors situate social support as a

transactional relationship between the in individual and their environment. They specified that perception and/or appraisal of the quality of their support is essential and that the nurturing of reciprocal social relationships is more impactful that the quantity of objective members in the individual's network or system.

Earvolino-Ramirez (2007) summarized the role of social support and positive relationships on resilience. They argued that for a child who faced adverse circumstances and demonstrated resilience that there was likely the presence of at least one strong adult attachment. Earvolino-Ramirez (2007) further explained that there is a strong correlation for adult populations and argued that at least one strong relationship within the individual's community or family impacted measures of resilience and explained that these interpersonal relationships not only provided for communication, resources and support, but also specified that perception and appraisal of the connections as "healthy" impacted the quality of resilience outcomes.

Environment. Rutter (1990) explained that resilience is not simply the compilation of qualities associated with the individual but includes environmental and circumstantial influences as well. He stated that "resilience cannot be seen as a fixed attribute of the individual. If circumstances change, the risk alters" (p. 184). Those who advocate resilience as a process dispute the notion of resilience as a static. In their review of resilience as a construct, Fletcher and Sarkar (2013) summarized that the development of resilience capacity changes over time in relation to person-environment interactions.

Like Lazarus's work on stress and coping as a transitional relationship between the individual and the environment, Waller (2001) agrees that environment is an important variable in the conceptualization of resilience. Specific environmental factors include the feeling of connectedness with community, life events and social factors (Tusaie & Dyer, 2004). While the

role of environmental factors is not fully understood (Tusaie & Dyer, 2004), situating resilience as a transactional relationship allows theorists to expand on a trait-based view of resiliency to a more complete conceptualization. This allows the study of resilience to be more dynamic rather than static, which ultimately allows practitioners to design, implement and study various resilience-based interventions which highlight growth capacity of the individual and the system.

Resilience and the Heart. Building on the role of individual and social coherence on organizational stress and optimal functioning, resilience plays a key role in building coherence while mitigating the damaging effects of workplace stress. To review, individual coherence refers to an optimal state of functioning where physical, mental and emotional subsystems work in a coherent state leading to optimal outcomes. Social coherence extends this concept to a systems perspective where all the individuals and subsystems of a group work in harmony to produce optimal work conditions for the individual workers as well as for the organization. McCraty (2015) illustrated that emotions and resilience are key variables in physiological processes associated with energy regulation and one's ability to adapt in the face of adversity.

McCraty (2015) defined resilience as "the capacity to prepare for, recover from and adapt in the face of stress, adversity, trauma or challenge" (p. 8). McCraty (2015) positions resilience as a state rather than a trait where one's resilience capacity is variable in relation to specific demands, circumstances and maturity levels. Building resilience capacity is positioned as one's ability to build energy capacity in four primary domains: (a) physical (endurance and strength); (b) emotional (positivity, supportive relationships); (c) mental (focus, attention, ability to integrate multiple points of view); and (d) spiritual (commitment to values, intuition, tolerance of other's beliefs).

McCraty (2015) explained that building resilience allows individuals (and subsequently groups) to actively regulate and improve performance in the four domains (physical, emotional, mental and spiritual). Improved resilience in each area allows individuals to mitigate the damaging physiological and psychological impacts of the stress response while improved resilience capacity and coherence levels allows for preventing such stress responses in the first place.

The Metatheory of Resilience and Resiliency. Tusaie and Dyer (2004) illustrated that the complex and dynamic nature of resilience has supported efforts of model development. Early efforts at model development focused on childhood and later family and systems-level resilience. Each model recognized resilience as dynamic process and highlighted key variables such as time, developmental state and context. Richardson (2002) recognized that most of the theories of resilience were population specific and thus developed the metatheory of resilience and resiliency to be applied to a range of populations, levels (individual, family, community) and stress inducing circumstances all while integrating the three "waves" of resilience-based inquiry.

Richardson (2002) defined resilience theory "as the motivational force within everyone that drives them to pursue wisdom, self-actualization, and altruism and to be in harmony with a spiritual source of strength" (p. 309). The resiliency process begins with a balanced state of physiological, mental and spiritual alignment or biopsychospiritual homeostasis. Homeostasis is disrupted when the individual lacks the protective factors or other resources to mitigate stressors, adversity or life events. Once the individual's homeostasis is disrupted, they will initiate the reintegration process. The reintegration process will result in one of four outcomes: (a) resilient reintegration – resulting in the acquisition of protective factors and improved resilience and growth; (b) reintegration back to homeostasis – where the individual has gotten past the

disruption and returned to original levels of homeostasis; (c) reintegration with loss – a return to lower levels of homeostasis as a result of loss of protective factors; and (d) dysfunctional reintegration – characterized by a loss of motivation and the acquisition of destructive behaviors such as substance abuse.

Richardson (2002) argued that interventions should target the development of protective factors to help mitigate stress, but also recognized that not all traumatic events can be avoided such as the death of a loved one. Richardson explained that interventions should target social skills, family support and spiritual development to increase resiliency and specifically biopsychospiritual homeostasis (or resilient reintegration). Richardson advocated education for children and adult population in schools, continuing education settings or rehabilitation programs with an emphasis on resilience skill building for the specific context. This skill building would help the individual successfully manage the traumatic event in a positive fashion and build protective factors for future stress-invoking events.

Proponents of the model recognize the value in a general mode of resilience which allows researchers and practitioners to target context-specific resilience building interventions. It was noted that the theory's positive psychology orientation elevates the model from deficit-based frameworks which focus on weaknesses of the individual, community or social environment to one which leverages the strengths of these populations to build their resilience capacity (White et al., 2008). Additionally, the metatheory is recognized for successfully integrating a wide range of theoretical constructs from several disciplines including physics, psychology and medicine (Fletcher & Sarkar, 2013). A specific criticism of the theory targets Richardson's summary regarding the transcendent nature of resilience interventions. Windle (2011) summarizes the theory's strengths and weaknesses when he said, "The suggestion by Richardson that resilience

may be the driving force that controls the universe may be a little overstated, but the capacity for 'ordinary magic' and the opportunity for positive adaptation should be an option for everyone" (p. 165).

Resilience Summary. Resilience as a construct is characterized by its dynamic, complex, inter-disciplinary and context-specific nature. This review followed Richardson's (2002) wave-like framework which summarized resilience qualities, the evolution of the construct of resilience being positioned as a process rather than a series of traits and finally the focus on theories and interventions for building resilience capacity. The multi-dimensional nature of the construct is reflected in the range of definitions offered by scholars and practitioners alike. Many definitions place an emphasis on the role of adversity, coping and adaptation in resilience. Some definitions emphasized the role of positive adaptation in the face of adversity and trait-specific characteristics of the individual as well as the role of appraisal and the interaction of the individual and the environment.

Early research (Jackson et al., 2007; Martin-Breen & Anderies, 2011) focused on child-populations who were able to thrive in the face of challenging early life situations. Research targeted specific traits or personality attributes which allowed these children to successfully adapt in the face of adversity. Additionally, researchers (Giordano, 1997; Jackson et al., 2007; Rutter, 1985) emphasized the role vulnerability played in conceptualizing resilience which recognized the interaction of the two variables as dynamic and an active process for resilience capacity building.

Integrating the biological processes associated with stress and coping allowed researchers (Fletcher and Sarkar, 2013; Jackson et al., 2007; Tusaie and Dyer, 2004) to identify another construct in the study of adversity which highlighted the role of the mind on health and disease.

This orientation shifted the study of adversity to the positive outcomes associated with overcoming adversity while recognizing the intersection of biology, physiology and psychology on one's ability to maintain and return to homeostasis and the subsequent resilience growth which is initiated by successfully mitigating the stress response. This orientation allowed researchers to highlight which specific physical and psychological traits allowed individuals to overcome adversity. These protective factors included cognitive, competence and physical factors.

It was also found that these traits, along with influences from family, community and other external factors help individuals regulate behavior and promote resilience. These variables contributed to the conceptualization of resilience as a process. This shift allows for advances in the field's ability to empirically study resilience and construct applied interventions focusing on building protective processes. Specifically, McCraty (2015) positioned resilience capacity as a state (rather than a trait) where individuals can learn to build resilience in four key domains: physical, emotional, mental and spiritual. This improved capacity mitigates the damaging physiological and psychological impact of the stress response, while improved resilience capacity also allows individuals to avoid the stressful interactions in the first place.

Building on resilience as a process, Richardson (2002) developed the metatheory of resilience and resiliency to study and create interventions to increase resiliency for a range of populations and circumstances. The theory situates resilience as a balanced state of physiological, mental and spiritual alignment or biopsychospiritual homeostasis and efforts aimed at mitigating challenging circumstances lead to four reintegration outcomes ranging from resilient to dysfunctional. Proponents recognize the positive versus deficit-based framework and

value the theory as it leverages the strengths of specific populations to build their resilience capacity.

Emotional Self-Regulation

In his review of emotional regulation as a construct, Gross (1998) explained that the emerging field differentiates itself from other areas of inquiry including coping, mood regulation and other forms of affective regulation by conceptualizing emotion regulation as "response tendencies". Specifically, he summarized emotion regulation as the study of "how individuals influence which emotions they have, when they have them, and how they experience and express them" (p. 271). Gross (1998) explained that how one views and acts on emotions is contextual as well as cultural and the study of the construct is informed by such questions as "how should we manage OUT emotions? Should we attend to them or disregard them? Esteem them or revile them? Encourage them or suppress them?" (p. 271). Like the constructs previously reviewed, this description highlights the multi-faceted and contextual nature of the concept.

Gross (1998) explained that ancient philosophers wrestled with the value associated with emotions and described the tension associated with viewing emotions as either "troublesome deviations from proper functioning" (p. 271) or positioning emotions as primary drivers of virtuous behaviors. The formal study of emotion regulation originated in developmental psychology and grew to include adult populations. Initial research focused on the development of emotions as well as their impact on personality and social interaction. Additionally, researchers recognized variables such as intensity, longevity, ability to modulate, and recovery from emotional responses informed the study of emotion regulation (Thompson, 1994). While initial research focused on stress and the irrational nature of emotion, more modern conceptualizations

demonstrate the physiologically and psychologically adaptive nature of emotions (Thompson, 1994).

Thompson (1994) explained that despite the expanding interest in emotional regulation, the phenomenon lacks a clear definition. This lack of consensus varies by research aim and can include the following continuums: self-management vs. management of emotional reactions in others; distinct emotions vs. the quality of the emotion (speed, strength, perseverance); and management of the expression of the emotion vs. the process of emotional expression. Given these different approaches, Thompson (1994) offered the following definition: "Emotion regulation consists of the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one's goals" (p. 27). A brief review of key themes supporting the conceptualization of emotion regulation including the adaptive nature of emotions, the role of social functioning, emotional development and theoretical contributions are briefly reviewed and analyzed.

Adaptive Nature of Emotion Regulation. Early American psychologist, William James (1884), in his exploration of the role of physiology and emotions, argued that emotions were both physiologically and behaviorally adaptive and are observable in an individual's response tendencies. The usefulness of this approach is explained as follows: "a person's habitual response tendencies, arising from previous interactions with the environment, might reasonably be seen as useful in present and future interactions with the environment" (p. 78). Gross (1998) explained that while these response tendencies are often expressed by an individual, there are instances when they are not; where the individual will employ efforts to modulate their response tendencies.

Gross' research focused on how, why and when an individual may attempt to regulate their response tendency (or regulate their emotional and behavioral response). Thompson (1994) explained that the process of emotional arousal and subsequent efforts at emotion regulation as having the ability to either improve or limit effective functioning. Further, Robinson et al. (2006) argued that humans' ability to successfully mitigate habitual response tendencies in favor of novel and more adaptive ones, is perhaps one of the most important abilities humans possess.

To recognize the value of emotion regulation, it is important to have a clear understanding of emotions. In their work on the interaction between affect, emotion, goal attainment and emotional self-regulation, Carver and Scheier (1990) positioned emotion as an indicator in a system where the difference between a goal and the current reality is shrinking. Thus, positive emotions would indicate a reduction in the discrepancy between the goal and reality, and negative emotions indicate a rate of goal achievement that is slower than anticipated. Further, emotion regulation is positioned not as a desired result, but an unintended outcome at goal achievement, where one may take specific action, such as devoting more resources to goal attainment, while subsequently decreasing negative emotion (Gross, 1998). Gross (1998) explained that these brief response tendencies impact physiological functioning, behavioral and experiential outcomes. The utility associated with emotions includes providing valuable information related to the individual and their environment while facilitating motor response and decision making (Gross, 1998). Research on the role of emotions and emotion self-regulation demonstrate the value of emotional response and subsequent efforts to change response tendencies in the pursuit of goal attainment.

Social Functioning. While emotions have demonstrated value in goal attainment, cognitive and executive functioning, the emotion regulation process can also positively impact

behavioral outcomes with peers and larger social systems (Thompson, 1994). Thompson (1994) explained the evolution of study of emotional development from initially targeting the biologically adaptive nature of emotions, to highlighting the need for emotional responses to be flexible and situation-specific, to recognizing the value of agile emotion regulation in a complex social environment.

Gross (1998) cited Averill's (1982) example of an emotional response and the impact on social relationships:

> The emotion of anger involves acute changes in posture, facial movements, tone of voice, verbal expression, experience, and autonomic responding. The emotion episode of anger includes all of these things as well as the instigator, the social context, and the whole sequence of responses and recriminations as they emerge in the ongoing interaction. (p. 273)

Gross (1998) explained that while the expression of anger provides information about the intraorganismic functions, it also provides social information in the context of intentions, quality of the interaction and provides information related to social behavior. The role of emotional self-regulation not only supports the individual's efforts at goal attainment but also provides data points related to social interaction and optimal functioning in social environment.

Emotional Development. The process of emotional self-regulation not only assists with successfully navigating the social environment, but also facilitates emotional development in the individual. Thompson (1994) explained that developing emotional competence (which includes modeling of emotional expression and selective reinforcement of emotional expression), fosters emotional development of the individual but also reinforces pro-social emotional behavior of the "emotion culture". Subsequently, individuals learn to become more adept at accurately interpreting and acting on their emotional experience in a culturally acceptable way (Thompson, 1994). Thus, emotional self-regulation impacts the individual as well as social outcomes.

Gross (1998) explained the developmental nature of emotion regulation as follows: "Emotion regulation refers to the processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (p. 275). Gross further explained that due to the multi-dimensional nature of emotions, the regulation process is one which is generative and includes "emotion dynamics" such as "latency, rise time, magnitude, duration, and offset of responses in behavioral, experiential, or physiological domains" (p. 275). The complex nature of individual, environmental and developmental aspects of emotional self-regulation mirror many of the contextual, appraisal-laden, and interactional themes informing the other constructs in this review.

Self-Regulation and the Heart. It has been argued that the ability to regulate emotional and subsequent behavioral responses is perhaps the most important skill in building community, responding to life's demands, resilience capacity, health outcomes and effective decision-making (Baumeister et al., 2006). From a biological perspective, the intrinsic cardiac nervous system, autonomic nervous system and specifically the vagus nerves play a key role in one's ability to self-regulate the emotional experience as well as social behavior (McCraty, 2015). In fact, we can initiate and activate emotional self-regulation and pro-social behaviors.

These processes are biologically informed by the vagus nerves. When individuals self-initiate an inhibitive process of the sympathetic branch of the autonomic nervous system they apply a "vagal break" which initiates calming and emotional self-regulation processes by "inhibiting sympathetic outflow to targets like the heart and adrenal glands" (McCraty, 20105, p. 13). McCraty (2015) summarized that there is a range of evidence across disciplines such as anatomy, physiology and clinic research which have identified regions of the brain (cortical, subcortical, brain stem) involved in cardiac regulation. McCraty cited Oppenheimer and

Hopkins' (1994) research which demonstrated the intricate systems including the cortex, amygdala and subcortical structures which play a role in neurocardiac output and regulation. Specifically, the amygdala is involved in integrating emotional content and subsequent cardiovascular responses. McCraty summarized Oppenheimer and Hopkins (1994) findings that portions of the prefrontal cortex (insular and medial) are involved in modulating the heart's rhythms during emotional events and that imbalances in the insula, amygdala and hypothalamus can lead to disturbances in cardiac rhythms. McCraty summarized that the intrinsic cardiac nervous system integrates mechanical (mechanosensitive) and chemical (chemosensitive) neural inputs with efferent (incoming) inputs from both branches of the autonomic nervous system (sympathetic and parasympathetic) which impacts HRV, heart rate and blood pressure.

Improving one's ability to impact the intrinsic cardiac nervous system, autonomic nervous system and the vagus nerves through emotional self-regulation and subsequently improve coherent HRV patterns leads to enhanced emotional, physiological, psychological and community outcomes. Emotional self-regulation techniques which focus on replacing "depleting emotional undercurrents with more positive, regenerative attitudes, feelings and perceptions" (McCraty, 2015, p. 10) targets improving physiological level functioning and subsequent implicit memory which is foundational to improved resilience and related outcomes (McCraty, 2015).

Theories. Thompson (1994) explained that there are themes related to emotion and emotion regulation in theory development. Specifically, that the interpretation of emotions are personal and contextual. For instance, some individuals may avoid or repress feelings of anger, while some might find that emotional experience empowering. These differences in emotional appraisal inform the process of emotional self-regulation and related model and theory development. Specifically, Thompson summarized that emotions theory development targets

personality, social functioning and associated individual differences in the regulation process and subsequent cognitive and behavioral outcomes.

Process Model of Emotion Regulation. Due to the complex and interdisciplinary nature of the construct of emotion regulation, Gross (2008) proposed a conceptual and empirical framework. Gross explained that emotion regulation "refers to how we try to influence which emotions we have, when we have them, and how we experience and express these emotions" (Gross, 2008, p. 497). Drawing on early work (Gross, 1998), the process model of emotion regulation is informed by the modal model of emotion which positions emotions as an outcome of a person-situation transaction. This transaction must generate attention and hold meaning for the individual and results in an ongoing, complex and flexible process of responses in the person-situation transaction.

The process starts with an external situation with physical features which is psychologically relevant to the individual (situation). Attention is generated and responded to in several ways which initiates the assessment (appraisal) of the event in terms of its novelty and intrinsic emotional value (valence). Once the situation is appraised, several emotional responses may be initiated including practical, psychological and behavioral. The process is cyclical as the resulting responses can change the situation and alter subsequent steps in the process (note the feedback arrow and the ability of emotions to alter the environment and subsequent emotional responses; Gross, 2008). An example would be the experience of embarrassment after violating a social norm. If others were to witness embarrassment, the individual may be more likely to forgive the initial behavior (Keltner, 1995).

Gross (2008) explained that the complex nature of emotion regulation is most simply situated as a means to goal attainment and specifically that "people are motivated to avoid pain

and seek pleasure . . . and that emotions are regulated with a view to both how they feel and what they help us do" (p. 500). Building on the modal model of emotion, Gross illustrated five opportunities for an individual to regulate emotions: situation selection, situation modification, attentional deployment, cognitive change, and response modulation.

It is important to note that the first four emotion regulation families occur before appraisal and subsequent emotional responses, thus they are antecedent-focused and include situation selection, situation modification, attentional deployment and cognitive change, while response focused emotion regulation occurs after responses are initiated and include response modulation and affective suppression. The process of emotion regulations begins with a situation (internal or external) which elicits attention and subsequent appraisal. The appraisal informs responses (experiential, behavioral, biological) which may alter the environment and alter the initial situation (illustrated by the feedback arrow). The top row illustrates strategies (both antecedent and response-focused) which can be used to regulate both positive and negative emotions at different stages of the emotion regulation process (Strauss et al., 2013).

In a critique of the key components of the process model of emotion regulation, Hwang (2006) explained that the model does positively contribute to the understanding of emotion regulation. Hwang's critiques of the model focuses on the ambiguous nature of key components including reappraisal, suppression and the use of maladaptive strategies. Additionally, an examination of the factor structure of the process model of emotion regulation (Situation Selection, Attentional Deployment, Cognitive Change, and Response Modulation) found that that the four-factor model demonstrated poor fit (Seligowski & Orcutt, 2015). The authors suggested a five-factor model including a broader construct of "emotional distancing" would improve the

conceptualization. The authors concluded that further research is necessary to support the new model (Seligowski & Orcutt, 2015).

Emotional Self-Regulation Summary. Emotional self-regulation is a multifaceted construct that explores the utility of emotions and processes involved in mitigating emotional and subsequent behavioral, biological and psychological responses in the complex transaction between the individual and their environment. Viewed as an adaptive process targeting adjusting "response tendencies" in service of goal attainment, emotion regulation is regarded as a one of the most valuable skills humans possess (Robinson et al., 2006).

The role of the heart integrates many of the themes that comprise emotion self-regulation. Specifically, the biological influences generated from the autonomic nervous system, intrinsic cardiac nervous system and particularly the vagus nerves all lead to more coherent HRV patterns which are associated with enhanced emotional, physiological, psychological and community outcomes. Building emotional self-regulation capacity targets improving implicit memory associated with these biological processes by replacing depleting emotional undercurrents with more regenerative emotions, beliefs and perceptions.

Emotion regulation theory development is informed by several constructs. Specifically, emotional appraisal, personality, social and contextual influences inform the process of emotional self-regulation and subsequent cognitive and behavioral outcomes. Gross' (2008) process model of emotion regulation is rooted in the modal model of emotion that highlights the person-situation transaction. This complex transaction must hold meaning and generation attention for the individual that leads to the ongoing process of responses in the transaction. The process model of emotion regulation (Gross, 2008) situates emotion regulation as a means to goal attainment where individuals are motivated to seek pleasure and avoid pain and provide for

five opportunities to regulate emotions: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. These antecedent and response focused processes have the potential to alter the environment and initial appraisal, thus creating an ongoing feedback loop. Gross' process model of emotion regulation is viewed as a strong model for adding to the understanding of emotion regulation as a construct, while critiques of the model point to the ambiguous nature of several components leading to empirical testing to identify a more accurate selection of predictive factors.

Critical Analysis

A critical analysis of the previously reviewed concepts (stress, organizational stress, resilience and emotional self-regulation) was conducted below to ground research in applicable knowledge bases when theory may not be guiding the research (Rocco & Plakhotnik, 2009). The aim of the analysis was to categorize, summarize and map the relationships among the concepts relevant to the study (Rocco & Plakhotnik, 2009). As such, a summary of the constructs is provided, followed by a thematic analysis (Braun & Clarke, 2006) of the combined variables associated with each construct, which leads to a discussion identifying how the themes contributes to methods of theory building, and finally a brief discussion exploring how the findings of this analysis contribute to the field of HRD.

Summary. The purpose of this conceptual review was to critically analyze key conceptual frameworks specific to HRV in the workplace. The research questions guiding this analysis were: what are the espoused benefits and values associated with a HRV intervention in the workplace? What are the key conceptual and/or theoretical frames underling the espoused benefits of the HRV intervention? How do the key conceptual and theoretical fames associated with HRV apply to components of theory building?

A thematic analysis (Braun & Clarke, 2006) was conducted to consolidate the espoused benefits (located in a sample of academic and marketing material) of the HeartMath®, The Resilience Advantage™ training intervention. The following themes were constructed as a result of the thematic analysis: (a) improve emotional self-regulation, (b) decrease stress, (c) increase resilience, and (d) improve organizational outcomes. Once the themes were constructed they were integrated with the variables found within the POQA-R4 which is offered by HeartMath® to assess intervention outcomes. As a result, the conceptual frames for this analysis were identified: (a) stress, (b) workplace stress, (c) emotional self-regulation, and (d) resilience. A brief summary of the literature review and critical analysis of the conceptual frames is as follows:

The review of stress literature followed a chronological organization where the roots of the concept were informed by physical mechanics. Bernard's (1978) work on the inner world and physiological reactions of the body in relation to stress led to Cannon's (1929) conceptualization of homeostasis and the organisms' attempts to remain at steady state during stressful events. Subsequently, Selye (1950) offered the general adaption syndrome that documented the three primary processes associated with the stress response: alarm, resistance and exhaustion. Addressing limitations of the model, Mason (1972) introduced the concept of response specificity, which highlighted variations in the individual's response to stress. Holmes and Rahe (1967) introduced social themes in their stimulus based stress model followed by McEwen's (2005) conceptualization of allostasis and allostatic load, which referenced the outcomes associated with chronic attempts to mitigate the stress response leading to a state of being "stressed out". Integrating the intrinsic cardiac nervous system illustrates the role emotions play in heart-brain communication and the role of the stress response. Finally, Lazarus and Folkman (1986) proposed the transactional theory of stress and coping which oriented the study of stress

as a complex interaction between the person and environment. Stress researchers indicated that there is much work to be done on stress and proposed that future areas of research should target the role of emotions and subsequent biological, neurological, psychological, environmental and social outcomes.

Organizational stress literature focused on the predictive and explanatory capabilities of the study of stress in organizations. In order to identify predictive variables, a number of researchers offered models of stress in the workplace: the person-environment fit model (French & Kahn, 1962) highlighted the interaction of personal attributes, work environment and health outcomes; the job characteristics model (Hackman & Oldham, 1976) offered three key variables (psychological, job characteristics and personal attributes) which determine job motivation and an individual's ability to respond to organizational stress; the vitamin model (Warr, 1987), uses the vitamin analogy to explain the non-linear relationship of workplace environmental variables on health; the Michigan model (French & Kahn, 1962) focused on environmental variables in the role of predicting work factors and subsequent impact on health; the person-environment fit (P-E Fit) model (French & Kahn, 1962) recognized the interaction of the individual and environment and subsequent behavioral and health outcomes; the demand control support model (Karasek, 1979) positioned organizational stress as an interaction between job demands and job decision latitude. Cox and Griffiths (1995) argued for the relationship between psychological stress and physiological injury in the workplace; the effort-reward imbalance model (Siegrist, 1996) of organizational stress, argued that stressful events were an exchange between a number of "high cost" and "low gain" conditions*;* the Demand Skill Support model (van Veldhoven et al., 2005) concluded that the key variables in the study of worker health consisted of physical demands, time demands, skill utilization and quality of social relationships;

De Jonge and Dormann (2003) combined several models to create the demand induced strain compensation model which predicts health outcomes and employee growth from a range of demands and resources; the job demand resources model (Demerouti et al., 2001) targets job demands and job resources and their impact on burnout and resulting illness and organizational commitment; finally, the DRIVE (Demands Resources and Individual Effects) model (Mark & Smith, 2008) was offered as a resource to mitigate some of the deficiencies of previous models related to complexity and individual experiences of stress in the workplace. Additionally, (McCraty, 2015) on stress and the physiology of the heart illustrated the damaging effects stress can have on the individual and the organization, while improvements in physiological and psychological coherence were associated with benefits to the individual as well as the organization. The study of organizational stress and specifically identifying key predictive variables which may support workplace interventions remains a multifaceted and evolving area of inquiry.

Like stress and organizational stress, resilience is a dynamic, evolving and complex construct. Informed by Richardson's (2002) wave of inquiry framework, which explained that resilience inquiry initially focused on resilience qualities, then explored the construct as a process and finally targeted theory building to support interventions. A range of resilience definitions reflect the multidimensional qualities of the construct and include variables such as adversity, coping, vulnerability, adaptation, traits, processes, appraisal and the environment. Biological influences of stress and coping integrated the role of the mind on health and disease as a line of inquiry in the study of vulnerability and resilience. This approach aligns with previous work on stress, homeostasis and the role of resiliency in mitigating the stress response. Integrating research on the physiology of the heart which highlights building physiological,

psychological and social coherence, explained that improved resilience allows individuals (and groups) to actively regulate and improve performance in the four resilience domains (physical, emotional, mental and spiritual). Finally, the metatheory of resilience and resiliency highlighted a balance of physiological, mental and spiritual variables, which can lead to the development of resilience. Like stress and organizational stress, resilience is a complex and dynamic variable and additional research is needed to help inform theory building and targeted interventions for building resilience capacity.

The final construct, emotional self-regulation, is viewed as an adaptive process targeting adjusting "response tendencies" in service of goal attainment. It was argued that emotion regulation is viewed as a one of the most valuable skills humans possess and reflects the multifaceted nature of the previous constructs (Robinson et al., 2006). Emotion regulation was conceptualized as the processes involved in mitigating emotional and subsequent behavioral, biological and psychological responses in the complex transaction between the individual and their environment. From a biological prospective the heart plays a key role as influences generated from the autonomic nervous system, intrinsic cardiac nervous system and particularly the vagus nerves, can all lead to more coherent HRV patterns which are associated with enhanced emotional, physiological, psychological and community outcomes. Theory development includes several constructs including emotional appraisal, personality, social and contextual influences which inform the process of emotional self-regulation and subsequent cognitive and behavioral outcomes. The process model of emotion regulation (Gross, 2008) situates emotion regulation as a means to goal attainment where individuals are motivated to seek pleasure and avoid pain and provide for five opportunities to regulate emotions: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Emotion regulation as a

construct is a growing area of inquiry and additional research is needed to help support models and empirical testing to help identify protective factors and effective interventions.

Conceptual and Theoretical Frames Critical Analysis. To categorize and summarize the relationships among the concepts relevant to the study the following tables were constructed (Rocco & Plakhotnik, 2009). Table 2.1 identifies the most comprehensive model associated with each construct. Table 2.2 specifies each variable contained within each of the selected models.

Table 2.1

Selection of the Primary Models for Each Construct: Stress, Organizational Stress, Resilience, Emotional Self-Regulation

Stress	Organizational stress	Resilience	Emotional self-regulation
Transactional theory of stress & coping (Folkman et al., 1986)	DRIVE model (Mark & Smith, 2008)	Metatheory of resilience & resiliency (Richardson, 2002)	Process model of emotion regulation (Gross, 2014)
Person Variables	Demands	Biopsychospiritual homeostasis	Situation
Environmental variables	Resources	Disruption	Attention
Appraisal	Individual Effects	Reintegration	Appraisal
Coping			Response
Effects/Outcomes			

Table 2.2

Specific Variables Contained Within the Selection of Models (Table 2.1)

Model/Variable	Transactional theory of stress & coping (Folkman et al., 1986)	DRIVE model (Mark & Smith, 2008)	Metatheory of resilience & resiliency (Richardson, 2002)	Process model of emotion regulation (Gross, 2014)
Causal antecedents				
Values	X			
Commitments	X			
Goals	X			
General beliefs	X			
Self-esteem	X			
Mastery	X			
Sense of control	X			
Interpersonal trust	X			
Existential beliefs	X		X	
Environmental variables	X			
Demands	X	X		X
Resources (social support)	X			
Constraints	X			
Temporal aspects	X			
Decision authority		X		
Skill discretion		X		
Extrinsic effort		X		
Intrinsic effort		X		
Rewards		X		
Physiological balance			X	
Mental balance			X	
Protective factors			X	
Psychological relevance				X
Motivation				X
Situation selection				X
Situation modification				X
Attentional deployment				X
Cognitive change				X

Model/Variable	Transactional theory of stress & coping (Folkman et al., 1986)	DRIVE model (Mark & Smith, 2008)	Metatheory of resilience & resiliency (Richardson, 2002)	Process model of emotion regulation (Gross, 2014)
Mediating processes				
Primary appraisal (stakes)	X			X
Secondary appraisal (coping options)	X			
Perceived job stress		X		
Coping (social support)	X	X		
Problem focused coping	X	X		X
Emotion focused coping	X			X
Seeking advice		X		
Self-blame		X		
Wishful thinking		X		
Escape/avoidance		X		
Attributional/explanatory Styles		X		
Reintegration			X	
Response modulation				X
Affective suppression				X
Outcomes/effects				
Affect	X			
Physiological changes	X			
Quality of encounter	X			
Psychological well-being (anxiety and depression)	X	X		
Somatic health/illness	X	X		
Social functioning	X			
Job satisfaction		X		
Homeostasis			X	
Protective factors			X	
Improved Resilience/growth			X	
Loss of protective Factors/resilience			X	
Loss of motivation			X	

Model/Variable	Transactional theory of stress & coping (Folkman et al., 1986)	DRIVE model (Mark & Smith, 2008)	Metatheory of resilience & resiliency (Richardson, 2002)	Process model of emotion regulation (Gross, 2014)
Destructive behaviors			X	
Altered environment				X
Altered initial situation				X

To successfully map the relationships (Rocco & Plakhotnik, 2009) among the concepts and associated specific variables, a thematic analysis (Braun & Clarke, 2006) was conducted. The six stages of conducting a thematic analysis include: (a) familiarize yourself with your data, (b) generate initial codes, (c) search for themes, (d) review themes, (e) define and name themes, and (f) produce the report. The following themes were constructed to represent the relationships of the four constructs and their corresponding models and variables:

1. *Resources:* The following variables highlight key themes associated with the stress response, organizational health, resilience and emotion regulation and include social, environmental and intrapersonal themes. Specifically, the presence of social support including interpersonal trust, social functioning and social coping are mitigating factors included in social resources. Environmental factors include time demands and decision authority in the work context. Intrapersonal resources include coping style, advice seeking behaviors, and skill discretion.
2. *Attributes:* Include both physiological and psychological protective and mediating factors. Physiological factors include efforts of the individual to maintain in a state of homeostasis during a stress response, which can be informed by several protective factors leading to corresponding outcomes including homeostasis, physiological balance, somatic

changes and resulting health/illness. Psychological factors include mental balance, affect, motivation, and cognitive appraisal including self-blame, wishful thinking. These emotion focused coping strategies can lead to changes in motivation levels, cognitive change and changes in psychological protective factors.

3. *Perception:* How an individual assesses their interactions, the environment and available resources affects their perception and subsequent stress response, resilience levels and efforts to regulation emotion. Primary appraisal of the stakes associated with the encounter and subsequent secondary appraisal of coping options are informed by several variables including: existential beliefs, perceived job stress, psychological relevance, quality of the encounter, and attributional/explanatory styles.
4. *Responses:* Responses to stress and subsequent resilience levels and emotion relegation are informed by a mediating process highlighted by intrinsic and extrinsic effort. Perceptions of available internal and external resources support a feedback loop which impacts initial and subsequent mediating processes, intrinsic effort, extrinsic effort, situation selection, situation modification and/or efforts targeting escape/avoidance.
5. *Outcomes:* The degree to which one can successfully mitigate stress informs their future resilience, efforts at emotion regulation and changes to environmental and social variables. Specific outcomes can include: attentional deployment (or shifting focus to or from emotional stimuli), reintegration, response modulation, affective suppression, altered initial situation, altered environment, destructive behaviors, increased or decreased protective factors, psychological well-being (anxiety and depression), rewards, improved resilience/growth, job satisfaction, changes to response tendencies and appraisal.

These themes represent the intersections of the constructs informing this inquiry: stress, organizational stress, resilience and emotional self-regulation. Rocco and Plakhotnik (2009) explained that in the absence of existing theory, it is important to identify main ideas and map the relationships among constructs. They explained that this process supports the study's research questions and problem statements by providing a framework for applicable areas of knowledge.

Theory Building. Callahan (2010) argued for the importance of conceptual literature reviews as supporting tools for subsequent efforts at theory building. Callahan (2010) explained that these documents support larger efforts of theory building by situating the study in applicable areas of knowledge and illustrating the relationships among them. Thus, the conceptual literature review grounds the research in applicable knowledge bases. Callahan (2010) explained that because of this, "conceptual models are linked to theory building and theory building leads to new theories tested through research" (p. 302).

The utility of theories allows for the expansion of existing knowledge while attempting to explain and verify the nature of the phenomenon. Swanson and Chermack (2013) stated that "a theory describes a specific realm of knowledge and explains how it works" (p. 14). Lynham (2002) explained that the act of theory building is an iterative process and includes "producing, confirming, applying, adapting, and refining theory" (p. 222). Swanson and Chermack (2013) explained that there are five primary phases to theory building which include the following: (a) conceptualize, (b) operationalize, (c) apply, (d) confirm, and (e) refine.

The *conceptualize* phase allows for a framework which provides an explanation of the phenomenon that is the focus of the theory. This phase includes formulating an understanding of the most current and relevant explanation of the conceptual frames in the appropriate context.

The *operationalize* phase serves as a bridge between conceptualizing and testing in real-world practice. This phase allows the theoretical frame to be verified with measurable components to be tested in the context in which the phenomena actually occurs. The *confirm* phase allows the researcher to apply the framework in practice. This phase allows the study to confirm or disconfirm the research by designing, implementing and evaluating the research design in a way that transitions the theory to practice with observable and verifiable components. The *apply* phase allows for further refinement and verification of the theory by integrating the learnings generated from real-world application. The application of theory ultimately informs its usefulness and relevance to practice and subsequent efforts of theory refinement. The *refine* phase is ongoing and never complete, until the theory is proven no longer applicable and trustworthy. The continuous adaptation of theory-to-practice allows for sustained relevance both in practice and in theory (Swanson & Chermack, 2013).

Based on the summary of the process of theory building, this review and critical analysis adds specific value to both theorizing and practice. Specifically, the act of summarizing, mapping and conceptualizing the key themes associated with this inquiry addresses the *conceptualize* phase of theory building. By conceptualizing the historical and contemporary frames relevant to the current study, there is now an opportunity to shift the theorizing process from conceptualization to operationalization and ultimately engage in the iterative process of continued application, confirmation and refinement.

Implications for HRD. Theory building is important to the advancement of the field of HRD. Lynham (2002) specified that the value of theory building to HRD helps to bridge the gap between research and practice, allows for the integration of multiple methods of research and helps to support professionalism in the field. More specifically, Swanson and Chermack (2013)

noted that "taken as a whole, the five phases of Theory Building in Applied Disciplines ensure that theories come from a comprehensive perspective with a required connection to practice" (p. 49). The stages of theory building help to integrate multiple research ideologies while advancing the field of HRD in both theory and practice. Thus, the contributions of this specific inquiry help to bring clarity to the ambiguous nature of the key constructs of an HRV intervention in the workplace while simultaneously supporting efforts of theory development leading to empirically sound applied interventions.

Specifically, the applied interventions in this review target enhancing employee's ability to mitigate the damaging effects of stress and organizational stress while simultaneously improving resilience capacity and one's ability to successfully self-regulation emotions. Evidence (McCraty, 2015) suggests that building capacity in these areas leads to improved health and wellbeing outcomes for the individual which subsequently improves social, environmental and systems outcomes.

These areas of growth align with key aims of the discipline of HRD. Swanson (2001) explained that the three theoretical foundations of HRD include: (a) psychological theory, (b) economic theory, and (c) system theory. Swanson specified that these theoretical foundations are grounded in the psychological and core aspects of the human and one's relationship to the system while targeting effectively utilizing resources to meet competitive goals of the organization all while recognizing the complex and dynamic nature of the person-environment fit of the overarching system. Given the conceptual and empirical underpinnings of both the current area of inquiry and the overarching frames and goals of the field of HRD it is argued that the act of reviewing and critically analyzing the key conceptual frames and empirical data associated

with an HRV intervention in the workplace directly contributes to the growing field of HRD in both theory and practice.

HRD is an emerging field which links theories informed by empirical evidence to the practical application of interventions designed to meet the psychological, economic and systems goals of both the individual and the organizational system. Evidence suggests that HRV interventions in the workplace demonstrate measurable benefits for individual and organizational outcomes (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014). Despite the positive impact of these interventions a clear conceptualization of the theoretical foundations of the intervention were challenging to identify.

Thus, the current review and critical analysis of the empirical data and conceptual frames informing the HRV intervention help to bring clarity to the area of inquiry and allow for a more successful transition from theory to practice. This contribution to theory and application is specifically informed by the five phases of theory building (conceptualize, operationalize, apply, confirm, refine) of which this specific analysis addresses the conceptualize phase while positioning this research to move into application, confirmation and refining stages.

CHAPTER THREE: METHODS

This chapter introduces the research design and associated methods and procedures for the empirical data collection and analysis for this inquiry. First, the research design, population and sampling procedures are reviewed, followed by an analysis of reliability and validity of relevant instruments and selection rationale for the POQA-R4 for this inquiry. Next, a description of the intervention and procedures for data collection and analysis using multivariate analysis of variance MANOVA are provided. Finally, limitations associated with the research design are discussed.

Research Design

This proposed research design seeks to measure how a heart rate variability self-regulation intervention affects measures of employee physiological and psychological health as well as organizational outcomes. HeartMath®, a non-profit research organization has studied stress, health, and performance since 1991 and has been involved in publishing over 300 peer reviewed articles on the role of heart/brain functioning and organizational performance. HeartMath® offers their Resilience Advantage™ (RA) training program to organizations to assist in improving worker health while also improving organizational outcomes. Specifically, the intervention teaches participants to decrease stress and improve resilience capacity by self-regulating emotions and heart rate variability (HRV). Evidence has suggested that improved HRV self-regulation leads to both employee psychological outcomes (Albinet et al., 2010; Kemp et al., 2010; Miu et al., 2009; Thayer et al., 2009), physiological gains (Buccelletti et al., 2009; Lehrer et al., 2004; McCraty et al., 2000; McCraty et al., 2009; McCraty et al., 1998; McCraty,

2015), as well as gains for the organization (Barrios-Choplin et al., 1997; McCraty, 2015; McCraty et al., 2003).

This study utilized a quantitative, between-groups, experimental design in order to test the effects of a HRV self-regulation training on active participants and non-participants (wait-list control) on psychological and physiological health and organizational outcomes by analyzing results of the POQA-R4 survey. Before conducting the study, IRB approval (see Appendix E) was granted in order to protect the rights of the human subjects. The active, independent variable was the Resilience Advantage™ (RA) training intervention, which had two levels: participant and non-participant (wait-list control; see Table 3.1).

Table 3.1

Between-Groups, Experimental Design

IV = Resilience Advantage Training™ (RA)		
Group A Training Participants		Group B Non-Participants (Wait-List Control Group)
DV	POQA-R4	POQA-R4

A MANOVA was used to analyze if a difference in means for the two groups was present, followed by significance testing to assess the individual dependent variables. Additional information is provided in the data analysis section.

Research Questions

Five research questions framed this study. The first four research questions, which focused on HRV self-regulation research domains/empirical evidence and conceptual/theoretical frames, were reviewed in detail in Chapter Two with brief summaries below:

- *Research Question 1 (RQ1):* What are the research domains associated with HRV self-regulation?

As reviewed in Chapter Two the following research domains are associated with HRV self-regulation: physiological health, psychological health, education and organizations.

- *Research Question 2 (RQ2):* What empirical evidence is associated with HRV self-regulation?

Chapter Two further detailed empirical evidence associated with HRV self-regulation and found that the following variables (and corresponding research domains) showed significant improvement:

- *Physiological:* assessment of cardiac risk, hypertension, sensorimotor rhythm, DHEA, cortisol, cholesterol, blood pressure, triglycerides, pulmonary function, baroreflex gains, medically unexplained physical symptoms, congestive heart failure, glycemic measures, binge eating and applied exercise physiology assessment and performance
- *Psychological*: depression, pediatric mental health, anxiety, autonomic nervous system function, executive function, cognitive performance, and sustained attention
- *Education*: test anxiety, emotional disposition, engagement, bonding, humor, persistence, empathetic listening and understanding, emotional problems, conduct problems, hyperactivity, relating to peers, development (including physical, cognitive, social, emotional, language), school burnout, school performance, cardiac health and psychophysiological functioning
- *Organizations:* stress, wellbeing, sleep quality, systolic blood pressure, depression, psychological distress, hypertension, anxiety, autonomic nervous system functioning peacefulness, positive outlook, workplace satisfaction, and value of contribution

The following research questions framed the critical analysis of conceptual frames and theory building content for this project:

- *Research Question 3 (RQ3):* What are the key conceptual and/or theoretical frames underlying the espoused benefits of the HRV intervention?

As reviewed in Chapter Two, the primary conceptual frames (with corresponding theoretical frames) informing the HRV intervention are as follows: stress (Transactional Theory of Stress & Coping; Folkman et al., 1986), organizational stress (DRIVE Model; Mark & Smith, 2008), resilience (metatheory of resilience & resiliency; Richardson, 2002), and emotional self-regulation (process model of emotion regulation; Gross, 2014).

- *Research Question 4 (RQ4):* How do these conceptual frames inform HRV self-regulation theory building and contribute to the field of HRD?

Following Swanson and Chermack's (2013) five phases of theory building, it was argued that the critical analysis in Chapter Two supported the *conceptualize phase* of theory building and that the act of theory building helps to integrate multiple research ideologies while advancing the field of HRD in both theory and practice. The following themes were constructed to represent the relationships of the four constructs and their corresponding models and variables and include: resources, attributes, perception, responses and outcomes (see Chapter Two for more details).

In addition to summarizing the HRD self-regulation research domains, corresponding empirical evidence, contributing to theory building and HRD, this study investigated how a HRV self-regulation training intervention affects employee physiological and psychological health and organizational outcomes. Measurements of personal and organizational quality (POQA-R4) were used to measure this effect, while the following research question and hypotheses are included to assess these effects:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?
- *Research Hypothesis 5a*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional vitality will be higher than that of the control group.
- *Research Hypothesis 5b*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention Organizational Stress will be lower than that of the control group.
- *Research Hypothesis 5c*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional stress will be lower than that of the control group.
- *Research Hypothesis 5d*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention physical stress will be lower than that of the control group.
- *Research Hypothesis 5e*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention intent to quit will be lower than that of the control group.

Population and Sample

The study population consisted of employees at a large, multi-national, independent public company in the multi-utilities industry. The organization, which represents $1.5 billion in annual revenue and over 4,000 employees who service 789 retail locations, is headquartered in

the mid-west region of the United States. Bands organize the organization's employee population (see Table 3.2) and necessitated the stratified sampling methods described below.

Table 3.2

Table of Employee Structure

Band	Description	Count
2	Skilled Crafts/Technicians/Admin • Driver • Service Tech • Customer Service and Support	3,565
3IC/3M	Managers/Professionals • Manager roles • Analyst • District Manager • Customer Service Manager	631
4IC/4M	Senior Leaders/Experts • Director • IT Architect • Corporate Counsel • GM • Plant Manager	99
5M	Vice-President • VP • Corporate Controller • VP, Retail Operations • VP, Subsidiary Operations	9
CEO	1	1
Executive	Officer/Executive • CFO • General Counsel • COO • CSO	2
Officer	1	1
Grand Total	4,308	4,308

Based on needs and logistics for the organization, the recruiting, stratified random sampling, intervention and data collection were facilitated in two phases. The intervention and data collection was divided into two phases to meet seasonal work demands and organized by employee band, to ensure coverage for functional priorities of the organization. Additionally, two sections of the HRV training intervention were offered for the active and wait-list control groups (for both phases) to help ensure staffing for business needs was prioritized along with research procedures.

- *Phase 1:* recruiting, random assignment to treatment or control group, pre and post testing and intervention for all customer service employees located in band 2 and 3 ($N \approx 349$ employees).
- *Phase 2:* recruiting, random assignment to treatment or control group, pre and post testing and intervention for a sample of employees from *bands 2, 3 and 4 (excluding drivers, service technicians and previously sampled customer service employees; $N \approx 730$).*

The population for this study consisted of 1079 total employees: phase 1 consisted of members of the customer service team ($N = 349$); phase 2 consisted of all additional band 2, 3 and 4 employees ($N = 730$). The total sample for the study consisted of 147 employees. Participation was incentivized by participant eligibility to win 1 of 8 Amazon gift cards provided by the organization upon completion of all study related procedures. Recruitment emails were sent to all employees within the eligible employment bands which contained a brief description of the Resilience Advantage^{TM} training intervention, anticipated benefits of participation, risks associated with participation as well as details regarding logistics (time/date of trainings, access to online learning platforms, general information regarding pre and post assessments).

Ensuring that participants understand the goals, potential benefits and risks to their participation in research is essential to an ethical research design (Purcaru et al., 2014). Procedures for informed consent, voluntary participation, protecting participants from harm and maintaining confidentiality were reviewed and approved by the sponsor university's Institutional Review Board (see appendix D). During the recruitment process all interested participants were asked to read the informed consent. Each participant was given an opportunity to ask questions before singing the form. Eligibility for participation was then assessed. Inclusion criteria consisted of employee band membership and functional group membership (customer service team).

Once recruited, participants associated with this between-groups, experimental design were randomly assignment to either an active intervention or a wait-list control group (for both *Phases 1* and *2*). Once assigned to the active or wait-list control groups, participants were then randomly assigned to one of two sections of the training intervention for each group (for both *Phases 1* and 2). The act of random assignment adds strength to the research design as randomization helps to ensure that participant characteristics are similar across groups, thus decreasing the chances that such characteristics influence the outcomes of the study.

Additionally, the use of a wait-list control group in psychosocial or behavioral studies can offer benefits for the research design (Kinser & Robins, 2013). Wait-list control design randomly assigns participants to the treatment group or a wait-list control group, where the wait-list control group will either experience the treatment immediately or upon a delay. Both groups are assessed on pre-and post-measures, while the active group receives the intervention and the control group proceeds with standard operations. With this design, participants can receive the treatment upon delay while still serving as a control group. (Lindquist et al., 2007).

These studies can benefit from a wait-list control group where a placebo control (as in pharmaceutical and/or clinical designs) may not be available, as the active/non-active mechanisms of the intervention are harder to identify (as reflected in the previous literature review). Additionally, a no-treatment control group can be considered unethical for individuals with a clinical diagnosis and/or could benefit from the study intervention (Kinser & Robins, 2013). Thus, the current design incorporates stratified sampling, random assignment, active treatment groups, and wait-list control groups to support the rigor of the design as well, participant outcomes and needs of the organization (see figure 3.1).

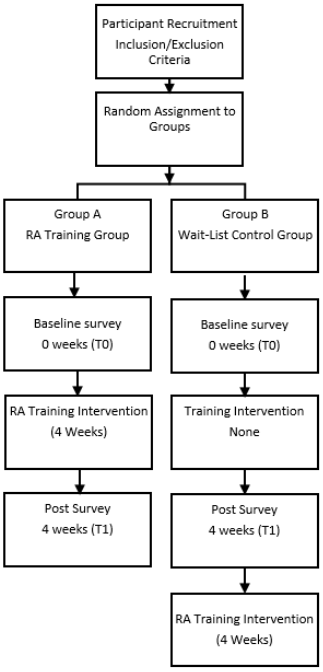

Figure 3.1

Diagram of Between-Groups, Experimental Design with Recruitment, Assignment, Assessment and Intervention

Power Analysis

An a priori (to control for type I and II errors) power analysis using G*Power (Faul et al., 2007) was conducted in order to determine a sufficient sample size. The calculation was conducted using F-tests and MANOVA Global effects. Specifically a power analysis for an MANOVA with two groups, five response variables, an effect size of f^2 = 0.0625, an alpha of 0.05, and a power of 0.80 were used. As a result, the desired sample size is 212 total participants (see Figure 3.2).

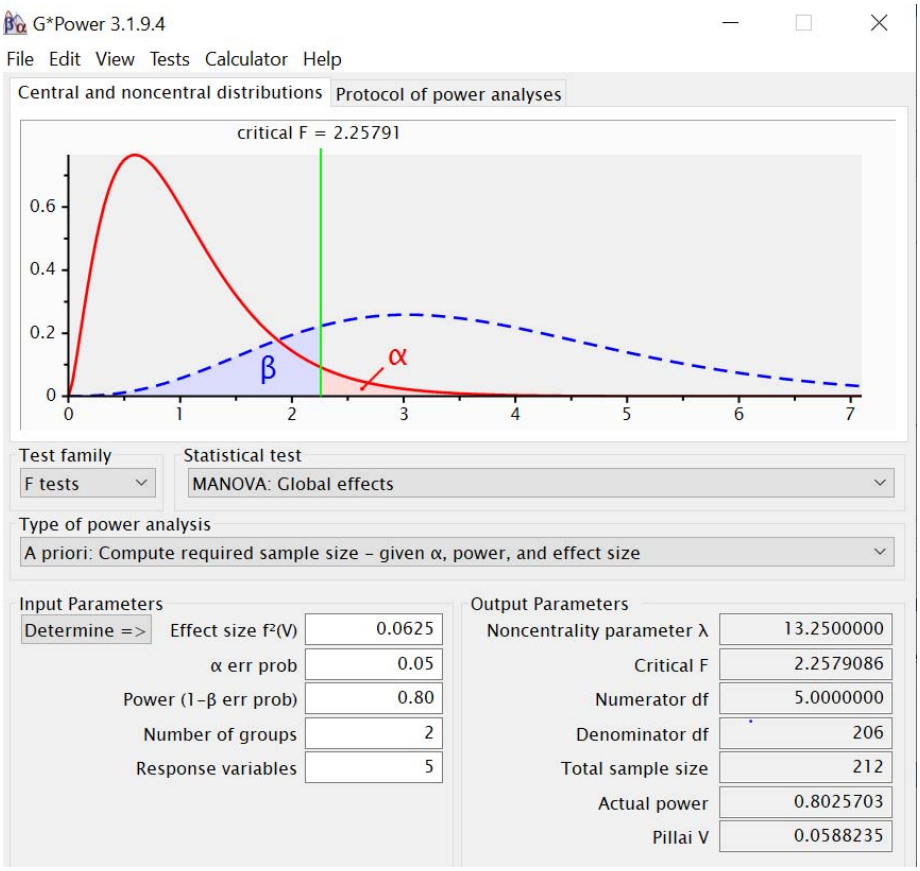

Figure 3.2

Power Analysis

Instruments and Measurement

A recent review explained that the study of resilience in complex work settings is challenging to both conceptualize and measure despite the utility associated with understanding

how workers respond to adversity (Hartmann et al., 2020). Similarly, the Center for Workplace Health Research and Evaluation (2017) with the American Heart Association also recognized the costs associated with organizational stress and the value of resiliency building. A component of their work includes recommending assessment tools for resilience intervention measurement. Their assessment tool recommendations recognize that there is no consistent tool for resilience assessment and emphasized strong measures of reliability and validity as well as ease of use in the workplace as important variables to consider when selecting a measurement tool (Center for Workplace Health Research and Evaluation, 2017). Finally, in a review of the factors associated with resilience in the workplace for nursing professionals, the authors suggested that the measurement of resilience in the workplace is complex and ambiguous and concluded:

> The review has found there is no consistent instrument for resilience measurement. . . . Accordingly, future research should focus on developing a new instrument or consistent scale with one of the existing measurements to encompass all personal and work-related factors. (Yu et al., 2019, p. 137)

Based on the above findings and recommendations, coupled with the current research design, the following inclusion criterial for assessments to review included: physiological/psychological stress and resilience factors, organizational outcomes factors, strong measures of reliability and validity, and relatively short time for participant to complete (approximately 15-20 minutes)**.**

The Connor-Davidson Resilience Scale (CD-RISC)

Conceptualizing resilience as a measure of stress coping ability, the Connor-Davidson Resilience scale (CD-RISC) was constructed as a tool for improving stress management, depression and anxiety. Reference scores were compiled from several groups including community members as well as those with mental health diagnoses (n = 806). The scale consists of 25 items on a 5-point scale representing five factors. Reference scores along with reliability,

validity and factor analytics were reported (see below). Additionally, treatment effects were analyzed in a clinical population and there was evidence to support a positive relationship between improved CD-RISC scores and improvement during treatment (with CD-RISC scores by clinical category and demographic group reported). The authors noted that based on these results, resilience can be measured and improved with interventions (Connor & Davidson, 2003).

Strong measures of internal consistency were reported. Specifically, measures of internal consistency (Cronbach's Alpha) meet the standard described by Taber (2018) that alpha values (α) of 0.70 are generally considered desirable. For the full scale a Cronbach's α of 0.89 was reported for Group 1 (community members) and item-total correlations were strong and ranged from 0.30 to 0.70.

Connor and Davidson (2003) conducted a factor analysis, and reported eigenvalues for the five factors (7.47, 1.56, 1.38, 1.13, and 1.07) they constructed. The factors were described as follows:

- **Factor 1** reflects the notion of personal competence, high standards, and tenacity.
- **Factor 2** corresponds to trust in one's instincts, tolerance of negative affect, and strengthening effects of stress.
- **Factor 3** relates to the positive acceptance of change, and secure relationships.
- **Factor 4** was related to control.
- **Factor 5** to spiritual influences. (p. 80)

Connor and Davidson (2003) summarized that based on the strong psychometric values the, CD-RISC is suitable for both research and practice as it helps to support resilience as quantifiable and modifiable with practice. As noted by Hartmann et al. (2020), the CD-RISC does not a have focus on resilience at work which may limit its applicability in a vocational conceptualizations

and measurements of organizational stress and resilience. While the CD-RISC does contain factors associated with affect, stress mitigation, relationships and instincts (which may correspond to intuition contained within the Resilience Advantage^{TM}), it does not address physiological outcomes of stress and emotional self-regulation. Influences such as high standards, acceptance of change and control are extraneous to this inquiry. Additionally, vague descriptions of the factors and the omission of test questions lead to difficulty in assessing fit for the current research design especially as it relates to the physiological effects of stress.

The Brief Resilience Scale

Highlighting the different and evolving meanings associated with the construct of resilience, the brief resilience scale (BRS) sought to specifically assess "resilience as bouncing back from stress, whether it is related to resilience resources and whether it is related to important health outcomes" (Smith et al., 2008, p. 195). The authors aimed to construct reliable scales with as few items as possible.

The BRS consists of six (three positively worded, three negatively worded), 5 point likert scale items. The brief resilience scale was constructed with both positive and negatively worded items to address positive response bias. To assess construct validity, measures of convergent and predictive discriminate validity were assessed against a range of other assessments. Correlations for the following constructs (with additional variables) were reported: resilience, personal characteristics, coping styles, social relationships, and health outcomes.

A factor analysis was conducted with the six items, which comprise the BRS, on the four samples, including two samples of undergraduate students, cardiac rehabilitation and chronic pain populations (Smith et al., 2008). The authors (Smith et al., 2008) reported that:

> Each sample revealed a one-factor solution accounting for 55– 67% of the variance. . . . The loadings ranged from .68 to .91. Internal consistency was good, with Cronbach's

> alpha ranging from .80–.91. . . . The BRS was given twice in two samples with a test-retest reliability (ICC) of .69 for one month in 48 participants from Sample 2 and .62 for three months in 61 participants from Sample 3. (p. 197)

The authors summarized that the BRS established good measures of test-retest reliability and internal consistency and the instrument's one factor is related to resilience resources, health outcomes and is predictive of health outcomes beyond those identified in relation to resilience resources (Smith et al., 2008). They noted limitations such as the need for longitudinal data, physiological indicators of resilience/recovery from stress and for correlations with other forms of resilience and positive adaptation.

When assessing fit for selecting the BRS as the measurement tool for this inquiry, a number of items suggest the need for a stronger match. Similar to the CD-RISC, the BRS does not have a focus on work contexts (Hartmann et al., 2020). Additionally, the BRS does not include items associated with psychological outcomes of stress such as anxiety and depression or physiological outcomes of stress. In addition, the BRS does not include items associated with workplace satisfaction and interpersonal relationships. These limitations indicate that while a useful measurement tool in some contexts, the conceptualization and associated factors of resilience are not a strong match for the current research design.

Resilience at Work Scale (RAW)

With a focus on increasing output demands on worker populations, the authors of the resilience at work scale (RAW) pointed to evidence that "work intensification" has led to health costs to employees as well as financial and productivity costs to the organization (Winwood et al., 2013). Despite these challenges, the authors noted that some employees are better able to cope with increasing demands, thus demonstrating higher levels of resilience than their colleagues do.

Drawing on some of the commonalities among the varied conceptualizations of resilience, the authors noted that resilience generally includes a challenge or adversity as well as varying degrees of adaptability (Winwood et al., 2013). Recognizing the challenges associated with an all-encompassing definition and measurement of resilience, the development of the RAW scale seeks to focus on "resilience at work" and specifically the variables which can be modified via interventions (as opposed to reliance as fixed genetic trait; Winwood et al., 2013). The development of the RAW scale is specifically informed by the neurophysiology of the stress response and recovery, while not focusing on the development of "an instrument that is relevant to particular work areas or types, but on the workers' capacities, wherever they work" (Winwood et al., 2013, p. 1206). It was hypothesized that the RAW scales scores would correlate with the following: "1. A measure of recovery (from work demands) 2. A measure of engagement at work 3. A measure of physical health 4. Measures of chronic fatigue and poor sleep" (Winwood et al., 2013, p. 1206).

Winwood et al. (2013) conducted a thematic analysis, which was informed by a literature review of stress and resilience, coupled with 25 years of practitioner observations of

> behaviors, which seemed to be consistently associated with moderating work-related stress problems, and mediating recovery, at both the individual and corporate levels. This led to the formulation of 45 statements, reflecting states, attitudes, and behaviors, which were believed to underpin resilient behavior in the specific workplace context. (p. 1206)

Client contact lists and a snowball method were used to secure 355 total participants representing varying work hours/week, occupations and work contracts who completed the 103, seven-point likert scale items for the study questionnaire. Additionally, validated scales measuring sleep health, recovery between shifts, general physical health along with the resilience items were included (Winwood et al., 2013).

A factor analysis of the 45 items yielded 13 factors (Eigen values of above 1.0) which explained 72.9% of the variance. Additional analysis indicated that seven factors (20 items with a minimum item factor loading of 0.510) was most reliable and explained 67.87% of the variance. Winwood et al. (2013) labeled the factors as follows:

> Component 1 = Living authentically (three items). Interpretation: This factor is seen to represent knowing and holding onto personal values, deploying personal strengths, and having a good level of emotional awareness and regulation.
>
> Component 2 = Finding one's calling (four items): Interpretation: This factor is essentially associated with seeking work that has purpose, a sense of belonging and a fit with core values and beliefs.
>
> Component 3 = Maintaining perspective (three items). Interpretation: This factor concerns having the capacity to reframe setbacks, maintain a solution focus, and manage negativity.
>
> Component 4 = Managing stress (four items). Interpretation: This factor speaks of using work and life routines that help manage everyday stressors, maintain work life balance, and ensure time for relaxation.
>
> Component 5 = Interacting cooperatively (two items). Interpretation: This factor refers to a workplace work style that includes seeking feedback, advice, and support as well as providing support to others.
>
> Component 6 = Staying healthy (two items). Interpretation: This factor identifies a pattern of maintaining a good level of physical fitness and a healthy diet.
>
> Component 7 = Building networks (two items). Interpretation: This factor concerns a pattern of developing and maintaining personal support networks (which might be both within and outside the workplace). (p. 1207)

Strong measures of internal consistency were reported (total scale Cronbach α was 0.84. Alpha values for the individual subscales ranged from 0.89 to 0.60. The lowest two scales with sub-optimal scores only contained two items making higher Cronbach α challenging to obtain. These scales were still included as they represent unique factors as they related to workplace resilience (Winwood et al., 2013).

A confirmatory factor analysis was conducted with a second study population to further validate the RAW scales. Participants were recruited using the same methods as Study 1, which yielded a sample of 195 participants representing a range of diverse backgrounds. The second questionnaire consisted of the original 20 items comprising the RAW scale and also included measures of work demands and resources as well as acute (end of shift) fatigue. Interactions between the RAW total scale from Study 1 and the new variables from Study 2 were developed (Winwood et al., 2013).

Structural equation modeling (SEM) statistics indicated an excellent fit between Study 2 data to Study 1 data "(ie, goodness-of-fit index = 0.968; Tucker–Lewis index = 0.975; root mean square error of approximation = 0.038)" (Winwood et al., 2013, p. 1210). The authors explained that acute/end of shift fatigue was mediated by available resources, and that high resilience is positively associated with recovery from fatigue, stronger physical health and engagement. The authors concluded that resilience as conceptualized by the RAW "is seen to have a significant impact on recovery (from work demand stress), which in turn is associated with improved engagement at work, and importantly, has a positive effect on physical health" (Winwood et al., 2013, p. 1211).

The RAW offers a simple and effective tool for identifying positive resilience behavior as well as those to be developed and mitigated in the context of workplace resilience. The authors recognize the inherent biases associated with self-report measures as well as the limitations related to causality. Despite these limitations, they concluded that the RAW is a valuable tool in identifying work health factors as well as behaviors associated with developing and maintaining adaptive qualities and behaviors in support of resilience (Winwood et al., 2013).

Positioning resilience as a skill that can be taught and developed provides rationale for the RAW as a tool to measure resilience in the workplace (Hartmann et al., 2020). Additional factors of the RAW indicate a strong match for selection for this research design, such as: emotional regulation, purposeful work and interpersonal interactions. Limitations of the RAW include the need for a stronger emphasis on psychological and physiological stress, (while an emphasis on diet is useful for overall health, diet was not identified as an influential construct in the current inquiry, literature review or training intervention). Additionally, the American Heart Association also recognized the value of a focus on resilience skill building and modification in the workplace, but noted that additional testing of the RAW is needed to further support validity and reliability (Center for Workplace Health Research and Evaluation, 2017). These limitations indicate the need for a more suitable measurement tool for this inquiry.

Predictive 6-Factor Resilience Scale

Noting that the predominant view of the construct of resilience has a mental focus, the authors of the predictive 6-factor resilience scale (PR6) include research which highlights the physiological or neurobiological nature of the construct (Rossouw & Rossouw, 2016). They specifically noted the bidirectional role of positive emotions in improving resilience capacity as well as the physiological roles of neuroplasticity and several health factors in adaptation and resilience.

Domains for the PR6 were constructed from thematic groups of traits of resilience that share neurobiological qualities. Drawing on Davidsons's six dimensions of emotional styles (Davidson & Begley, 2012) the authors (Rossouw & Rossouw, 2016) compared them with ten existing measurement scales of resilience. This analysis resulted in both inter and intrapersonal protective factors which informed five of the scale's dimensions. A sixth dimension was added to

represent physiological health. The six domains of the PR6 are as follows: (a) Vision (self-efficacy, goal setting); (b) Composure (emotional regulation, ability to recognize, understand and act on internal prompts and physical signals); (c) Tenacity (perseverance, hardiness); (d) Reasoning (higher cognitive traits, problem solving, resourcefulness); (e) Collaboration (psychosocial interaction, secure attachment, support networks, context, humor); and (f) Physiological Health [where the first three factors are informed by brain-derived neurotrophic factor (BDNF) production and include: (a) Regular Exercise (BDNF, hippocampal function); (b) Nutrition (sugar, dietary fats, alcohol); and (c) Sleep Hygiene (stress, sleep BDNF levels)]. Two additional items were included to measure Approach/Avoidance Motivation (momentum; Rossouw & Rossouw, 2016).

The PR6 consists of 16, 5-point, likert scale items with two items from each domain (aside from the momentum items and the health domain which includes four positively scored items; each domain including one positive and one reversed-scored items).

A study sample ($N = 204$) was comprised of two groups from Melbourne, Sydney, Brisbane and Dunedin: (a) Healthcare and Education Professionals ($n = 128$) and (b) Financial Services Professionals employed by a major bank in Sydney ($n = 76$). In order to produce an overall resilience score, or PR6, score the average of each domain was calculated and assigned a score from 0 (lowest) to 1 (highest). Rossouw and Rossouw (2016) reported the following:

> The distribution of PR6 scores for N = 204 (Figure 1) resulted in M = 0.6879, SD = 0.117, and 95% CI [0.67178, 0.70409]. The results mostly followed the SD, with additional clustering around the 75th and 85th percentiles. Normality was confirmed with an Anderson–Darling test of 0.440 and a p-value of 0.289 for the full population. Floor and ceiling effects were not encountered as no responses reached the lowest level, while only one response reached near the upper bound with a score of 0.9911. (p. 38)

Additional scores for age, gender and industry were reported. The authors reported that no statistically significant differences between industry, gender, age and location were observed

except for a different between finance and healthcare in composure scores. “Composure scores, 95% CI (0.6262, 0.6863), for Healthcare were significantly higher (M = 0.6971, p = 0.027)” (Rossouw & Rossouw, 2016, p. 38). When analyzing domains between genders, the authors noted a significant difference in the Health domain: “95% CI (0.6047, 0.6613), compared to females males scored much lower (M = 0.5696, p = 0.012)” (Rossouw & Rossouw, 2016, pp. 38-39).

A correlation matrix between the five Davidson styles found that the Composure and Reasoning domains demonstrated the strongest relationship. Rossouw and Rossouw (2016) hypothesized relationship between the Davidson styles and the Health domain was:

> positive at 0.169 with a p-value of 0.016. While the Pearson value is in the lower range, the < 0.05 p-value indicates the relation is of statistical significance. . . . Item analysis yielded a Cronbach’s alpha of 0.7364, indicating good internal consistency and validity as a psychometric tool. (p. 39)

Additional internal consistency analyses retain alphas above 0.70 for the resilience domains and the Health domain (Rossouw & Rossouw, 2016).

Rossouw & Rossouw (2016) summarized that the positive correlations between the original five domains of resilience and the health domain support its inclusion in the construct and measurement of resilience. They concluded that the PR6 is a short and simple measurement tool, which expands the reach of traditional resilience scales. They conclude that the six resilience domains, which include neurobiological factors, can lead to effective measurement and treatment for well-being and resilience (Rossouw & Rossouw, 2016).

The Center for Workplace Health Research and Evaluation (2017) indicated that strengths of the PR6 include its foundations from existing validated resilience measures with the addition of physiological health factors. Factors that strongly align with the current research design include: emotional regulation, cognitive traits, and collaboration. Additionally, the strong

emphasis on physiological resilience is a strength, although the specific items (exercise, nutrition and sleep hygiene) do not closely align with the previous literature review, nor do they appear prominently in the training intervention associated with this inquiry. Additionally, the Center for Workplace Health Research and Evaluation (2017) noted that the PR6 has promising measures of reliability and validity and recommended further testing. While the PR6 indicates promise in the measure of workplace resilience, specific factors and items contained within the PR6 suggest the need for a stronger match for the selection of a measurement tool for this inquiry.

Personal and Organizational Quality Assessment-Revised 4 Scale (POQA-R4)

The Institute of HeartMath® (Barrios-Choplin & Atkinson, 2004) offers the personal and organizational quality assessment-revised 4 scale (POQA-R4) which was informed by their conceptual framework. The POQA-R4 was selected for review because it directly informed the analysis of the conceptual frames supporting the research (see Chapter Two). The POQA-R4 is a self-report questionnaire measuring workplace quality (personal and organizational quality). The assessment contains 49 questions (seven-point, ordinal, Likert scale) as well as socio-demographic data (gender, age, marital status, employment status, level of education, hours worked per week, number of years in the organization, and number of years in the current job). Normative data was comprised of a convenience sample of over 5000 adults, working processionals (Barrios-Choplin & Atkinson, 2004).

As previously reviewed, the framework guiding the construction of the POQA-R4 summarizes the relationships between organizational stress and its impact on emotions, specifically contributing to an increase in depleting emotions while reducing positive or regenerative emotions. This process can negatively affect employee physiological and psychological health. Additionally, this stress response and corresponding emotional responses

can lead to organizational outcomes such as increases in health care costs and employee turnover and decreases in employee performance and organizational functioning. By introducing HeartMath®/HRV self-regulation tools to employees, the authors explained that these negative outcomes may be counteracted, by improving an employee's ability to self-regulate emotions and the stress response, which can lead to increases in positive emotions, decreases in depleting emotions and improved employee and organizational (Barrios-Choplin & Atkinson, 2004). Scales and subscales of the POQA-R4 are categorized as positive (emotional vitality) or negative (organizational stress, emotional stress, physical stress), where positive factors improve health and performance and negative factors have harmful impacts on well-being and performance. Intention to quit is an additional subscale. A summary of each of the primary and subscales is provided below:

- *Emotional vitality scale:* Wholehearted positive emotional energy that enriches life experience and enhances health and well-being. Subscales include (a) emotional buoyancy: emotional energy available for work and personal life, and (b) emotional contentment: feeling of contentment and inner peace.
- *Organizational stress scale:* Organizational impediments and relational discord that impair work performance, reduce job satisfaction, and increase employee turnover. subscales include, (a) pressures of life: feeling overwhelmed by work pressures and the demands of life; (b) relational tension: stressed by relational disaffection and coworker conflict; and (c) intention to quit: thinking about leaving the organization.
- *Emotional stress scale:* Emotional discord that reduces the quality of life experience and jeopardizes health and well-being. Subscales include, (a) anxiety/depression: feelings of

anxiety, unhappiness, sadness, and/or depression, and (b) anger/resentment: feelings of anger and resentment and difficulty in emotional control.

- *Physical stress scale:* Physical symptoms of fatigue and poor health that reflect the overall stress an employee is experiencing. Subscales include: (a) fatigue: feelings of tiredness, fatigue, and physical exhaustion; and (b) health symptoms: physical tension, aches, and pain, stomach upset, rapid heartbeats, and headaches (Barrios-Choplin & Atkinson, 2004, pp. 5, 7).
- *Intention to quit subscale:* High scores on this subscale should be a red flag to management, because they indicate an increased likelihood that a notable proportion of employees are feeling sufficiently dissatisfied with their work environment that they are thinking about leaving the organization (quitting their job; Barrios-Choplin & Atkinson, 2004, pp. 5, 8).

The POQA-R4 has strong measures of validity and reliability supporting the four factors/scales. The POQA-R4 summarized that all of the primary scales and all but one of the subscales met this standard (Barrios-Choplin & Atkinson, 2004). Analyses of internal consistency resulted in the four primary scales meeting sufficient Cronbach's alpha with primary scales ranging from 0.76 - 0.92. The subscales showed that all but one subscale (Relational Tension $\alpha = 0.69$) met standards for adequate measures of Cronbach's alpha (0.76 - 0.90).

To confirm validity of the item assignment to scales and subscales a second factor analysis was conducted. Results reported that:

> All 49 items were factor analyzed (results not shown) to compare the item classifications resulting from the factor analysis with their nominal designation into the four primary scales and nine multi-item subscales of the POQA-R4's. With few exceptions, the factor analysis item classifications corresponded to the nominal classification of the items into the categories for the primary scales. (Barrios-Choplin & Atkinson, 2004, p. 14)

It was summarized that based on these analyses, the POQA-R4 has strong measures of validity of the item assignment to the scales and subscales, as well as strong measure of reliability. The authors noted that there are limitations associated with the assessment such as those associated with the accuracy of self-report measures, lack of random sampling methods/associated ability to generalize, and the possibility of confounding variables (Barrios-Choplin & Atkinson, 2004). A Google Scholar search found that the POQA-R4 has been used in the assessment of personal and organizational quality in a range of domestic and international organizations, such healthcare (Buchanan & Reilly, 2019, first responders (Ramey et al., 2017) and industry (Low & McCraty, 2018a).

The previous literature review (see Chapter Two) guided by the POQA-R4 theoretical model indicates strong construct validity as it relates to the current research design and analysis of conceptual frames (see Chapter Two). Additionally, the RA training intervention coupled with the POQA-R4 indicates strong criterion validity as the intervention and assessment align closely. Literature indicates that they study of resilience is complex and challenging to conceptualize and measure in work settings (Hartmann et al., 2020). The previous literature review recommended that the conceptualization and measurement of resilience needs to integrate contextual elements to best match the environment, participants and research design. Given these recommendations, the POQA-R4 was selected as the measurement tools for this inquiry as it includes factors that directly correspond to the literature, and critical analysis of the conceptual frames associated with this inquiry: stress (physiological and psychological), organizational stress, resilience, and emotion regulation. Despite the strong measures associated with each of the reviewed measurement instruments, the POQA-R4 was selected for this inquiry as it most comprehensibly supports findings associated with this inquiry's literature review, critical analysis of

conceptual/theoretical frames as well as the RA training intervention (including analysis of espoused benefits).

Data Collection

During both phase 1 and phase 2 of data collection eligible participants were recruited for participation in research. Specifically, all employees associated with each band were eligible for research participation. Once lists of eligible employees (by employee band) for each phase of recruitment were obtained from the research organization, a recruitment email was sent to all employees. The recruitment email contained a brief description of the Resilience Advantage™ training intervention, anticipated benefits of participation, participation incentive ($25 Amazon gift cards), risks associated with participation as well as details regarding logistics (time/date of trainings, access to online platforms, general information regarding pre and post assessments). When employees indicated they were interested in research participation via an online sign-up system used by the organization, they were sent an electronic *IRB Informed Consent Form* (see Appendix D), followed by dates and times of workshop options as well as virtual invitations for participation. Because of COVID-19 restrictions, the study setting and data collection procedures were designed to be conducted remotely. Thus, participant recruitment, delivery of the intervention and data collection were conducted via technological mediums appropriate to the organization.

Upon completion of the informed consent forms, the volunteer participants associated with each phase were randomly assigned using the GraphPad website to one of the two groups: Resilience Advantage group (active) or the wait-list control group. Once participants were assigned to the active or wait-list control groups, they were once again assigned to one of two sections for either the active intervention or the wait-list control intervention (this procedure was

conducted for both phase 1 and phase 2 participants). This procedure allowed each participant the same probability of participation in each of the groups. Once assigned to groups, participants were asked to generate a four-digit code to use while completing the POQA-R4 (both pre and post assessment) to help ensure confidentiality during data collection and analysis.

The Institute of HeartMath® virtually administered the POQA-R4 pre and post testing (by phase) for all research participants. The lead researcher for this investigation sent the HeartMath® contact a secure spreadsheet, with details regarding when each participant should receive their pre-POQA-R4 assessment (based on random assignments) and when they should receive their post-assessment. Baseline survey data was collected before the training interventions were administered on all participants (active and control), and again for all participants (active and control) upon completion of the active participants' intervention. These procedures were conducted twice, once for phase 1 and once for phase 2. Non-responders were contacted with email reminders detailing that completion of both pre and post surveys were terms of eligibility for the drawing for the $25 Amazon gift card.

After pre-assessment (for each phase) the training intervention was administered for the experimental group, while the wait-list control group did not receive the intervention. The training intervention was administered by a certified HeartMath® trainer. Each participant received all learning materials (including workbooks, handouts, demonstrations, learning materials) associated with each training. Upon completion of the training intervention with the experimental group, a post survey assessment for all participants (active and wait-list control) was then collected. Finally, the wait-list control group received the HeartMath® intervention. These procedures were conducted twice, once for phase 1 and once for phase 2.

The Resilience Advantage™ (RA)

The RA training intervention includes six, one-hour modules which cover themes such as stress, the science of the heart, resilience, depleting and renewing emotions, physiological and psychological coherence, emotional and HRV self-regulation, intuition and relation energetics as well as associated techniques to improve emotional and HRV self-regulation. The six hours of the RA training intervention were condensed into four, one-hour sessions in order to be facilitated in a virtual medium and to align with needs of the organization.

The RA is proprietary to The Institute of HeartMath® and in order to replicate this research, an investigator must secure a HeartMath® Certified Trainer credential to acquire the RA curriculum. A preview of the RA training intervention is included below. The RA curriculum was administered in four, one-hour sessions and followed the HeartMath® prescribed curriculum. The specific training modules were organized as follows:

1. Module 1:
    - Resilience framework
    - Coherence
    - Stress and the science of the heart
    - *Technique: Quick Coherence*
2. Module 2:
    - Depletion to renewal grid
    - *Technique: Inner Ease*
    - Coherence practice outcomes
3. Module 3:
    - Three Strategies for building and sustaining resilience

- Establishing a new baseline
- Practical Intuition
- *Technique: Freeze Frame*

4. Module 4:
    - Relational Energetics/Energetics of Communication
    - *Technique: Coherent Communication*
    - Strategies for Building Resilience Capacity
    - *Technique: Heart Lock-In*
    - Wrap-up

The RA intervention specifically targets the science, awareness and skill building related to participants' ability to self-regulate emotions and HRV while improving biopsychosocial outcomes. Specifically, participants learn to balance the cognitive, emotional and physiological systems. One of the systems associated with the ability to self-regulate is the intrinsic cardiac nervous system, including the heart's ability to send afferent neural signals to the brain's subcortical and cortical systems (emotional and cognitive systems respectively). This ascending information from the heart to the brain is transmitted via the heart's rhythms (HRV) which are impacted by participants' emotional states, where regenerative emotions help to facilitate coherent HRV patterns and depleting emotions facilitate incoherent HRV patterns. Both patterns impact the information sent from the limbic (emotional/behavioral) system of the brain to the cortex (cognitive) region of the brain which is associated with executive function and emotional self-regulation. The RA training intervention teaches participants to build awareness of these processes while intentionally activating a coherent HRV pattern via self-regulating emotions (McCraty, 2015).

Data Analysis

The research question and corresponding hypotheses for this inquiry are included below:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?
    - *Research Hypothesis 5a*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional vitality will be higher than that of the control group.
    - *Research Hypothesis 5b*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention Organizational Stress will be lower than that of the control group.
    - *Research Hypothesis 5c:* In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional stress will be lower than that of the control group.
    - *Research Hypothesis 5d:* In a controlled study of large organizations (over 200 employees), the experimental group's post intervention physical stress will be lower than that of the control group.
    - *Research Hypothesis 5e*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention intent to quit will be lower than that of the control group.

Once both phases of data collection (phase 1 and phase 2) were complete, data for both active and control groups for both phases were combined to establish a total active and control

group data set. A multivariate analysis of variance (MANOVA) was used in order to determine if means of the two independent, categorical groups (active, wait-list control) associated with this inquiry differed on the five outcome variables (French et al., 2008). Data analyses were performed using the *IBM SPSS Statistics* (Version 22.0) to determine (once assumptions were met) if there were statistically significant differences on the ordinal dependent variables (seven-point, likert scale; ordinal approximation of a continuous variable) between the RA intervention group and the waitlist control group.

Assumptions

Assumptions for MANOVA are as follows: (a) normality, (b) linearity, and (c) homogeneity of variance (French et al., 2008). See Chapter Four for detailed assessment of assumptions.

- *Normality:* The assumption of normality for MANOVA assumes that the population associated with the depended variable is normally distributed. This assumption was assessed by computing descriptive statistics (to assess skewness and kurtosis) to confirm that data was within the acceptable range to meet the assumption of normality.
- *Linearity:* In order to maintain the power of the analysis, the MANOVA linearity assumption indicates the need for a linear relationship between all pairs of dependent variables
- *Homogeneity of variance:* This assumption assumes that the variance or distribution in each independent group is equal/comparable. Meeting this assumption helps minimize Type 1 errors (or rejecting the null hypothesis when it should not be rejected).

Experimental research can be met with missing data that may compromise the outcomes of the study by decreasing effective sample sizes and ability to detect significant effects if not

handled appropriately (Li & Stuart, 2019). If a participant did not complete the POQA-R4 assessment (pre or post), of if they failed to respond to all questions in the POQA-R4, listwise deletion was used to eliminate that participant's data from analysis. Additionally, outliers, or data points which differ significantly from the usual data pattern can reduce the validity of results for this MANOVA data analysis. In order to detect outliers in the data a boxplot and normal probably plots were assessed.

Limitations

There are several limitations associated with the current research design: generalizability, self-reported data, and contamination.

Generalizability

A threat to external validity concerns the study sample, which was limited to the selected organization and units within the organization. With this design, although supported by randomization and the use of a control group, generalizability of findings may still be limited to similar populations and circumstances.

Self-Report Data

As with any self-report survey, the POQA-R4 has limitations associated with the accuracy of self-report data related to perceptions, attitudes and behaviors. While objective measure of HRV do exist, limitations associated with this research design, specifically the need to conduct research remotely due to COVID-19 restrictions, informed the selection of self-report measure (POQA-R4). Such measures may present internal validity limitations such as participant familiarity with the assessment due to repeated measures as well social desirability bias, which may alter responses in a way that the participant views their responses socially desirable by others.

Contamination

Contamination bias refers to exposure of research control participations to conditions of the intervention in controlled research designs (Simmons et al., 2015). Control participants being exposed to intervention materials and/or interacting with active treatment participants may have contributed to this bias. This interaction may influence measures of effectiveness of the intervention.

Summary

This chapter presented the study design, the rationale for this design, review and selection of relevant assessment instruments, procedures, description of one-way ANOVA data analysis, as well as limitations associated with the research design. Results and analysis of data are presented in the subsequent chapter.

CHAPTER FOUR: RESULTS

This chapter includes data preparation and descriptive statistics for the study sample, followed by inferential statistics related to Research Question 5 and the associated hypotheses. Histograms, boxplots and inferential statistics are provided with key findings related to study hypotheses included.

Research Questions

Five research questions framed this study. The first four research questions, which focused on HRV self-regulation research domains/empirical evidence and conceptual/theoretical frames, were reviewed in detail in Chapter Two and summarized in Chapter Three. This chapter focuses on research question five included below with corresponding hypotheses:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?
    - *Research Hypothesis 5a*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional vitality will be higher than that of the control group.
    - *Research Hypothesis 5b*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention Organizational Stress will be lower than that of the control group.

- *Research Hypothesis 5c*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional stress will be lower than that of the control group.
- *Research Hypothesis 5d*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention physical stress will be lower than that of the control group.
- *Research Hypothesis 5e*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention intent to quit will be lower than that of the control group.

Measurements of personal and organizational quality (POQA-R4) were used to measure these effects for the study sample as detailed in Chapter Three.

Data Acquisition

Data for this inquiry was originally acquired from HeartMath® as the POQA-R4 (the assessment used for RQ5) is proprietary to the organization. Once phase 1 and phase 2 data collection was complete (detailed in Chapter Three), the Excel files were sent from HeartMath® to the primary investigator of this study. Four data sets were included in the files: (a) phase 1 active (treatment), (b) phase 1 wait-list control, (c) phase 2 active (treatment), and (d) phase 2 wait-list control. The data files contained responses from 249 total participants (both active and wait-list control from phases 1 and 2). Data was acquired (for both the active and waitlist control groups) before and after the active groups (phase 1 and phase 2) participated in the treatment (see Figure 3.1).

The current study is a cross-sectional design where post-intervention data was compared between the active and wait-list control groups (as opposed to a longitudinal design; see Table

3.1). Due to participant attrition, there were a number of participants who did not participate in the post-treatment assessment resulting in a data set of 148 total post-intervention survey responses. Listwise deletion was used for any study participant who did not complete all post-intervention data items. This procedure resulted in the elimination of one participant. Thus, the total *n* for this study was 147 participants. Perugini et al. (2018) explained that when conducting a power analysis, researchers should consider different circumstances for the research design by changing a number of variables associated with the power analysis. These variables may include expected effect size, levels of power, uncertainty in the estimate (confidence interval) and needed sample sizes that will inform the sample size estimate that will efficiently protect against operationalizing a study that overestimates the effect size leading to insufficient power. Additionally, when logistics of the research design limits the available sample size, the power analysis can still provide value by determining the strength of an effect that can be detected with acceptable reliability (Perugini et al., 2018). This research fell below the desired sample size estimated in the previous power analysis (see Figure 3.2), yet still had significant power and effect sizes to secure reliable outcomes.

Table 3.3

Between-Groups, Experimental Design

IV = Resilience Advantage Training™ (RA)		
Group A Training Participants		Group B Non-Participants (Wait-List Control Group)
DV	POQA-R4	POQA-R4

Data Conditioning

Pre-analysis data preparation for this inquiry was conducted using several methods described below. These methods included the preparation of a single *SPSS* file constructed from

the previously described POQA-R4 excel files. Additionally, results were assessed for accuracy and extraneous values.

Data Transfer

To prepare a single *SPSS* data file for analysis, the four POQA-R4 excel files were merged. All scale and sub-scale responses were included in the POQA-R4 excel files. To prepare the *SPSS* files, only data associated with the four primary scales and intent to quit subscale, associated with the research question and hypotheses for this inquiry were included: *emotional vitality*, *organizational stress*, *emotional stress*, *physical stress*, and *intent to quit*. Once the data was combined, the following coding was assigned in the *SPSS* file: (a) research phase 1 and research phase 2, (b) treatment vs. control, and (c) time: pre and post-treatment. Additionally, the demographic data from the excel files were included in the *SPSS* file.

Data Validity Checks

Once the data was prepared in the *SPSS* file, histograms (with normal curves overlaid) and boxplots for the ordinal variables associated with this study were examined for outliers, which may indicate untruthful, misinterpretations, or extreme (outliers) responses by participants. Figures 4.1 through 4.10 contain histograms and boxplots for these ordinal variables.

The histograms were assessed in order to check for the MANOVA assumption of normality. As illustrated in Figures 4.1, 4.2, 4.3, 4.4, four of the five histograms (*emotional vitality, organizational stress, emotional stress* and *physical stress)* show approximate normality. Conversely, *Intent to Quit* (Figure 4.5) is strongly skewed to the right. Note that in subsequent analyses it is observed that the *intent to quit* alpha level far exceeds 0.05, thus a Type II error is

unlikely. As such, in relation to *intent to quit,* practitioners should use caution when acting on results.

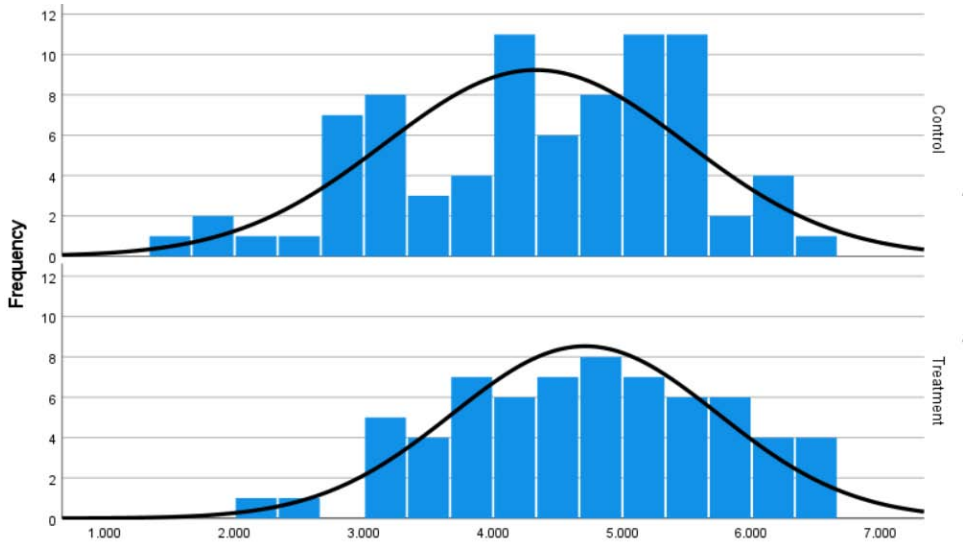

Figure 4.1

Histogram, Emotional Vitality (Wait-List Control Group and Treatment Group)

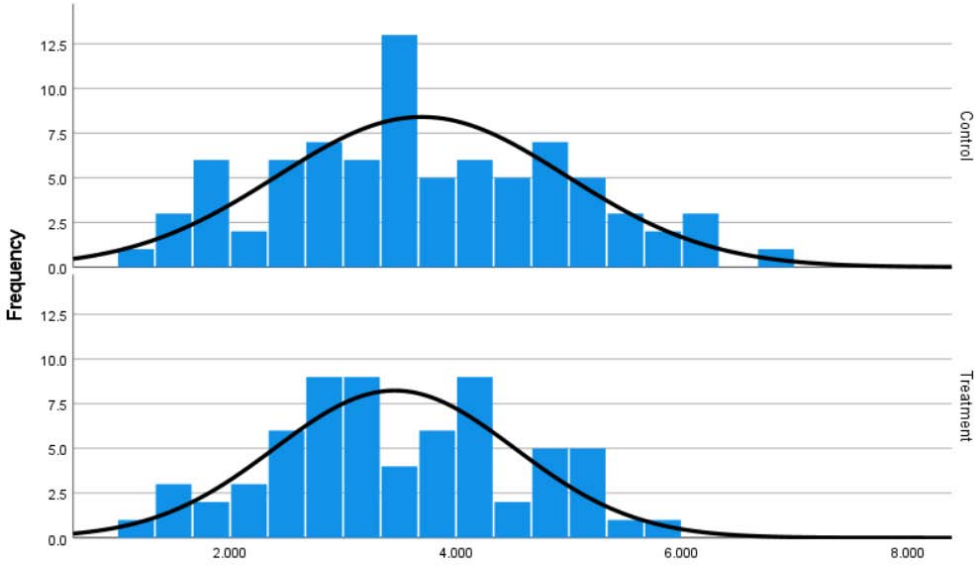

Figure 4.2

Histogram, Organizational Stress (Wait-List Control Group and Treatment Group)

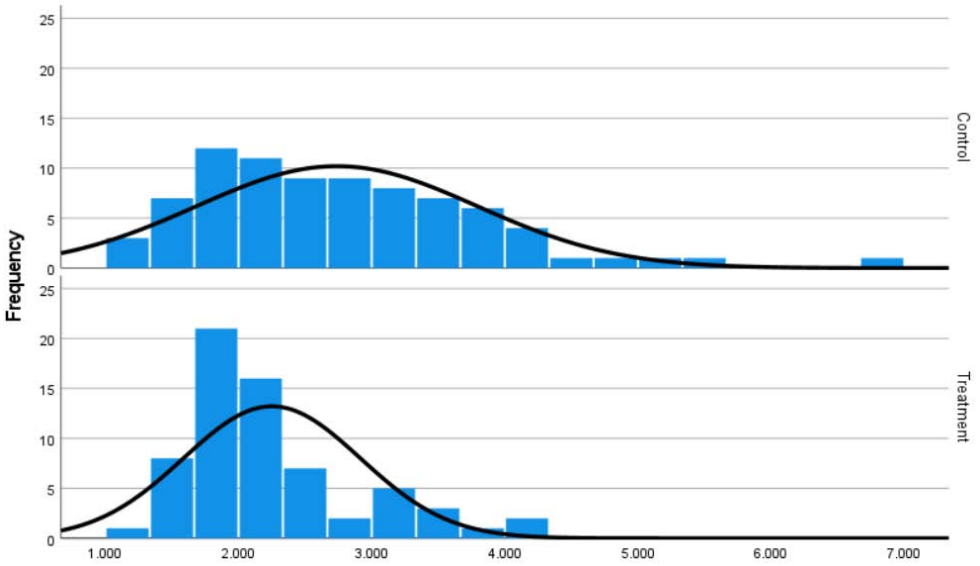

Figure 4.3

Histogram, Emotional Stress (Wait-List Control Group and Treatment Group)

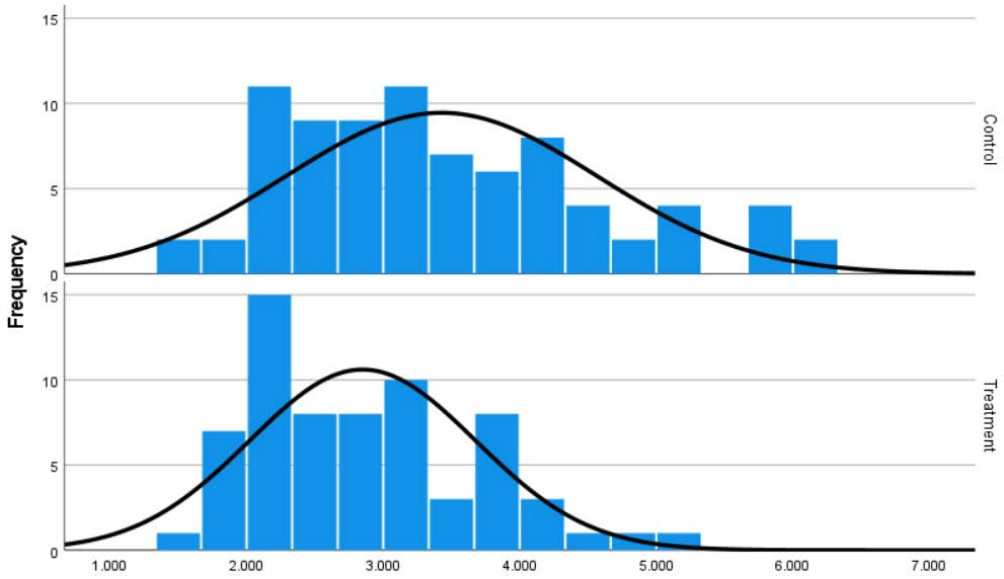

Figure 4.4

Histogram, Physical Stress (Wait-List Control Group and Treatment Group)

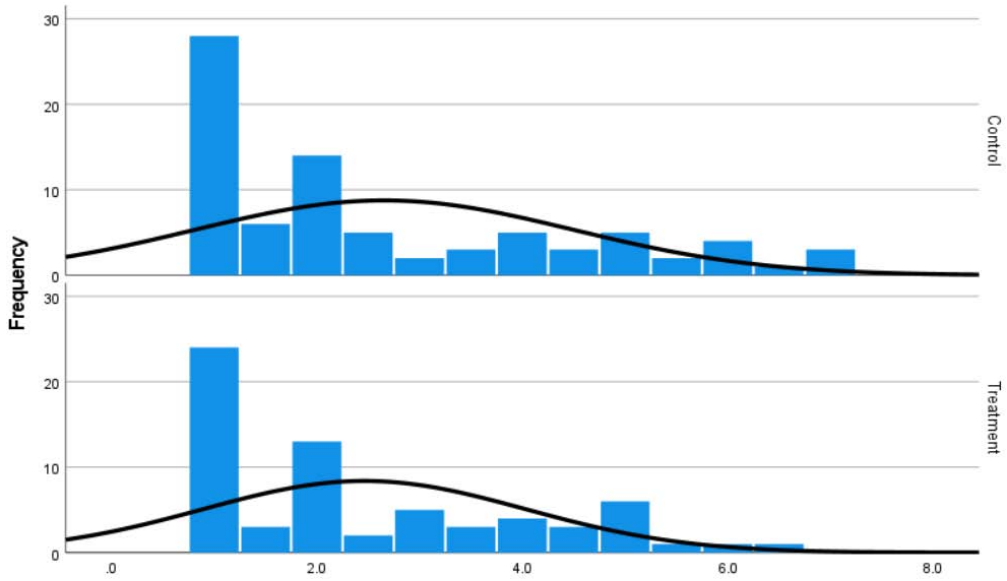

Figure 4.5

Histogram, Intent to Quit (Wait-List Control Group and Treatment Group)

To assess the variables for untruthful responses, misinterpretations or extreme (outliers) responses, boxplots associated with each variable were reviewed. The boxplots contained in Figures 4.6 (emotional vitality), 4.7 (organizational stress), 4.9 (physical Stress), and 4.10 (intent to quit), did not demonstrate extreme responses by participants. The boxplot associated with emotional stress (Figure 4.8) did show extreme responses (as illustrated by asterisks and circles). It was not considered unusual for some participants to experience extreme levels of stress, thus these outliers may not indicate untruthful responses nor misinterpretations by the participants (Kar et al., 2021). Additionally, there was no evidence of extreme responses by the same respondents or extreme responses by any respondent while examining the boxplots for the remaining variables, thus none of the cases were removed from the study dataset.

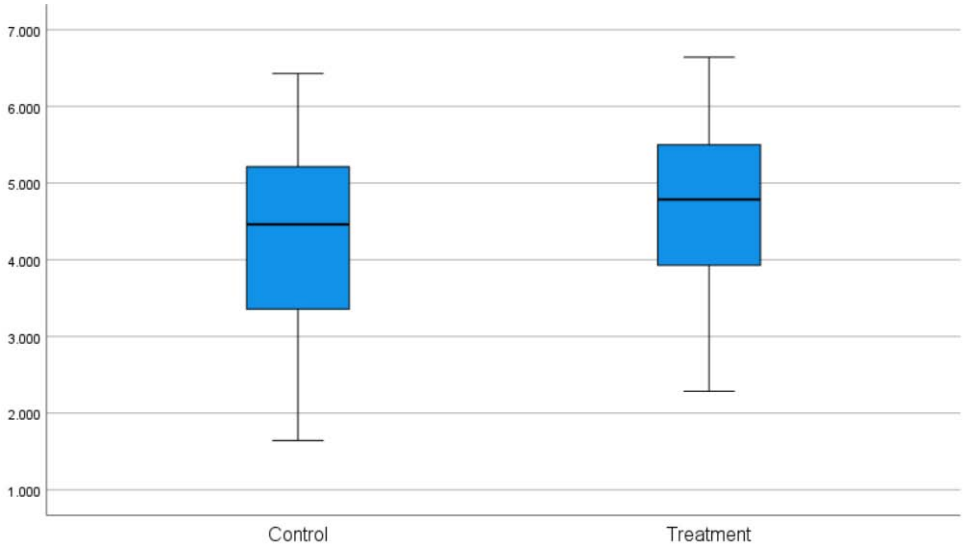

Figure 4.6

Boxplot, Emotional Vitality (Wait-List Control Group and Treatment Group)

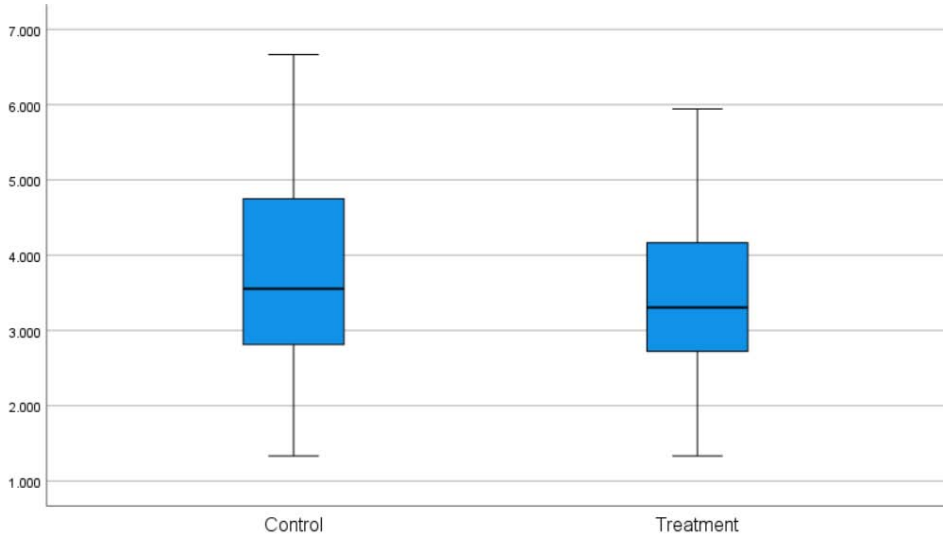

Figure 4.7

Boxplot, Organizational Stress (Wait-List Control Group and Treatment Group)

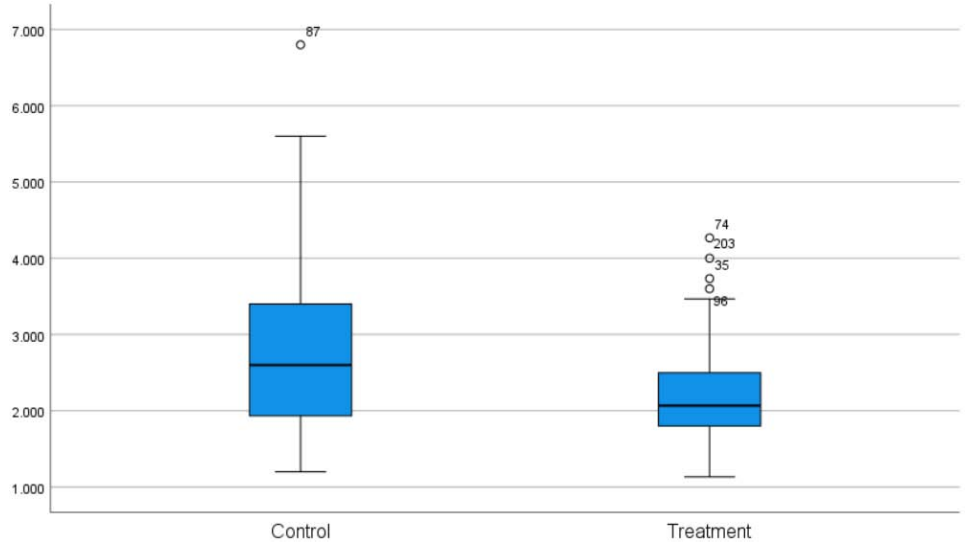

Figure 4.8

Boxplot, Emotional Stress (Wait-List Control Group and Treatment Group)

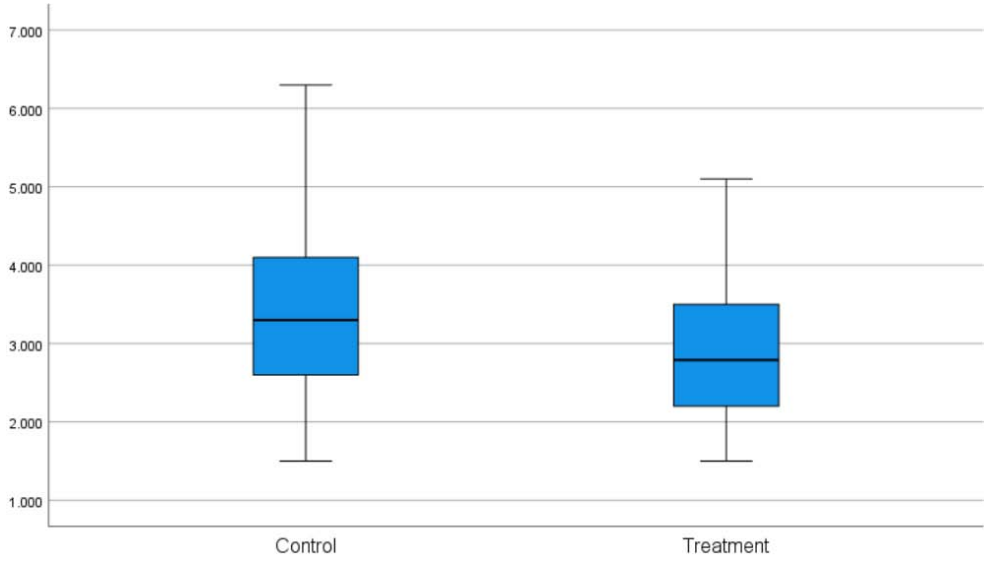

Figure 4.9

Boxplot, Physical Stress (Wait-List Control Group and Treatment Group)

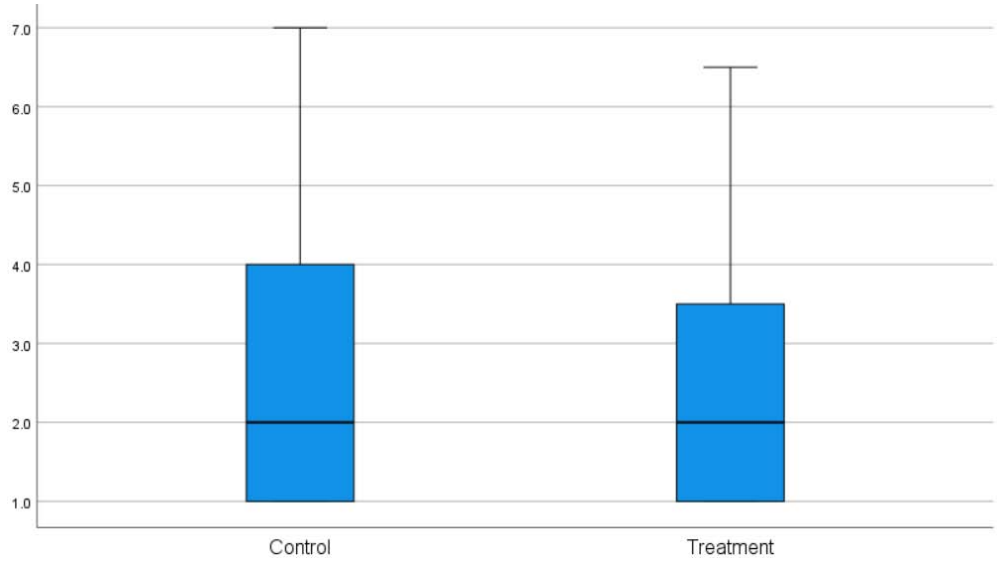

Figure 4.10

Boxplot, Intent to Quit (Wait-List Control Group and Treatment Group)

Descriptive Statistics

This section includes descriptive statistics for the 147 participants who comprised the sample for this study. Table 4.1 provides mean, medians and standard deviations for each of the five variables. Tables 4.2 through Table 4.10 includes demographic data for the sample. An analysis of the total median values for the active and control groups was assessed for each of the constructs and are shown in Table 4.1. Median values were provided as it was recommended that when reporting descriptive statistics for Likert scale data, the median be used (Boone & Boone, 2012). Participant's *emotional vitality* was in the neutral to vital range. The median value for participant *organizational stress* was neutral to somewhat low stress. Responses for *emotional stress, physical stress* and *intent to quit* were low.

Table 4.1

Descriptive Statistics

Variable	Experimental Group	*N*	Mean	Median	Std. Deviation
Emotional vitality	Control	81	4.330		1.166
	Treatment	66	4.712		1.029
	Total	147	4.502	4.643	1.119
Org Stress	Control	81	3.698		1.282
	Treatment	66	3.457		1.065
	Total	147	3.590	3.444	1.192
Emotional stress	Control	81	2.738		1.056
	Treatment	66	2.250		0.664
	Total	147	2.519	2.267	0.931
Physical stress	Control	81	3.427		1.140
	Treatment	66	2.849		0.827
	Total	147	3.168	3	1.049
Intent to quit	Control	81	2.654		1.845
	Treatment	66	2.462		1.570
	Total	147	2.568	2	1.724

Gender breakdowns for the sample are contained within Table 4.2 below. The sample contained 85% female respondents with 15% male respondents. Table 4.3 includes age demographics for the sample. Approximately half of the participants were in their 40's, while only 8% were over 70 years old. Table 4.4 shows that 64% percent of respondents were married, while 36% were single, partnered, separated, divorced or widowed. Table 4.5 includes education level of respondents and shows that 70% of participants had a two or four-year degree, while 25% had a high school education.

Table 4.6 includes income data, which shows that 80% of participants earned under $70,000 per year and 44% made under $40,000 per year. Table 4.7 contains employment type

and shows that 45% of respondents were laborers and skilled/clerical professionals, while 28% occupied management positions. Table 4.8 shows that 48% of participants worked 41-60 hours/week. Tables 4.9 and Table 4.10 show tenure with the company and time in position with 27% working 10-20 years with the organization and the and 65% working in their role 0-5 years.

Table 4.2

Respondents' Gender

Gender	Frequency	Percent
Male	22	15
Female	125	85
Total	147	100

Table 4.3

Respondents' Age

Age Range	Frequency	Percent	Cumulative Percent
<21	1	0.7	0.7
21-30	22	15	15.6
31-40	25	17	32.7
41-50	52	35.4	68
51-60	39	26.5	94.6
61-70	7	4.8	99.3
>70	1	0.7	100
Total	147	100.0	

Table 4.4

Respondents' Marital Status

Frequency	Frequency	Percent	Cumulative Percent
Single	26	17.7	17.7
Married	94	63.9	81.6
Partnered	7	4.8	86.4
Separated	3	2	88.4
Divorced	16	10.9	99.3
Windowed	1	0.7	100
Total	147	100	

Table 4.5

Respondents' Levels of Education

Level	Frequency	Percent	Cumulative Percent
High school	34	23.1	23.1
Technical school	2	1.4	24.5
Associate	70	47.6	72.1
Bachelor	33	22.4	94.6
Graduate partial	1	0.7	95.2
Master	6	4.1	99.3
Doctorate	1	0.7	100
Total	147	100	

Table 4.6

Respondents' Salary

Salary Ranges	Frequency	Percent	Cumulative Percent
< 20K	4	2.7	2.7
20K- < 30K	9	6.1	8.8
30K- < 40K	52	35.4	44.2
40K- < 50K	18	12.2	56.5
50K- < 60K	12	8.2	64.6
60K- < 70K	24	16.3	81
70K- < 80K	7	4.8	85.7
80K- < 90K	4	2.7	88.4
90K- < 100K	1	0.7	89.1
100K- < 150K	11	7.5	96.6
>150K	5	3.4	100
Total	147	100	

Table 4.7

Respondents' Employment Type

Type	Frequency	Percent	Cumulative Percent
Laborer	2	1.4	1.4
Skilled/clerical	64	43.5	44.9
Management	41	27.9	72.8
Professional	25	17	89.8
Executive	2	1.4	91.2
Engineer/technical	1	0.7	91.8
Other	12	8.2	100
Total	147	100	

Table 4.8

Hours Worked per Week

Hours Worked	Frequency	Percent	Cumulative Percent
<25	4	2.7	2.7
26-35	2	1.4	4.1
36-40	71	48.3	52.4
41-50	50	34	86.4
51-59	16	10.9	97.3
60+	4	2.7	100
Total	147	100	

Table 4.9

Time with Organization

Time	Frequency	Percent	Cumulative Percent
0–6 mo.	7	4.8	4.8
6 Mo.–1 yr.	14	9.5	14.3
1–3 yrs.	13	8.8	23.1
2–5 yrs.	37	25.2	48.3
5–10 yrs.	24	16.3	64.6
10–20 yrs.	40	27.2	91.8
20 yrs.+	12	8.2	100
Total	147	100	

Table 4.10

Time in Position

Time	Frequency	Percent	Cumulative Percent
0–6 mo.	11	7.5	7.5
6 mo.–1 yr.	17	11.6	19
1–2 yrs.	28	19	38.1
2–5 yrs.	40	27.2	65.3
5–10 yrs.	19	12.9	78.2
10 yrs.+	32	21.8	100
Total	147	100.0	

Inferential Statistical Results

The research hypotheses associated with research question five were operationalized using a MANOVA and are included below for reference:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?
- *Research Hypothesis 5a*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional vitality will be higher than that of the control group.
- *Research Hypothesis 5b*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention Organizational Stress will be lower than that of the control group.

- *Research Hypothesis 5c*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional stress will be lower than that of the control group.
- *Research Hypothesis 5d*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention physical stress will be lower than that of the control group.
- *Research Hypothesis 5e*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention intent to quit will be lower than that of the control group.

Variable Correlations

Before conducting the MANOVA, correlations of the five dependent variables were analyzed and results of the bivariate Pearson correlations are located below in Table 4.11. All correlation pairs were significant at least at the $p<.05$ level. *Emotional stress* and *emotional vitality* demonstrate a strong inverse Pearson correlation observed at –0.66. This outcome may suggest that the constructs are in fact related and may be mirroring each other. Additionally *emotional stress* and *physical stress* are highly correlated (Pearson correlation of +0.69). This correlation may indicate that respondents did not clearly distinguish the two constructs as separate. A discussion of these correlations is included in the MANOVA results section, as an assumption of MANOVA is that the dependent variables are independent of each other.

Table 4.11

Pearson Correlations

	Emotional vitality	Org stress	Emotional stress	Physical stress
Org Stress	-.41**			
Emotional Stress	-.656**	.486**		
Physical Stress	-.43**	.348**	.687**	
Intent to Quit	-.484**	.549**	.368**	.173*

Note. * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.

MANOVA Omnibus Results

A MANOVA was first used to assess if there were significant differences between the two levels of the independent variable (active and control) on a linear combination of the five dependent variables, while also safeguarding against inflation of *Type I* error. As observed in Table 4.12 the overall MANOVA was significant ($p < .05$). Since there were only two groups in this study (active and control), all of the test statistics (from *Pillai's Trace* to *Roy's Root*) have the same levels of significance. The *SPSS* MANOVA effect size statistic, *partial eta squared*, has a value of 0.09, which is considered a medium effect size (Cohen, 1988). Medium and large effect sizes are considered useful to both practitioners and researchers.

Table 4.12

MANOVA Omnibus Statistics

	Effect	Value	*F*	Sig.	Partial eta squared
Intercept	Pillai's Trace	0.988	2346.337a	0.000	0.988
	Wilks' Lambda	0.012	2346.337[a]	0.000	0.988

	Effect	Value	*F*	Sig.	Partial eta squared
	Hotelling's Trace	83.203	2346.337[a]	0.000	0.988
	Roy's Largest Root	83.203	2346.337[a]	0.000	0.988
Group	Pillai's Trace	0.087	2.691[a]	0.023	0.087
	Wilks' Lambda	0.913	2.691[a]	0.023	0.087
	Hotelling's Trace	0.095	2.691[a]	0.023	0.087
	Roy's Largest Root	0.095	2.691[a]	0.023	0.087

Note. [a]Exact statistic.

To test the assumption of MANOVA that covariances of the matrices of the dependent variables are equal across all groups (for this study the active and control groups), a *Box's M* test was conducted. Since *Box's* M test is a very sensitive test, an *alpha* of 0.01 was used. In this analysis *Box's M* was significant ($F = 44.28$, $p < .001$), indicating the matrices were not equal. Hair et al. (2019) explained that if the group sizes differ by less than a factor of 1.5, the significant *Box's M* result has little influence on the MANOVA results. In this study the ratio of the group sizes is 1.23, so it safe to accept the omnibus results of the MANOVA.

It was previously observed that there was a strong inverse correlation (Akoglu, 2018) between *emotional stress* and *emotional vitality (*Pearson correlation observed at –0.66) and a strong correlation (Akoglu, 2018) between *emotional stress* and *physical stress* (Pearson correlation of +0.69). While these results indicate some lack of independence, these intercorrelations do not invalidate the MANOVA results for this inquiry as the purpose was to ensure that these inferential analyses did not inflate *Type I* error. Thus, the results of the MANOVA were not invalidated by intercorrelations.

MANOVA Results for Each Dependent Variable

Similar to individual ANOVA analyses, the MANOVA group differences are located in Table 4.13. That table shows that *emotional vitality*, *emotional stress*, and *physical stress* are significant ($p < .05$, $p < .01$, and $p < .01$ respectively). The *partial eta squared* and Cohen's *d* values, indicate *emotional vitality* produced a borderline moderate effect size, while *emotional stress* and *physical stress* exhibit clear moderate effect sizes.

Table 4.13

Variable Differences Across Groups

Source	Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial eta squared	Cohen's *d*
Emotional Vitality	5.293[a]	1	5.293	4.320	0.039	0.029	0.34
Organizational Stress	2.110[b]	1	2.11	1.491	0.224	0.01	0.2
Emotional stress	8.665[c]	1	8.665	10.664	0.001	0.069	0.52
Physical stress	12.159[d]	1	12.159	11.881	0.001	0.076	0.55
Intent to quit	1.343[e]	1	1.343	0.45	0.503	0.003	0.11

Note. Group differences for each variable: *emotional vitality*, *emotional stress*, and *physical stress*.

In order to assess the MANOVA and ANOVA assumptions that the variances of the two groups (active and control) are equal, a Levene's Test for Equality of Variance was conducted. A significant outcome of Levene's Test means that the groups have unequal variance and the assumption of equal variance has been violated. Table 4.14 shows the results of the Levene's Test for all five dependent variables. The table shows that *emotional stress* and *physical stress* are significant ($p < .05$ in both cases), and hence do not have equal variances.

Additionally, the MANOVA results for *emotional vitality*, *organizational stress*, and *intent to quit* can be considered valid. Next, the results for these three variables can be used to determine whether this study's related hypotheses can be upheld. (See the next subsection for the handling of *emotional stress* and *physical stress*.)

Related to *Hypothesis 5a,* Table 4.13 shows that *emotional vitality* is significant, and Table 4.1 shows that the mean for the Treatment (Active) Group is higher than that of the Control Group. Hence, *Hypothesis 5a is upheld.*

Related to *Hypothesis 5b,* Table 4.13 shows that *organizational stress* is not significant. Hence, *Hypothesis 5b cannot be upheld.*

Related to *Hypothesis 5e,* Table 4.13 shows that *intent to quit* is not significant. Hence, *Hypothesis 5e cannot be upheld.*

Regarding the final two variables, *emotional stress* and *physical stress,* which violated the equal variance assumption of the MANOVA: the corresponding hypotheses to those variables cannot yet be assessed despite observed differences both at a significant level in the MANOVA ($p < .01$). The following section will provide results for *robust tests for differences of means* and corresponding analyses of hypotheses for the remaining two variables.

Table 4.14

Levene's Test Results[a]

Variable	Levene statistic	*df*1	*df*2	Sig.
Emotional vitality	1.677	1	145	0.197
Organizational stress	1.936	1	145	0.166
Emotional stress	10.443	1	145	0.002
Physical stress	5.283	1	145	0.023

Variable	Levene statistic	*df*1	*df*2	Sig.
Intent to quit	1.662	1	145	0.199

Note. All values are for the trimmed mean.

Robust Tests for Differences of Means

Two ANOVA tests, the Brown-Forsythe and Welch tests, do not rely on equal variances and will allow further analysis for the *emotional stress* and *physical stress* variables. Despite being less powerful that than regular ANOVA analyses, these tools become relevant when MANOVA or ANOVA outcomes produce unequal variances. Additionally, the omnibus MANOVA showed that all five variables (when analyzed together), produced a significant result, thus, the risk of an elevated Type 1 error is no longer applicable. See Table 4.15 for results of the Brown-Forsythe and Welch tests.

Both the Brown-Forsythe and Welch tests show that *emotional stress* and *physical stress* are significant ($p < .01$ in both cases). Thus, the results of the Brown-Forsythe and Welch tests can be used to determine whether the hypotheses related to the final two dependent variables can be upheld.

Related to *Hypothesis 5c,* Table 4.15 shows that *emotional stress* is significant, and Table 4.1 shows that the mean for the Treatment (Active) Group is lower than that of the Control Group. Hence, *Hypothesis 5c is upheld.*

Related to *Hypothesis 5d,* Table 4.15 shows that *physical stress* is significant, and Table 4.1 shows that the mean for the Treatment (Active) Group is lower than that of the Control Group. Hence, *Hypothesis 5d is upheld.*

Table 4.15

Brown-Forsythe & Welch Test Results

Variable	Test	Statistic	*df*1	*df*2	Sig.
Emotional stress	Welch	11.657	1	136.847	0.001
	Brown-Forsythe	11.657	1	136.847	0.001
Physical stress	Welch	12.662	1	143.216	0.001
	Brown-Forsythe	12.662	1	143.216	0.001

Summary of Inferential Results

As illustrated in the previous analysis, three of this study's five hypotheses were upheld. Hypotheses related to *organizational stress* and *intention to quit* were not upheld. Conversely, hypotheses related to *emotional vitality*, *emotional stress* and *physical stress* were upheld. With respect to emotional and physical stress, the effect sizes were moderate, so the results can be considered relevant to practitioners. *Emotional vitality* had a borderline moderate effect size, which can be considered marginally relevant to practitioners.

CHAPTER FIVE: DISCUSSION

This chapter provides conclusions based on research findings from the five research questions related to heart rate variability as an intervention to improve employee health and organizational outcomes. Specifically, this chapter will review the purpose of the study, literature review, research questions (and hypotheses), methods and findings. Finally, a discussion and implications for future theory building, research practice and implications for HRD will be offered.

Summary

The purpose of this study was to investigate the effects of a HRV training intervention on measures of employee health and organizational outcomes. Data indicated that work-related stress can cost organizations from $221 million to $187 billion (Hassard et al., 2018), with losses specifically associated with decreased productivity (70-90%) and healthcare costs (10-30%). Additionally, stress can cause significant costs to the employee as measured by declines in psychological and physiological health. The Centers for Disease Control and Prevention (CDC, 2020) indicated that employees impacted by excessive stress may experience physiological symptoms such as feeling tired, overwhelmed, burned out and trouble sleeping; and psychological symptoms such as inability to concentrate, anxiety, nervousness, irritation, anger, depression and denial. Additionally, worker stress may also influence the well-being of other members of both work and social systems and the organization's ability to meet business goals.

Stress induced health symptoms and corresponding costs to the organization may be exacerbated by the COVID-19 Pandemic (CDC, 2020). Disruptions associated with the COVID-19 pandemic can impact organizational functioning as well the system's ability to dynamically

respond to opportunities, challenges and organizational goals (Arora & Suri, 2020), all of which can further increase employee stress and associated health outcomes. HRD professionals are in a position to offer interventions to help employees and organizational systems adjust to these new demands. Specifically, interventions that support employees who experience stressors such as remote working and new work demands associated with the pandemic, were recommended (Hammer, 2021). Additionally, an emphasis on personal leadership practices focusing on integrating qualities of the heart to both to support employees while meeting business needs were also recommended (Dirani et al., 2020).

HRV self-regulation as a workplace wellness intervention to reduce stress for impacted employees has emerged as a promising line of research and applied work. HRV is defined as, "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para.1). The foundations of HRV self-regulation are rooted in an interconnected and systems approach referred to as psychophysiological coherence. The study of coherence is complex and is rooted in bi-directional interactions between the brain and the body. Evidence suggests that optimizing these pathways can positively influence physiological and psychological health, cognition, emotional self-regulation, social functioning and wellness (Elbers & McCraty, 2020). These outcomes have been observed in a range of organizational settings including leadership development (Ruderman & Clerkin, 2015), industry (Low & McCraty, 2018a), special forces police officers and non-special forces officers (Andersen et al., 2015), first responders (McCraty & Atkinson, 2012; Ramey et al., 2017), healthcare (Buchanan & Reilly, 2019; King et al., 2017; Linden et al., 2010; Pipe et al., 2012), and first responders (Ramey et al., 2017).

The risks associated with organizational stress, coupled with new stressors associated with the COVID-19 pandemic, have produced significant costs to worker health as well as to the functioning of the organization. As such, this research was supported by the following problem statement: On one hand, the cost of organizational stress can be harmful to the individual employee's physiological and psychological heath. Additionally, organizational stress can generate significant costs to the organization in the form of absenteeism, organizational dysfunction, healthcare costs and productivity. On the other hand, there is growing evidence related to the efficacy of workplace wellness interventions, and increased use of such programs in the workplace. Furthermore, there is a growing body of evidence, which indicates that stress management interventions specifically targeting HRV self-regulation can produce healthier and more productive employees. Therefore, there is a need to investigate if HRV self-regulation interventions can also positively affect performance at the individual and organizational levels.

Conclusions

This research was driven by five research questions and corresponding hypotheses for Research Question 5. The following section includes the research questions, summary of the results and analyses. The first four research questions, which focused on HRV self-regulation research domains/empirical evidence and conceptual/theoretical frames, were reviewed in detail in Chapter Two with brief summaries below.

Research Question 1 (RQ1)

A literature review was conducted in order to ground this research inquiry in the appropriate knowledge bases. This review driven by research RQ1 that asked *what are the research domains associated with HRV self-regulation*? The literature review associated with RQ1 found that HRV is a broad and multifaceted subject with applications in a wide range of

research and applied disciplines. This literature review found that the research domains associated with HRV self-regulation included the following: *physiological health, psychological health, education and organizations.*

Research Question 2 (RQ2)

The results of RQ1 supported an additional literature review of the empirical data associated with the research domains of HRV self-regulation (physiological health, psychological health, education and organizations). RQ2 asked: *What empirical evidence is associated with HRV self-regulation?*

In order to address RQ2, an empirical literature search and review was conducted. Informed by RQ1, HRV has been studied as a variable in a range of physiological health, psychological health, education and organizations. Below is a brief review of the empirical literature of HRV (with particular attention paid to HRV training interventions as an independent variable) in physiological and psychological health (including a review of HRV measurement and analyses located in Appendix A), and education, followed by a more thorough review and critical analysis of HRV in organizations.

Physiological Outcomes Summary

HRV was found to be predictive of several health outcomes. Additionally, increasing one's ability to self-regulate HRV demonstrated efficacy in mediating physiological conditions. The following is a sample of such studies, which were reviewed in detail in Chapter Two and are summarized in Table 5.1 below.

Table 5.1

Summary of a Sample of HRV Physiological Studies

Authors	Significant Outcome(s)
Buccelletti et al. (2009)	Assessment of cardiac risk
Luskin et al. (2002)	Elderly patients with congestive heart failure (CHF)
Lehrer et al. (2003)	Baroreflex gains, predictors of cardiac complications
Lehrer et al. (2004)	Pulmonary function and decreased dependence on steroid medication in asthma patients
Reid et al. (2013)	Improvements in focus and relaxation as measured by sensorimotor rhythm (SMR) in trained athletes and those with mental health diagnoses such as anxiety and ADHD
McCraty et al. (1998)	DHEA (vitality/wellbeing hormone) and reductions in cortisol (stress hormone)
McCraty (2015)	Reductions in total cholesterol and LDL cholesterol, systolic/diastolic blood pressure and triglycerides in employee participants
Katsamanis Karavidas et al. (2011)	Physical and depressive symptoms in populations with medically unexplained physical symptoms (MUPS)
McCraty et al. (2000)	Health, quality of life and glycemic measures for participants with Type 1 or Type 2 diabetes
Godfrey et al. (2018)	Loss of control and overeating in obese participants with a history of binge eating

Note. Summary of a sample of physiological outcomes associated with improved HRV.

A brief review of HRV and exercise physiology is included in Appendix B. Research illustrated how HRV was used to both assess and improve a number of fitness measures while highlighting the interplay of physiological and psychological systems. Specifically, data supports the use of HRV interventions and assessment in recovery, intensity, training loads and psychological and physiological performance.

To summarize, HRV has been used to assess a number of physiological health outcomes, while HRV self-regulation reviewed in this study have been observed to improve physiological health in the following measures: assessment of cardiac risk, hypertension, sensorimotor rhythm, DHEA, cortisol, cholesterol, blood pressure, triglycerides, pulmonary function, baroreflex gains, MUPS, CHF, glycemic measures, binge eating and applied exercise physiology assessment and performance. Researchers suggest that HRV interventions are both effective and efficient tools for improving physiological health.

Psychological Outcomes Summary

Along with improved physiological health outcomes, HRV was used in the study and treatment of mental health. Below is a review of a small sample of the empirical data on the relationship between HRV functionality on measure of psychological health and executive function. The following is a sample of such studies, which were reviewed in detail in Chapter Two and are summarized in Table 5.2 below.

Table 5.2

Summary of a Sample of HRV Physiological Studies

Authors	Significant Outcome(s)
Katsamanis Karavidas et al. (2007)	Improved depressive symptoms and cardiac function
Kemp et al. (2010)	Observed association between HRV, antidepressant medication and depression
Pop-Jordanova (2009)	Improvements in clinical mental health diagnoses such as conduct disorder and anxiety
Miu et al. (2009)	Trait anxiety
Thayer et al. (2009)	Observed relationship among HRV, the autonomic nervous system (ANS) and neural structures associated with cognition

Authors	Significant Outcome(s)
Albinet et al. (2010)	Observed relationship between executive function and HRV among elderly participants
Luque-Casado et al. (2013)	Observed relationship between HRV, fitness levels and cognitive processing, in particular sustained attention

Note. Summary of a sample of psychological outcomes associated with improved HRV.

To summarize, HRV has been associated with a number of psychological outcomes that also support an interaction between HRV and related ability to regulate emotions, executive functions and cognitive performance. The literature review detailed in Chapter Two highlighted the benefits of HRV regulation in the following psychological outcomes: depression, pediatric mental health, anxiety, autonomic nervous system function, executive function, cognitive performance, and sustained attention

Educational Outcomes Summary

HRV self-regulation has been studied in a number of educational settings. The following is a sample of such studies, which were reviewed in detail in Chapter Two and are summarized in Table 5.3 below.

Table 5.3

Summary of a Sample of HRV and Education Studies

Authors	Significant Outcome(s)
Bradley et al. (2007)	Improved psychophysiological, academic, and social measures in a sample of 10^{th} graders.
Connolly (2009)	Improvements in measures of emotional problems and a significant improvement in relating to peers in a sample of primary and post-primary students.

Authors	Significant Outcome(s)
Bradley et al. (2012)	Improved psychosocial development in four developmental categories (physical, cognitive, social/emotional and language development) in a sample of preschool aged children.
May et al. (2019)	Improvement on measures of school burnout and improved mathematical performance in a sample of college students.

Note. Summary of a sample of educational outcomes associated with improved HRV.

This brief review of HRV in education has indicated that improvements in HRV self-regulation has demonstrated efficacy in the following outcomes: test anxiety, emotional disposition, engagement, bonding, humor, persistence, empathetic listening and understanding, emotional problems, conduct problems, hyperactivity, relating to peers, physical, development (cognitive, social/emotional and language), school burnout, school performance, cardiac health and psychophysiological functioning.

Organizational Outcomes Summary

Similar to previous psychophysiological health and educational findings, improvements in one's ability to regulate HRV has been associated with a number of health and performance outcomes in organizations. The following is a sample of such studies, which were reviewed in detail in Chapter Two and Appendix C and are summarized in Table 5.4 below.

Table 5.4

Summary of a Sample of HRV and Organizational Studies

Authors	Significant Outcome(s)
Trousselard et al. (2014)	Improved ability to mitigate harmful stress, improved wellbeing and sleep quality in a sample of laboratory workers undergoing an organizational restructuring. The highest results were observed among participants with higher levels of trait anxiety.

Authors	Significant Outcome(s)
McCraty et al. (2003)	Improved systolic blood pressure, improved emotional health, decreased stress, depression and psychological distress and increased peacefulness, positive outlook, workplace satisfaction and value of contribution in a sample of employees with hypertension.
Barrios-Choplin et al. (1997)	Decreased tension and anxiety, and improved autonomic nervous system functioning in a sample of telecommunications employees.

Note. Summary of a sample of organizational outcomes associated with improved HRV.

This brief review of HRV in organizations has indicated that improvements in HRV self-regulation has demonstrated efficacy in the following outcomes: stress, wellbeing, sleep quality, systolic blood pressure, depression, psychological distress, hypertension, anxiety, autonomic nervous system functioning, peacefulness, positive outlook, workplace satisfaction, and value of contribution.

Research Question 3 (RQ3)

Once RQ1 identified the research domains associated with HRV self-regulation and RQ2 reviewed the empirical evidence associated with HRV self-regulation, RQ3 sought to identify conceptual (and/or theoretical) frames associated with HRV interventions in the workplace. RQ3 asked: *What are the key conceptual and/or theoretical frames underlying the espoused benefits of the HRV intervention?*

Chapter Two introduced the Institute of HeartMath®, a research organization with a leading HRV training intervention, which is provided to both individuals, and organizations. Founded in 1991, the Institute of HeartMath® has produced over 300 independent peer reviewed studies investigating stress, health and performance. Their HRV training intervention for organizations is called The Resilience Advantage™, which teaches participants the science HRV

and how to self-regulate emotions while building cardiac coherence. This specific intervention has evidence to support several biopsychosocial outcomes for employees and improvements for organizations. Marketing materials promoting The Resilience Advantage™ contained a number of espoused benefits, such as improved work relationships, focus, problem solving and interpersonal relationships, increased vitality and resilience and decreased stress, worry and fatigue (HeartMath®, 2018).

To measure outcomes for organizations who use The Resilience Advantage™ training intervention, HeartMath® offers an assessment, the personal and organizational quality assessment (POQA-R4). In order to identify the conceptual and/or theoretical frames supporting the HRV training intervention, the POQA-R4 measurements were included in the assessment of supporting constructs because the instrument includes scales assessing the outcomes of the intervention. The POQA-R4 includes the following scales:

1. emotional vitality (emotional buoyancy, emotional contentment);
2. organizational Stress (pressures of life, relational tension, intention to quit);
3. emotional stress scale: anxiety/depression, anger/resentment;
4. physical stress (fatigue, health symptoms);
5. intention to quit (subscale).

To map the relationship among these variables, the POQA-R4 provided a diagram that illustrates the effects of organizational stress as well as the effects of the HeartMath® intervention. The diagram starts with the effects of organizational stress, which initiates a feedback loop where organizational stress influences emotions by inducing negative affect, while decreasing positive emotions. This stress response then decreases health, well-being, job involvement and performance. The outcomes associated with the HeartMath® training

intervention shows another feedback loop where the training intervention introduces stress management tools that induce positive emotions while decreasing negative emotions. These emotional responses then increase health, well-being, job involvement and performance. Finally, these improvements initiate a feedback loop were original organizational stress levels are decreased (Institute of HeartMath®, 2009).

Upon review of the academic and marketing materials associated with HRV training it was challenging to identify clear conceptual frames. As explained by Rocco and Plakhotnik (2009) clear conceptual frameworks are important when conducting research as they ground the research in applicable knowledge bases. A thematic analysis (Braun & Clarke, 2006) was conducted to consolidate the concepts located in the POQA-R4 assessment tool with the espoused benefits from a number of HeartMath® academic and marketing materials. As a result, the following themes were constructed (and originally appear in Chapter Two):

1. *Improve emotional self-regulation:* Emotional self-regulation is the foundational skillset and benefit associated with The Resilience Advantage™ training intervention. Specific claims indicate that these tools are highly practical for a range of participants and generate increases in ability to self-manage and self-regulate.
2. *Decrease stress:* A strong focus on decreases in both physiological and psychological stress indicate that participants should see improvements in overall health and emotional wellbeing.
3. *Increase resilience:* Improvements in personal stability, increased positive emotions, creativity, insight, fulfillment, and personal effectiveness, all point to the benefits associated with the broader claim of improved resilience.

4. *Improve organizational outcomes:* Decreased stress, improvements in self-regulation capacity and improved resilience at the individual level lead to improvements at the team and organizational level. Specific benefits include: improved communication, cooperation, ability to reach group objectives, innovative problem solving, employee satisfaction and health outcomes, which all lead to measurable social and financial benefits to the organization.

Next, the themes generated from the thematic analysis were integrated with those from the POQA-R4. This produced the key conceptual frames for this analysis and provided a concise response to RQ3. The key conceptual frames underlying the espoused benefits of the HRV intervention include: (a) stress, (b) organizational stress, (c) resilience, and (d) emotional self-regulation. Finally, a literature review of the conceptual frames associated with this inquiry was conducted in Chapter Two. Additionally, a critical analysis was also conducted and directly informs the outcomes of RQ4. Below is a brief summary of the literature review of the four conceptual frames.

Conceptual Frames Summary

Organized chronologically, the literature review of stress started with the origins of the construct, which were informed by physical mechanics. Focusing his work on the *inner world*, Bernard (1878), mapped the impact of stress on the body and homeostasis or an organism's attempts to remain at steady state during stressful events (Cannon, 1929). Next, the general adaption syndrome and Selye's (1950) work catalogued three primary processes associated with the stress response: alarm, resistance and exhaustion. Noting the broad nature of the general adaption syndrome, which did not account for individual variations to stress responses, Mason (1972) introduced the concept of response specificity, which highlighted a wider range of ways

that individuals responds to stress and the influence of social themes (Holmes & Rahe, 1967). The term *allostasis,* introduced by McEwen (2005), referenced the outcomes associated with chronic attempts to mitigate the stress response leading to a state of being "stressed out" or allostatic load. Next, the role of heart-brain communication was integrated into the review of stress by introducing the intrinsic cardiac nervous system, which highlighted the role emotions play in bi-directional communication between the heart and the brain as well as the stress response. The transactional theory of stress and coping introduced by Lazarus and Cohen (1977) oriented the study of stress as a complex interaction between the person and environment. The transactional theory of stress and coping was the most comprehensive model of stress in this review. It was noted that additional research on stress should focus on the role of emotions and subsequent biological, neurological, psychological, environmental and social outcomes.

The literature review of organizational stress highlighted the predictive and explanatory capabilities of the study of stress in organizations. Several models of organizational stress were offered in an effort to identify predictive variables. For example, the person-environment fit model (French et al., 2008) identified the interaction of personal attributes, work environment and health outcomes in organizational stress, while the job characteristics model (Hackman & Oldham, 1976) identified psychological, job characteristics and personal attributes as key variables associated with job motivation and an individual's ability to respond to organizational stress. Warr (1987) used a vitamin analogy (not too much, not too little) when they proposed the vitamin model to explain the non-linear relationship of workplace environmental variables on health. The Michigan model (French & Kahn, 1962) focused on environmental factors as predictors of worker stress's and employee health, along with the person-environment fit (P-E fit) model (French et al., 2008) which recognized the interaction of the individual's appraisal and

environment on behavioral and health outcomes. Job decision latitude emphasized control as a variable in the demand control support model (Karasek, 1979). Cox and Griffiths (1995) identified psychological stress and physiological injury in the workplace as key variables in the study of organizational stress. The effort-reward imbalance model (Siegrist, 1996) described how stressful work events occurred when there were an exchange between a number of "high cost" and "low gain" conditions. The demand skill support model (van Veldhoven et al., 2005) concluded that physical demands, time demands, skill utilization, and quality of social relationships were the key variables in the study of worker health. The demand induced strain compensation model was a result of De Jonge and Dormann (2003) combining several models that included a range of demands and resources, which they concluded are predictors of health outcomes and employee growth. The job demand resources model (Demerouti et al., 2001) positioned job demands and job resources as variables associated with organizational commitment, burnout and resulting illness. The review in Chapter Two identified the DRIVE (demands resources and individual effects) model (Mark & Smith, 2008) as the most comprehensive model for organizational stress. The DRIVE model was offered as a balance between the complexity of previous models while integrating individual factors into the conceptualization of stress in the workplace. Finally, research on stress and the physiology of the heart was offered to illustrate to costs associated with stress in the workplace. It was noted that there is evidence to suggest that organizational stress can lead to costs to both the individual and the organization, while improvements in physiological and psychological health can be recognized with improved HRV regulation. In summary, organizational stress remains a multifaceted and evolving area of study with recommendations for future inquiry to focus on identifying key predictive variables that may support workplace interventions.

Similar to the review of stress and organizational stress, the study of resilience was characterized as dynamic, evolving and complex. Informed by Richardson's (2002) wave of inquiry framework, the study of resilience began by identifying resilience qualities, followed by positioning the construct as a process and finally evolved to include theory building to support optimal interventions to support enhanced resilience capacity. Chapter Two identified several definitions of resilience, which highlighted the complex nature of the construct (Bonanno, 2004; Fletcher & Sarkar, 2013; Rutter, 1985, 1999; Tugade & Fredrickson, 2004; Tusaie & Dyer, 2004). The psychophysiological nature of stress and coping positioned the study of resilience in relation to health, disease and vulnerability and rooted in the mind-body interplay (Jackson et al., 2007; Tusaie & Dyer, 2004). As with stress and organizational stress research on the physiology of the heart was integrated into the review of resilience (McCraty, 2015). This illustrated that supporting coherence (physiological, psychological, and social) is strongly associated with improved resilience, which allows individuals (and groups) to actively regulate and improve performance in the four resilience domains (physical, emotional, mental, and spiritual; McCraty, 2015). Chapter Two identified the metatheory of resilience and resiliency Richardson (2002) as the most compressive model of resilience in this review. The theory was supported by a balance of physiological, mental, and spiritual variables (biopsychospiritual) which can lead to the development of resilience. Similar to the review of stress and organizational stress, resilience is also an evolving, complex and dynamic construct. Additional research was recommended in order to support both theory building and optimal applied interventions in support of building resilience capacity.

Emotional self-regulation was the fourth and final construct reviewed. They study of emotional self-regulation was positioned as an adaptive process, where one learns the process of

adjusting response tendencies in an effort to reach goals (Gross, 1998). The ability to self-regulate emotions was argued to be one of the most valuable skills one can develop (Robinson et al., 2006). Emotion regulation is a processes involved in mitigating emotional and subsequent behavioral, biological and psychological responses in the complex transaction between the individual and their environment (Thompson, 1994). The review also integrated a biological perspective which illustrated the role of the heart, autonomic nervous system, intrinsic cardiac nervous system (particularly the vagus nerves) which all influence HRV, where optimal HRV was associated with enhanced emotion regulation and subsequent emotional, physiological, psychological and community outcomes (Baumeister et al., 2006; McCraty, 2015). The review of emotional self-regulation theory identified a number of key variables including: emotional appraisal, personality, social, and contextual influences which inform the process of emotional self-regulation and subsequent cognitive and behavioral outcomes. The review in Chapter Two identified the process model of emotion regulation (Gross, 2008) as the most comprehensive model. This model positions emotion regulation as a means to goal attainment where individuals are motivated to seek pleasure and avoid pain. The model includes five opportunities to regulate emotions to support efforts at goal attainment: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Again, the study of emotion regulation is complex and evolving and this growing area of inquiry is supported by a need for identifying protective factors and effective interventions.

To summarize, RQ3 sought to identify the conceptual frames associated with HRV self-regulation in organizations. Despite strong evidence supporting biopsychosocial outcomes for employees and organizations, the conceptual frames for HRV self-regulation interventions were challenging to identify. To do so, a number of methods were employed, which identified stress,

organizational stress, resilience and emotional self-regulation as the primary constructs informing the intervention. Subsequently, a literature review of each of the four constructs was produced and summarized above.

Research Question 4 (RQ4)

Once the conceptual frames associated with HRV self-regulation in organizations were identified and reviewed, research question 4 drove the next steps in the analysis. Research question 4 (RQ4) focused on theory building and contributions to HRD: *How do these conceptual frames inform HRV self-regulation theory building and contribute to the field of HRD?*

First, in order to address RQ4, the primary conceptual frames were identified and reviewed. Next, the most comprehensive theory/model associated with each construct were also identified and critically analyzed. These constructs and theories are as follows (see Table 2.1): stress (transactional theory of stress & coping; Folkman et al., 1986), organizational stress (DRIVE model; Mark & Smith, 2008), resilience (metatheory of resilience & resiliency; Richardson, 2002), and emotional self-regulation (process model of emotion regulation; Gross, 2014).

Once the constructs and theories were identified and reviewed, the critical analysis sought to successfully map the relationships (Rocco & Plakhotnik, 2009) among the concepts and associated specific variables (see Table 2.2). Once the constructs, theories and variables were mapped, a thematic analysis (Braun & Clarke, 2006) was conducted and the following themes were constructed to represent the relationships of the four constructs and their corresponding models and variables (which originally appears in Chapter Two):

1. *Resources:* The following variables highlight key themes associated with the stress response, organizational health, resilience and emotion regulation and include social, environmental and intrapersonal themes. Specifically, the presence of social support including interpersonal trust, social functioning and social coping are mitigating factors included in social resources. Environmental factors include time demands and decision authority in the work context. Intrapersonal resources include coping style, advice seeking behaviors, and skill discretion.
2. *Attributes:* Include both physiological and psychological protective and mediating factors. Physiological factors include efforts of the individual to maintain in a state of homeostasis during a stress response, which can be informed by several protective factors leading to corresponding outcomes including homeostasis, physiological balance, somatic changes and resulting health/illness. Psychological factors include mental balance, affect, motivation, and cognitive appraisal including self-blame, wishful thinking. This emotion focused coping strategies can lead to changes in motivation levels, cognitive change, and changes in psychological protective factors.
3. *Perception:* How an individual assesses their interactions, the environment and available resources affects their perception and subsequent stress response, resilience levels, and efforts to regulation emotion. Primary appraisal of the stakes associated with the encounter and subsequent secondary appraisal of coping options are informed by several variables including: existential beliefs, perceived job stress, psychological relevance, quality of the encounter, and attributional/explanatory styles.
4. *Responses:* Responses to stress and subsequent resilience levels and emotion relegation are informed by a mediating process highlighted by intrinsic and extrinsic effort.

Perceptions of available internal and external resources support a feedback loop which impacts initial and subsequent mediating processes, intrinsic effort, extrinsic effort, situation selection, situation modification, and/or efforts targeting escape/avoidance.

5. *Outcomes:* The degree to which one can successfully mitigate stress informs their future resilience, efforts at emotion regulation and changes to environmental and social variables. Specific outcomes can include: attentional deployment (or shifting focus to or from emotional stimuli), reintegration, response modulation, affective suppression, altered initial situation, altered environment, destructive behaviors, increased or decreased protective factors, psychological well-being (anxiety and depression), rewards, improved resilience/growth, job satisfaction, changes to response tendencies and appraisal.

These themes and descriptions represent the intersection of the key constructs associated with this research. Informed by Rocco and Plakhotnik (2009) who argued that in the absence of existing theory, it is important to identify main ideas and map the relationships among constructs (and corresponding variables). This process supported the study's research questions (and problem statement) by providing a framework for identifying applicable areas of knowledge. As a result, the themes above represent the intersections of the constructs informing this inquiry: stress, organizational stress, resilience, and emotional self-regulation.

The act of applying the steps of theory building (Swanson & Chermack, 2013) to this inquiry brings clarity to the ambiguous nature of HRV self-regulation in the workplace. The act of conceptualizing the theoretical and conceptual frames associated with the current study provided an opportunity to shift the theorizing process from conceptualization to operationalization and ultimately engage in the iterative process of continued application,

confirmation and refinement. These steps of theory building (Swanson & Chermack, 2013) support RQ5 which was aligned with the operationalize and confirm phases of theory building and is characterized by designing, implementing and evaluating the research so the outcomes may be transitioned from theory to practice with observable and verifiable components. As such, additional conclusions about theory building and implications for HRD will be offered in subsequent sections.

Research Question 5 (RQ5)

In addition to identifying the HRV self-regulation research domains, summarizing empirical evidence, applying methods of theory building and related application to HRD, this study investigated how a HRV self-regulation training intervention affects employee physiological and psychological health and organizational outcomes. Measurements of personal and organizational quality (POQA-R4) were used to measure this effect, while the following research question and hypotheses were included to assess these effects:

- *Research Question 5 (RQ5):* For employees in a large (over 200 employees) for-profit organization, what effect, if any, does the use of a HRV self-regulation training intervention have on physical health, psychological health and organizational outcomes, as compared to a control group?
    - *Research Hypothesis 5a*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional vitality will be higher than that of the control group.
        - *Research Hypothesis 5b*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention Organizational Stress will be lower than that of the control group.

- *Research Hypothesis 5c*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention emotional stress will be lower than that of the control group.
- *Research Hypothesis 5d*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention physical stress will be lower than that of the control group.
- *Research Hypothesis 5e*: In a controlled study of large organizations (over 200 employees), the experimental group's post intervention intent to quit will be lower than that of the control group.

To *operationalize* and *confirm* (Swanson & Chermack, 2013) RQ5, a quantitative, between-groups, experimental research design was employed to test the effects of a HRV self-regulation training on active participants and non-participants (wait-list control) on psychological and physiological health and organizational outcomes by analyzing results of the POQA-R4 survey (see details in Chapter Three). The study population consisted of employees at a large, multi-national, independent public company in the multi-utilities industry. The total sample for the study consisted of 147 employees and data collection was conducted in two phases. Once recruited, participants were randomly assignment to either an active intervention or a wait-list control group (for both *Phases 1* and *2*). Once assigned to the active or wait-list control groups, participants were randomly assigned to one of two sections of the training intervention for each group (for both *Phases 1* and 2). Once assigned to groups, participants were asked to complete the POQA-R4 pre and post testing (by phase) for all research participants. Baseline survey data was collected before the training interventions were administered on all participants (active and control), and again for all participants (active and control) upon completion of the active

participants' intervention. These procedures were conducted twice, once for *Phase 1* and once for P*hase 2*. The training intervention was The Resilience Advantage™ (RA) and was administered by a certified HeartMath® trainer. The workshops consisted of four, weekly, virtual workshops with corresponding emails, points of contact, and suggestions for practice.

Once both phases of data collection were complete, data for both active and control groups for both phases were combined to establish a total active and control group data set (N = 147). A multivariate analysis of variance (MANOVA) was conducted in order to determine if means of the two independent, categorical groups (active, wait-list control) associated with this inquiry differed on the five outcome variables (French et al., 2008). Data analyses concluded that three of this study's five hypotheses were upheld. Hypotheses related to *emotional vitality* (borderline moderate effect size), *emotional stress* (moderate effect size) and *physical stress* (moderate effect size) were upheld. Hypotheses related to *organizational stress* and *intention to quit* were not upheld. What follows is a discussion related to the three hypotheses whose relationships were upheld and how this relates to existing research. Additionally, a discussion related to the two variables whose hypotheses were not upheld and how this relates to previous literature and the critical analyses conducted by this inquiry is provided. This analysis is organized by research question and corresponding hypotheses.

Research Question 5 (RQ5)

The focus of RQ5 was to investigate how a HRV self-regulation training intervention affects employee physiological and psychological health and organizational outcomes. Three of the research hypotheses were upheld, while two of the hypotheses were not. Hypotheses related to *organizational stress* and *intention to quit* were not upheld. The nonsignificant results are partially consistent with previous analyses that indicate challenges with construct validity as it

relates to HRV interventions in the workplace. Results also indicated that three of the five hypotheses associated with RQ5 were upheld. Specifically, data suggested a significant decrease in measures of physiological stress and psychological stress and a significant increase in measure of emotional vitality for active participants who participated in the HRV training intervention versus control participants. These outcomes support previous literature (Dekker et al., 1997; McCraty, 2015), which suggested that the emotional and physiological systems of the body are interconnected, and influence a range of physiological and psychological health outcomes.

Specifically, HRV self-regulation is rooted in awareness and skill building related to participants' ability to self-regulate emotions and HRV while improving biopsychosocial outcomes (Dekker et al., 1997; McCraty, 2015). From a psychophysiological perspective, HRV regulation relies on balancing the cognitive, emotional and physiological systems. Specifically, this ability to self-regulate is strongly associated with the intrinsic cardiac nervous system, which includes the heart's ability to send afferent (upward) neural signals to the brain's subcortical (emotional) and cortical (cognitive) systems. This ascending information from the heart to the brain is transmitted by the heart's rhythms (HRV) via the autonomic nervous system. These HRV patterns are influenced by one's emotional states, where regenerative emotions help to facilitate coherent HRV patterns and depleting emotions facilitate incoherent HRV patterns. Both incoherent and incoherent HRV patterns influence the information sent from the limbic (emotional/behavioral) system of the brain to the cortex (cognitive) region of the brain. The cortex is associated with executive function and emotional self-regulation, which are both relevant to successful functioning for the employee and, in turn, the organization.

The current study outcomes related emotional stress, physical stress and emotional vitality in RQ5 are consistent with the literature. The outcomes related to organizational

variables are more ambiguous. The nonsignificant results are consistent with previous analyses that indicate challenges with construct validity as it relates to HRV interventions in the workplace. Next, the analyses of the individual hypotheses associated with RQ5 further explores where the findings are supported by previous literature and where there is ambiguity which may support additional opportunities for inquiry.

Research Hypothesis 5a: Higher Emotional Vitality with HRV Intervention

The results indicated that the experimental group had a higher level of emotional vitality, when compared to the control group, with a borderline moderate effect size, which supports Hypothesis 5a. Chapter Two reviewed evidence suggesting that improved HRV self-regulation would positively influence psychological health outcomes. The empirical studies (Albinet et al., 2010; Katsamanis Karavidas et al., 2007; Kemp et al., 2010; Luque-Casado et al., 2013; Miu et al., 2009; Pop-Jordanova, 2009; Thayer et al., 2009) indicated that improved HRV self-regulation was associated with improvements in the following psychological health outcomes: depression, pediatric mental health, anxiety, autonomic nervous system function, executive function, cognitive performance, and sustained attention. Note that mental health outcomes associated with improved HRV self-regulation generally decreased mental health conditions such as anxiety and depression, while increasing positive outcomes associated with pre-frontal cortex functioning such as executive function, cognitive performance, and sustained attention.

The primary and subscales of *emotional vitality* scale in the POQA-R4 included: "Wholehearted positive emotional energy that enriches life experience and enhances health and well-being. Subscales include (a) Emotional Buoyancy: emotional energy available for work and personal life, and (b) Emotional Contentment: feeling of contentment and inner peace" (Barrios-Choplin & Atkinson, 2004, pp. 5, 7). It is notable that the correlational analysis in Chapter Four

found that the *emotional stress* and *emotional vitality* pair correlate at –0.66. This outcome may suggest that these two scales (*emotional stress* and *emotional vitality)* are strongly related constructs and may mirror each other. This is consistent with the literature review that indicated that improved HRV decreases a number of maladaptive mental health outcomes with less research supporting improvements in variables associated with the *emotional vitality scale.* This observation may indicate an opportunity for additional research especially as it relates to HRV self-regulation and *emotional vitality,* which could focus on variables such as emotional energy and feelings of contentment. This may lead to improved construct validity while supporting optimal interventions.

Research Hypothesis 5b: No Significant Difference in Organizational Stress with HRV Intervention

Data analyses conducted in Chapter Four showed that there was not a significant difference between the active and control groups on measures of organizational stress and as a result, Research Hypothesis 5b was not upheld. The empirical studies (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014) of for-profit organizations indicated that improved HRV self-regulation was associated with improvements in the following: mental health (psychological distress, anxiety, depression, wellbeing, peacefulness, positive outlook), physical health (stress, sleep quality, systolic blood pressure, hypertension, autonomic nervous system functioning), and organizational outcomes (workplace satisfaction and value of contribution). The primary and subscales of *organizational stress* in the POQA-R4 included:

> Organizational impediments and relational discord that impair work performance, reduce job satisfaction, and increase employee turnover. Subscales include, (a) Pressures of Life: feeling overwhelmed by work pressures and the demands of life; (b) Relational Tension: stressed by relational disaffection and coworker conflict. (Barrios-Choplin & Atkinson, 2004, pp. 5, 7)

While there was no observed statistical difference between the active and control group for this scale, the median value for participant *organizational stress* was neutral to somewhat low stress for both the active and control groups. This observation may indicate that low organizational stress was a relatively stable quality of the organization.

The observations in this study where physical stress and emotional stress scales were significantly lower for the active group versus the control group, and organizational stress was not significant prompts additional inquiry into why some variables associated with mental and physical health did significantly improve while organizational stress did not despite previous empirical evidence.

To further investigate these outcomes, data from the analysis (see Table C.1 for a summary) of other research designs which investigated the use of HRV self-regulation trainings in organizations were analyzed. Study 1 was a non-experimental design investigating the use of HRV training on psychological (anxiety, perceived stress, wellbeing, and sleep), endocrine (cortisol, salivary alpha-amylase—a digestive enzyme associated with mental stress), and physiological (sleep, HRV) outcomes were assessed. The organization was a research laboratory with 160 employees with a study population of nine male employees (Trousselard et al., 2014). Study 2 investigated the impact of an organizational stress reduction (HRV training) intervention on measures of blood pressure, emotional health and work-related outcomes in a sample of hypertensive employees (McCraty et al., 2003). A randomized, wait-list control trial consisted of 36 participants, both male and female, at a global information technology company who were diagnosed with hypertension by their physicians. Study 3 investigated how one's perceptions, reactions to stress, and how stress is communicated relates to activation of the stress response. Stress was measured by psychological assessments, blood pressure, and electrocardiogram

(ECG) was used to assess HRV. Subjects included three levels of employees (n = 48) at Motorola (a telecommunications company) using a HRV training intervention as the independent variable (Barrios-Choplin et al., 1997).

Results for each of the three studies (see Table C.1) illustrates where the outcome variables among studies intersect. Specifically, Study 1 did not observe any changes in HRV post intervention while study 3 did observe improvements in some HRV variables. Additionally, study 3 reported large changes to both systolic and diastolic blood pressure while study 2 only observed significant improvements in systolic blood pressure.

Psychological data indicated that improvements in perceived stress/stress symptoms were observed by study 1 and study 2 while physical wellbeing in study 1 and physical stress were observed in study 3. Additionally, workplace satisfaction data observed in study 2 aligned with job satisfaction improvements observed by study 3.

The analysis of these three studies illustrates that each of the research designs had different ways of contextualizing organizational stress, participant selection criteria, different measurement criteria and different outcomes. While the studies were operationalized in different ways the empirical literature review did indicate that HRV self-regulation in organizations has produced significant outcomes in several mental health (psychological distress, anxiety, depression, wellbeing, peacefulness, positive outlook,), physical health (stress, sleep quality, systolic blood pressure, hypertension, autonomic nervous system functioning), and organizational outcomes (workplace satisfaction and value of contribution). While the current study did observe significant outcomes related to physical and mental health, data did not support hypothesis 5b which measured organizational stress.

These findings do align with research that points to ambiguity related to conceptualization, measurement, and outcomes associated with *organizational stress* in this inquiry (and others) as explained in the review of the conceptual frames, specifically *organizational stress*. The critical analysis in Chapter Two identified the demands, resources, and individual effects model (DRIVE; Mark, 2008) of organizational stress as the most comprehensive model in the review. Predictive variables which informed the model included job stress, job demands, social support, decision authority, skill discretion, extrinsic effort, intrinsic effort, rewards, 40 coping behaviors including categories for problem focused coping, seeking advice, self-blame, wishful thinking, and escape/avoidance, attributional/explanatory styles, and demographic variables of age and gender. Job stress was measured as anxiety, depression, and job satisfaction.

When the DRIVE model is compared to the *organizational stress* scale of the POQA-R4 as well as measurement variables and outcomes associated with previous organizational stress studies, a range of measurements and inconsistent outcomes are observed. This points to a need for stronger conceptualization and measurement of organizational stress which may support more consistent research designs and a stronger ability to compare outcomes across studies. This observation also points to the need for continued efforts at theory building of HRV interventions in the workplace.

Research Hypothesis 5c: Lower Emotional Stress with HRV Intervention

The results indicate that the experimental group had a lower level of emotional stress with a moderate effect size, when compared to the control group, which supports Hypothesis 5c. The empirical studies (Albinet et al., 2010; Katsamanis Karavidas et al., 2007; Kemp et al., 2010; Luque-Casado et al., 2013; Miu et al., 2009; Pop-Jordanova, 2009; Thayer et al., 2009)

reviewed in Chapter Two included evidence suggesting that improved HRV self-regulation would positively influence psychological health outcomes. The data indicated that improved HRV self-regulation was associated with improvements in the following psychological health outcomes: depression, pediatric mental health, anxiety, autonomic nervous system function, executive function, cognitive performance, and sustained attention.

The primary and subscales of the *emotional stress* scale in the POQA-R4 included: "emotional discord that reduces the quality-of-life experience and jeopardizes health and well-being. Subscales include, (a) anxiety/Depression: feelings of anxiety, unhappiness, sadness, and/or depression, and (b) Anger/Resentment: feelings of anger and resentment and difficulty in emotional control" (Barrios-Choplin & Atkinson, 2004, pp. 5, 7), which closely aligns with empirical findings. The moderate effect size observed in the data analysis of this inquiry aligns with previous empirical data indicating improved emotional stress/psychological health outcomes are associated with HRV self-regulation.

Research Hypothesis 5d: Lower Physical Stress with HRV Intervention

The results indicate that the experimental group had a lower level of physical stress with a moderate effect size, when compared to the control group, which supports Hypothesis 5d. The analysis conducted in Chapter Two, which reviewed empirical studies (Buccelletti et al., 2009; Godfrey et al., 2018; Katsamanis Karavidas et al., 2011; Lehrer et al., 2003; Lehrer et al., 2004; Luskin et al., 2002; McCraty, 2015; McCraty et al., 1998; McCraty et al., 2000) related to HRV self-regulation, provided evidence that improved HRV self-regulation would positively influence physiological health outcomes. The empirical literature review in Chapter Two summarized that improved HRV self-regulation was associated with the following physiological health outcomes: assessment of cardiac risk, hypertension, sensorimotor rhythm, DHEA, cortisol, cholesterol,

blood pressure, triglycerides, pulmonary function, baroreflex gains, MUPS, CHF, glycemic measures, binge eating, and applied exercise physiology assessment and performance.

The primary and subscales of *physical stress* scale in the POQA-R4 included:

> Physical symptoms of fatigue and poor health that reflect the overall stress an employee is experiencing. (a) Fatigue: feelings of tiredness, fatigue, and physical exhaustion; and (b) Health Symptoms: physical tension, aches, and pain, stomach upset, rapid heartbeats, and headaches. (Barrios-Choplin & Atkinson, 2004, pp. 5, 7)

The empirical findings and the variables informing the *physical stress* scale were strongly associated. The moderate effect size observed in the data analysis of this inquiry aligns with previous empirical data indicating improved physiological health outcomes were associated with HRV self-regulation.

Research Hypothesis 5e: No Significant Difference in Intent to Quit with HRV Intervention

Data analyses conducted in Chapter Four showed that there was not a significant difference between the active and control groups on measures of intent to quit and as a result, Research Hypothesis 5e was not upheld. The subscale of *intent to quit* in the POQA-R4 included the following:

> High scores on this subscale should be a red flag to management, because they indicate an increased likelihood that a notable proportion of employees are feeling sufficiently dissatisfied with their work environment that they are thinking about leaving the organization (quitting their job). (Barrios-Choplin & Atkinson, 2004, 2009, pp. 5, 8)

The examination of the *intent to quit* histogram (see Figure 4.5) showed that this measurement has a strong right skew. Additionally, the total median values (2.0; 7-point Likert scale) for the active and control groups were assessed (see Table 4.1) and *intent to quit* was low post-intervention, which may indicate that employees were especially committed to the organization.

These finding are particularly notable given the sharp increases in employee resignations associated with the COVID-19 pandemic and the resulting "Great Resignation." Zhongming et

al. (2021) explained that Americans are resigning in never-before-seen rates, resulting in over 11 million job vacancies (which is larger than the 8.4 million unemployed Americans). Given these statistics, a higher outcome for *intent to quit* might have been expected, as this research was conducted during the COVID-19 pandemic. Similar to the findings for the *organizational stress* scale these outcomes may indicate that low intention to quit is a relatively stable condition of the organization's culture.

These observations may indicate that qualities of the organization serve as a meaningful protective factor for employees who are experiencing stress and that these protective qualities may serve as strong mediating factor to stress regardless of whether that stress originates inside or outside of the organization (as is the case with pandemic related stressors). When integrating concepts previously reviewed on coherence and in particular social coherence, these outcomes are supported. Coherence is characterized by optimal functioning of physical, mental and emotional subsystems and is associated with HRV levels (McCraty, 2015). Social coherence builds on these processes by including social interactions where individual coherence levels interact with and influence social systems. "Social coherence is reflected as a stable, harmonious alignment of relationships that allow for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action" (McCraty, 2015, p. 28). The concept of social coherence was supported by Neuroscientist Pribram and Sociologist Bradley who developed the general theory of social communication. This theory suggested that groups created a "field" of emotional energetics, which impacts all members regardless of the group characteristics (Bradley, 1987). Benefits to strong social coherence in organizations include improved organizational performance, teamwork and communication, while low social coherence results in maladaptive outcomes (McCraty, 2015). It was summarized that high

personal coherence helps to combat the damaging effects of stress while improving resilience at the individual level while also contributing to a stronger field environment or social coherence. A range of other protective factors at the individual and social levels may also influence resilience to stress. These processes may indicate that organizations with high levels of social coherence serve as strong protective factors or resource for individuals and teams experiencing stress.

The nonsignificant outcomes for *organizational stress* and *intention to quit* support a need for stronger conceptualization and measurement of organizational stress, which may lead to more consistent research designs and a stronger ability to compare outcomes across studies. It is recommended that assessments of the organization's culture, representing the complex interaction of the employee and their environment, be included in continued efforts at theory building of HRV interventions in the workplace, optimal research designs and outcomes for participants.

RQ5 Summary

The data associated with RQ5 supports the previously reviewed empirical data on HRV interventions in the workplace as it relates to physical and mental health. HRV reflects the complex and dynamic interactions of a number of psychophysiological systems where optimal performance is reflected in coherent HRV patterns and represents coherent functioning of the cognitive, emotional and physiological systems. These coherent or incoherent HRV patterns influence the information sent to the emotional/behavioral system of the brain to the cortex or cognitive region of the brain, resulting in cortical facilitation or cortical inhibition. Cortical facilitation is associated with executive function and emotional self-regulation, which are both essential skills for optimal functioning for the employee and, in turn, the organization.

Coherence is extended to the organizational level where individual coherence levels contribute to group or social coherence by supporting a field environment, where optimal field environments may serve as a protective factor for employees and the organization experiencing stress in the environment. These processes align with the transactional theory for stress and coping (Lazarus & Folkman, 1987), which illustrated that stress is influenced and mediated by the complex interaction between the individual and their environments.

These analyses demonstrate that the organizational variables (*organizational stress* and *intent to quit*) are more ambiguous to interpret than the psychophysiological variables. Additionally, the hypotheses that were upheld, lend further support to research which observed that improved HRV functioning leads to improved physical and mental health outcomes. Based on these findings, recommendations for future research, application, theory building and implications for HRD are discussed in the subsequent sections.

Implications for Theory

The conclusions drawn from each of the research questions can contribute to efforts at more robust theory building of HRV interventions in the workplace. RQ1 identified the primary domains associated with HRV, RQ 2 offered a brief review and summary of the empirical outcomes associated with HRV self-regulation, and RQ 3 sought to identify and integrate the primary constructs associated with HRV self-regulation. These analyses supported RQ4, which applied these findings to methods of theory building. This process found that the analyses associated with RQ1-4 aligned with *conceptualize phase* (Swanson & Chermack, 2013) of theory building. RQ5 investigated the use of an HRV self-regulation training on measures of personal and organizational quality (POQA-R4) and produced empirical data that were used to analyze where the previous literature was supported and where it was not. These analyses allowed for

continued theory building (Swanson & Chermack, 2013) as it relates to the *operationalize*, *apply, confirm* and *refine* phases. Specifically, RQ 5 sought to test the outcomes of the *operationalize phase* in the real world with measurable components in the context where the phenomena occurs. The data analyses and conclusions prompted the *apply* and *confirm phases* where the framework was applied in practice in order to confirm and disconfirm previous findings. All of these processes now position the analysis to proceed with the *refine phase* with a focus on evolving existing theory by integrating learnings from the real-world application and confirmation. These processes support the iterative process of continuous adaptation of theory-to-practice (Swanson & Chermack, 2013)

To continue this process, the outcomes of the conceptualize phase are included below for reference. To summarize, the primary conceptual frames related to HRV self-regulation interventions in the workplace (stress, organizational stress, resilience and emotional regulation) were first identified. Next, the most comprehensive model or theory associated with each of the conceptual frames were identified, next the variables informing each of the models were identified and consolidating via a thematic analysis. The thematic analysis produced the following themes: *resources, attributes, perception, responses* and *outcomes.*

These newly constructed themes and variables identified and mapped the main ideas and relationships among the constructs in the absence of existing theory. The following working model of HRV interventions in the workplace is offered (see Figure 5.1) to illustrate the integration of the conceptual frames and empirical outcomes. While the proposed model did not include every variable associated with the thematic analysis, it does highlight key attributes, which balance the conceptual frames, their associated models and empirical findings.

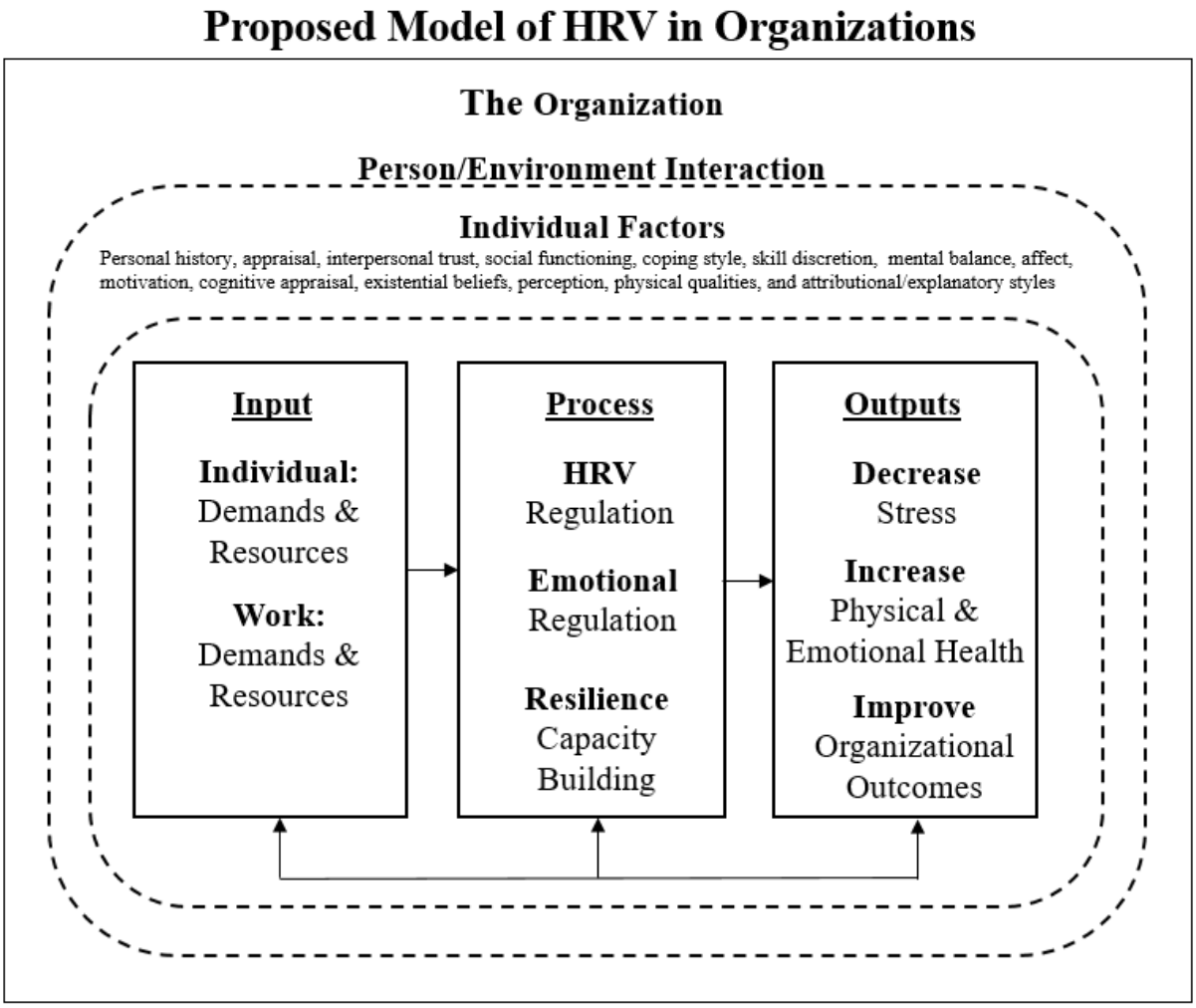

Figure 5.1

Proposed Model of HRV in Organizations

The top of the model situates the phenomenon within the organization as illustrated by the primary boundary. The next boundary shows the complex interaction between the individual and their environment as informed by the transactional theory for stress and coping (Lazarus & Folkman, 1987). Next, individual factors that emerged as a result of the review of the conceptual frames (particularly resilience and emotion regulation) were included to emphasize the individual qualities which may inform one's reaction to stress, their internal protective factors and perceptions and appraisals of external demands and resources. The next boundary integrates

the input, process, and outputs associated with the intervention. The inputs delineate key antecedent variables, deemed relevant from the review of organizational stress (DRIVE model; Mark & Smith, 2008) and denotes that a range of both individual and workplace demands and resources influence the stress response. Next, the process section displays that that the primary processes associated with HRV in the workplace include increasing HRV regulatory capacity along with resilience building capacity and emotional regulation. The output category emphasized the empirical evidence, which supported that improved HRV regulation leads to improved mental and physical health as well as organizational outcomes. Finally, drawing from the original HRV in the workplace model (located in the POQA-R4) as well as the critical analysis of the conceptual frames, a feedback loop shows that improved outcomes associated with improved HRV self-regulation will initiate a loop which informs subsequent inputs. These inputs (including individual and work demands and resources) influence subsequent processes including efforts at HRV self-regulation, emotional regulation and resulting resilience capacity.

The empirical findings associated with this inquiry (RQ5) inform subsequent efforts of theory *refinement.* The highlighted sections contained within the revised model below (see Figure 5.2) indicate where the empirical findings and resulting analyses do not align with expected outcomes. This process proves useful as it provides for specific opportunities for future refinement of the *conceptualize, operationalize, apply*, *confirm, and refine* phases of theory building, thus helping to secure the iterative process that supports optimal theory to practice.

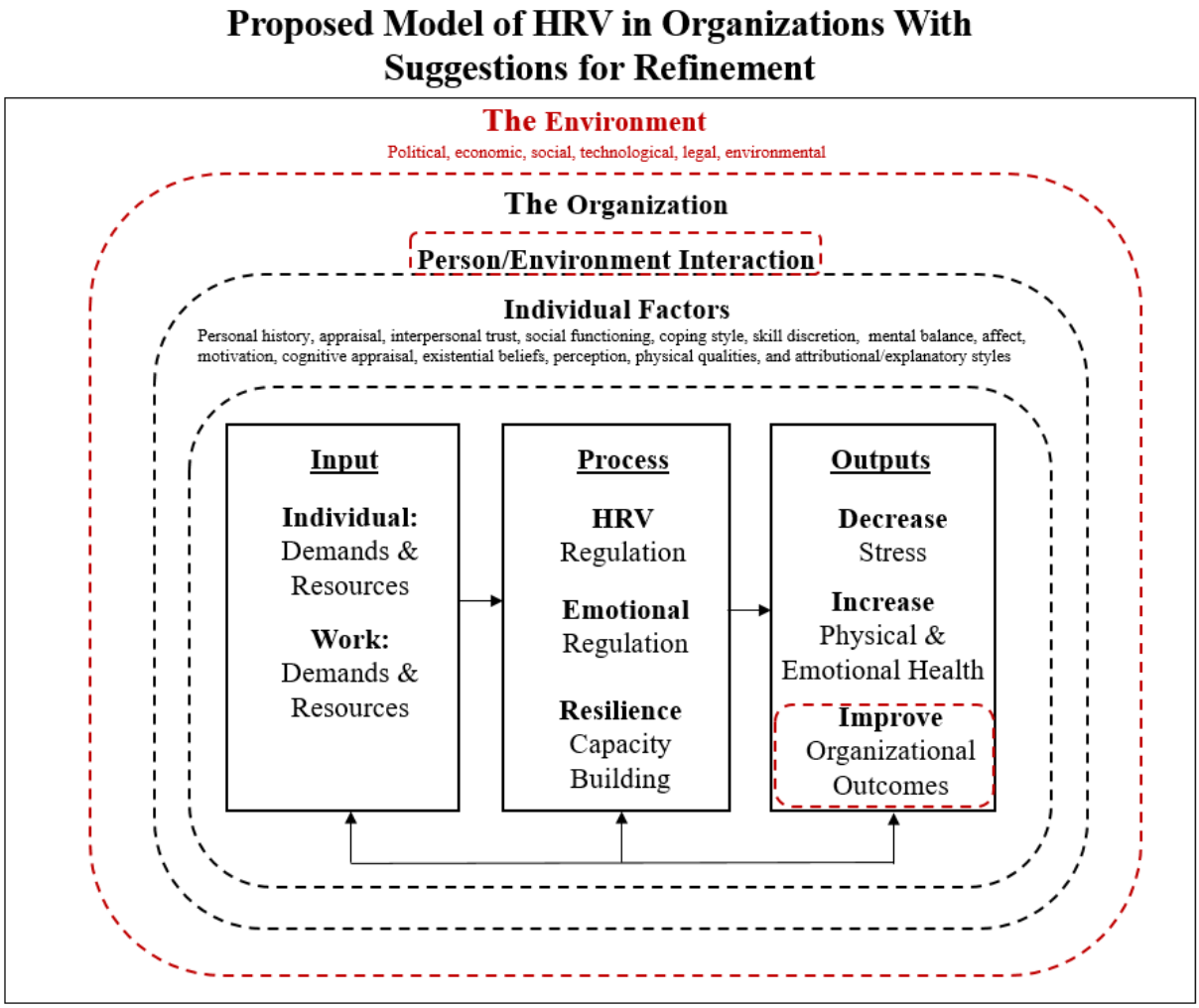

Figure 5.2

Proposed Model of HRV in Organizations With Suggestions for Refinement

Note. The areas with the red boundary indicate key areas for future research and theory refinement.

As noted in the review of assessment tools, the study and measurement of stress and resilience in the workplace is ambiguous and highly contextual (Center for Workplace Health Research and Evaluation, 2017; Hartmann et al., 2020; Yu et al., 2019). This may contribute to inconsistent results with measurements of outcome variables. When situated with the literature, this observation was confirmed by the empirical analysis of data associated with this inquiry. As reviewed in the analyses of RQ5, *intent to quit* and *organizational stress* did not produce

significant outcomes for research participants. These two variables represent the only organizational outcomes measured in RQ 5. Since the descriptive statistics measuring the total median values (active and control) for these variables found that responses were low, it was argued that the low measures of *organizational stress* and *intention to quit* may reflect enduring qualities of the organization's culture. The analysis further argued that social themes were important constructs to include in the measurement and assessment of organizational stress interventions.

Specifically, the transactional theory for stress and coping (Lazarus & Folkman, 1987) explained that stress is influenced and mediated by the complex interaction between the individual and their environments. The COVID-19 pandemic has illustrated how global disruption can influence a range of domains including political, economic, societal, technological, legal, and environmental (Nexis Newsdesk™, 2022) and that these disruptions are felt at the organizational level (Zhongming et al., 2021). Additionally, the review of social coherence explained that high personal coherence contributes to social coherence levels of the organization, thus contributing to a strong field environment, which may serve as a protective factor or resource for individuals and teams experiencing stress. This may also influence the measurement of organizational variables in the study of HRV in the workplace. As a result, key areas for theory refinement may include emphasizing social and environmental variables (as illustrated by the red boundaries) and further refinement of theory and measurement of organizational outcome variables (such as productivity, absenteeism and organizational dysfunction highlighted in red; Hassard et al., 2018) associated with HRV in the workplace.

These specific recommendations for *refining* theory also inform recommendations for future research. Specifically, the process of applying the steps of theory building to this research

has brought clarity to the phenomena of HRV in the workplace, which allowed the research to shift from conceptualization to operationalization and ultimately engage in the iterative process of continued application, confirmation and refinement. Next, suggestions for future research are offered to support more useful research designs, outcomes and to ultimately support optimal interventions anchored in sound recommendations for transitions of theory to practice.

Implications for Research

The analysis of the five research hypotheses show where the results of this study align or deviate from previous research. Hypothesis 5a indicated that the experimental group had higher levels of emotional vitality when compared to the control group. Hypothesis 5c observed lower levels of emotional stress in the experimental group as compared to the control group. These outcomes align with previous empirical research which suggested that improved HRV can lead to improved emotional vitality including improved executive functions, cognitive performance and sustained attention, while also decreasing maladaptive mental health outcomes such as depression and anxiety (Albinet et al., 2010; Katsamanis Karavidas et al., 2007; Kemp et al., 2010; Luque-Casado et al., 2013; Miu et al., 2009; Pop-Jordanova, 2009; Thayer et al., 2009). Similarly, organizational studies of HRV found that improved HRV self-regulation was associated with improved mental health outcomes such as wellbeing, depression, psychological distress, anxiety, and positive outlook (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014).

Hypothesis 5d observed lower levels of physical stress in the experimental group as compared to the control group. These outcomes align with previous empirical research (Buccelletti et al., 2009; Godfrey et al., 2018; Katsamanis Karavidas et al., 2011; Lehrer et al., 2003; Lehrer et al., 2004; Luskin et al., 2002; McCraty, 2015; McCraty et al., 1998; McCraty et

al., 2000) which suggested that improved HRV can lead to improved physiological health outcomes such as assessment of cardiac risk, hypertension, sensorimotor rhythm, DHEA, cortisol, cholesterol, blood pressure, triglycerides, pulmonary function, baroreflex gains, MUPS, CHF, glycemic measures, binge eating, and applied exercise physiology assessment and performance. Similarly, organizational studies (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014) of HRV found that improved HRV self-regulation was associated with improved physical health outcomes such as sleep quality, systolic blood pressure, hypertension, anxiety, autonomic nervous system functioning,

The data associated with hypotheses 5a, 5c, and 5d were supported by the review of the conceptual frames that highlighted psychophysiological mechanisms associated with HRV (Dekker et al., 1997; McCraty, 2015), where HRV regulation relies on balancing the cognitive, emotional and physiological systems which may lead to improved mental and physical health. The data associated with research hypotheses 5a, 5c and 5d add to the growing bodies of literature that suggest that improved HRV functioning is supported by psychophysiological mechanisms which may lead to improved mental and physical health outcomes.

Hypotheses 5b and 5e assessed organizational outcomes. Hypothesis 5b assessed organizational stress, while hypothesis 5e assessed participant intent to quit. Both of these hypotheses did not observe significant differences between the experimental and the control groups. The empirical studies (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014) of for-profit organizations indicated that improved HRV self-regulation was associated with improvements in workplace satisfaction, value of contribution, physical stress and emotional stress, which align with the organizational variables associated with these hypotheses. It is important to note that participant organizational stress and intent to quit were neutral to

somewhat low stress for both the active and control groups. This observation may indicate that low organizational stress and low intent to quit were relatively stable qualities of the organization.

These observations prompt additional inquiry into why some variables associated with organizational outcomes did not significantly improve despite previous empirical evidence. One of the primary findings of the review of the conceptual frames associated with this inquiry suggested that there may be substantial ambiguity related to conceptualization, measurement, and outcomes associated with HRV interventions in the workplace. This observation may partially explain the unanticipated outcomes associated with hypotheses 5b and 5e. The analysis of the organizational studies (Barrios-Choplin et al., 1997; McCraty et al., 2003; Trousselard et al., 2014) indicated that there was a lack of consistent measurement variables and outcomes associated with previous organizational stress studies. Additionally, the review of conceptual frames positioned social factors as key mediating or protective factor for employees experiencing stress. It was further suggested that benefits associated with strong social support in organizations may lead to improved organizational performance and health outcomes for employees (McCraty, 2015). These assessments may suggest that HRV research in organizations need to assess the existing organizational culture and social systems to accurately measure the impact of HRV interventions. These procedures may also contribute to stronger conceptualization and measurement of such studies, which may support more consistent research designs and a stronger ability to compare outcomes across studies.

Additional suggestions for future research involve including objective measures of HRV, as well as other biological data such as endocrine, sleep, and/or blood pressure data to measure the physiological impacts of stress and influences on HRV (see Appendix C for details) into the

research design. It is of note that there is opportunity to resolve remaining ambiguity related to HRV objective assessments. As reviewed in Appendix A (titled HRV Analysis*),* object measures of HRV are an effective and efficient way of assessing several clinical physiological and psychological health outcomes. This has led to the development of automated devices allows which allow both clinicians, cardiologists and consumers to assess HRV. Despite these developments, there is ambiguity regarding the interpretation of HRV measurement. "Measures of HRV are more complex than generally appreciated and there is a potential for incorrect conclusions and for excessive or unfounded extrapolations" (Task Force of the European Society Electrophysiology, 1996, p. 354). To address these inconsistencies a task force was commissioned to develop appropriate standards of measurement, define psychological and physiological correlations, clinical applications and associated terms and definitions. Primary findings highlighted two methods for measuring HRV and included time-domain methods and frequency-domain methods (Task Force of the European Society Electrophysiology, 1996). Subsequent analyses provided recommendations for improvement which included improved HRV assessment, normative data and suggestions for the field of practice (Nunan et al., 2010). These findings mirror assessments within this inquiry, which demonstrate the need for more consistent conceptualization, measurement and operationalization of HRV in the workplace.

Along with incorporating objective measure of HRV, follow-up studies may wish to incorporate phenomenological approaches into the methods and methodologies to integrate the participants' lived experience. Methods may include participant interviews, observations, and subjective survey responses to the HRV intervention in a qualitative, or even mixed methods design.

Additionally, the methods associated with RQ5 (as depicted in Figure 3.3 titled *Diagram of Between-Groups, Experimental Design with Recruitment, Assignment, Assessment and Intervention*) included data collection for both pre and post assessments for both the active and wait-list control groups. RQ5, which emphasized the between-groups design, drove the data analysis, which did not include pre-intervention assessment data. As such, additional data including pre-assessment measures for active and wait-list control participants comprise the complete data set. Additionally, the hypotheses associated with RQ5 were informed by the primary scales (plus the intention to quit subscale) of the POQA-R4. As such, the full data set includes variable level data for each of the scales. Recommendations for future research include assessing participant outcomes by analyzing pre-assessment data. Additionally, given the ambiguity related to construct validity of HRV interventions in the workplace, it is recommended that the full data set be utilized to explore additional research questions targeting variable level inquiry especially as it pertains to the organizational scales of the POQA-R4 (organizational stress and intent to quit). This approach may support the previous recommendations for refining organizational variables in the conceptualization and measurement of HRV interventions in the workplace.

These recommendations build from the observations made from analyses of the five research questions. Specific opportunities for future research included recommendations for including objective measures of HRV into the research designs. Additional recommendations for including alternate methodologies, methods and measurements were offered. Finally, recommendations for follow-up studies included utilizing the complete data set to support further *refinement* related to construct validity were recommended.

Implications for Practice

The empirical evidence associated with RQ5 led to observations that teaching participants to self-regulate HRV leads to significant improvements in physical and mental health outcomes and, as such, HRV self-regulation is recommended for practitioners who aim to support employee wellness. Additional analyses related to conceptualization, measurement and implementation provide additional insights for professionals and are offered below.

The COVID-19 pandemic has produced unprecedented levels of disruption. This disruption provides an opportunity for reassessing work values and practices in a way that better promotes wellness, productivity, engagement and satisfaction. These priorities may better represent the values of HRD practitioners (Bierema, 2020). Additionally, these disruptions impact organizational functioning as well the system's ability to dynamically respond to opportunities, challenges and organizational goals (Arora & Suri, 2020), which can lead to increased levels of employee stress and associated health outcomes. HRD professionals are uniquely positioned to offer interventions to help employees adjust to the new challenges associated with the COVID-19 pandemic. How leaders respond to these changes can influence employee confidence and organizational performance (Hammer, 2021). Bierema (2020) noted that employee health and wellness have not been traditional topics within HRD and cautioned that organizations who do not address employee and organizational wellness will not recognize long-term profits and sustainability. Bierema questioned how new models of wellbeing and leadership can be positioned at the forefront of HRD.

The findings and conclusions associated with this inquiry may provide insights into evolving leadership and organizational practices to better support employee and organizational health. Specifically, this analysis observed that resilience, self-regulation and improved executive

functions are key variables in employee health, which may lead to improved organizational outcomes. Practitioners, including HRD professionals, can use the empirical data and proposed models to first bring awareness to how stress manifests in the workplace, how it may affect organizational goals, how to reinforce a culture of care, and how to offer evidenced based wellness interventions.

The proposed models of HRV in the workplace (see Figures 5.1 and 5.2) includes key empirical findings, conceptual frames and individual variables of a workplace wellness intervention. The model highlights the importance of social influences at the organizational level and the broader environmental level, as influential in employee health. Individual factors of the employee indicate that wellness needs and employee resilience to stress are highly personal and that optimal wellness interventions should reflect that variability. Assessing employee and work demands and resources serves as an opportunity to identify tactical resources and strengths while also assessing additional resources that could support work functions. Processes associated with the wellness intervention for this research positions resilience skill building, HRV regulation and emotional regulation as evidenced based approaches, which can lead to improved mental and physical health while supporting organizational goals.

Practitioners can use this model to assess organizational cultures as it relates to workplace wellness, while also identifying wellness needs and optimal interventions. Suggestions for using this framework begin with bringing awareness to the conceptual frames within this analysis and assessing how they show up in the workplace. Question that might drive this analysis include the following: How does the broader environment influence our organization's culture and worker health? Are there tactical resources that would support work demands and resources? How are high levels of individual and system resilience observed? What

about low levels? If employees experience high stress and low resilience, how does it affect employee wellbeing? Team functioning? Organizational resources and goals? Absenteeism? Actuarial costs? How do these outcomes impact the mission of the organization and the bottom line?

By initiating these processes leaders begin to position wellness as both a reflection of the organization's values and also a business proposition with measurable benefits for employee wellness, and team functioning/social coherence which may positively influence organizational goals deemed valuable to the organization. Assessing culture was a key finding in the preceding analyses and was recommended to identify, operationalize and evaluate wellness interventions. This inquiry explored one workplace wellness intervention, but research indicates that employee wellness interventions are on the rise, and that in order to engage broad participation, a range of interventions should be offered in order to support individual and organizational health. One such resource for conceptualizing, assessing and providing resources for a broad range of wellness needs is to utilize a wellness wheel model. One such wellness wheel (Yale University, 2019) highlights seven wellness domains including emotional, occupational, environmental, financial, spiritual, physical, and social wellness. This framework is both comprehensive and customizable, thus positioned to meet a range of individual and organizational wellness goals.

Bierema (2020) cautioned that workplaces that do not prioritize employee and organizational wellness will be limited in their profits and sustainability. This assessment mirrors the study of stress. If stress in the environment (whether in the organization or global environment) continues to rise and employees are not armed with optimal interventions, organizations run risk of high levels of stress perhaps even leading to a trauma response. In their recent article Cohen Silver (2020) categorized the COVID-19 pandemic as a trauma. Decades of

trauma research indicate that individual responses to traumas depend on a range of factors (Cohen Silver, 2020), many of which have been reviewed in this inquiry. Along with the physical health challenges associated with COVID-19, the pandemic is associated with a range of distressing mental health outcomes and Cohen Silver (2020) indicated that there is no one-size-fits-all solution. Griffin (2020) argued that during the COVID-19 pandemic systems should use a trauma-informed response targeting building resilience capacity of their members. Additionally, it was noted that policies, research and interventions are contextual and will be specific to the environment (Griffin, 2020). Similar to the study of HRV, the pandemic brings to life the complex mind-body connection and the need for interventions that incorporate individual differences, environmental influences and evidenced based resources that support biopsychosocial coherence.

The polyvagal theory (Porges, 2018) of trauma compliments processes and variables that inform the study of HRV as an intervention for stress reduction and resilience capacity building. Polyvagal theory articulates how three branches of our nervous system are deployed when navigating the environment. The ventral vagal branch (or the social nervous system) of the vagus nerve is dominant when we feel safe and are socially engaged. In this state, our defense systems are inhibited. When experiencing stress, we often first turn to our social system to help mitigate the perceived threat. If these efforts do not resolve the threat, we engage the sympathetic nervous system and fight or flight is activated. If the fight or flight response does not mitigate the threat, we engage the dorsal vagal pathway of the parasympathetic nervous system. This primitive part of our defense response is activated when one perceives that there is no escape to the life-threating situation (often referred to as the faint response).

Applying polyvagal theory to organizations, illustrates the impacts of traumatic stress on employees and organizational functioning. The first system activated in response to an organizational or environmental threat is the ventral vagal branch or the social nervous system. If resources and protective factors associated with this social system are not adequate to mediate the threat, then the sympathetic branch is engaged. The primary behaviors associated with the sympathetic nervous system are *fight* and *flight*. In the workplace, fight may be observed as adversarial behaviors among colleagues while flight may be observed when employees leave the organization (as evidenced by the great resignation). If sympathetic activation is unable to resolve the treat, the dorsal vagal pathway is engaged. Behaviors associated with dorsal vagal activation include *faint* which, may be observed as *freeze* or *appease* in the workplace. Freeze in employees may include a range of behaviors associated with employee disengagement, while appease may include attempts of the employee to secure basic resources needed for survival, thus appeasing or placating those who are in control of the distribution of resources.

Similar to the analysis of HRV, polyvagal theory (Porges, 2018) positions the autonomic nervous system and the vagus nerves as key systems associated with the stress and trauma responses. Additionally, social systems and the complex interaction of the individual and their environment, explains that for trauma recovery (in the context of polyvagal theory) treatment should focus on building awareness of these processes and engaging social systems to build protective factors to mitigate the damaging effects of stress and even trauma. In this context, one of the primary goals of research and applied interventions for stress in the workplace is to build protective factors supporting the social nervous system and social field environments to build resilience capacity in order to avoid and mitigate maladaptive responses to threat, which would impede organizational systems' ability to reach business goals.

Limitations

There were several limitations associated with this study. These limitations, coupled with empirical findings, analyses of conceptual frame and subsequent efforts at theory building inform suggestions for future research. Limitations associated with this research (originally reviewed in Chapter Two) included limitations associated with generalizability of the results, which should be limited to similar populations and circumstances. As with any measure of self-reported data, the POQA-R4 had limitations associated with the accuracy of self-reported data related to perceptions, attitudes and behaviors, which may influence internal validity of the results. Wait-list control participants continued to engage with normal business operations during the intervention and data collection phases, which indicates that contamination bias may be a limitation. This contamination bias may have may have influenced measures of effectiveness of the intervention. A major limitation associated with this study were the adjustments made to accommodate a virtual intervention and data collection. While there are objective measures of HRV, the COVID-19 pandemic required remote methods to ensure the health and safety of the researchers and participants. Additionally, limitations related to construct validity may have influenced how HRV in the workplace was conceptualized and measured.

HRV and HRD

HRD has long grappled with the utility of defining features and foundational disciplines of the field (Wang & McLean, 2007). Some have reasoned that the field of HRD can only recognize its potential once it has identified its foundational knowledge bases and areas of practice (Grieves & Redman, 1999). Conversely, McLean (1998) argued that HRD as a discipline contains "almost limitless sources of input" (p. 375) and that a single unifying theory might be too simplistic to accurately conceptualize the evolving, contextual and multidisciplinary

nature of HRD. While the evolving nature of HRD may position the field as agile during times of change, which could lead to diversification and growth, these qualities may also call into question HRD's core identity and boundaries (Han et al., 2017). Given the evolutionary nature of HRD, Lee (2001) argued that attempts to define the field categorize HRD as "a thing of *being* rather than a process of *becoming"* (p. 327; emphasis in original).

HRD as a field is immersed in pandemic related stress and unpresented times of change. These changes come with both costs and opportunities that can influence the health and performance of individual employees, organizations and complex environmental systems. The COVID-19 pandemic has amplified organizations' need to address complex challenges, solve problems and make decisions. When pandemic related complexity contributes to increased uncertainty and complexity, then wellbeing, productivity and stability are impacted (Crocco & Grenier, 2021). HRD professionals' ability to dynamically respond to the COVID-19 pandemic lend support to arguments that HRD is agile with interdisciplinary roots, which in turn, supports the field's ability to successfully transition theory to practice in support of organizational goals.

Recognizing that employees, organizations and HRD benefit from core values rooted in care may lead to evolving HRD's values while also transforming work practices to better reflect these values (McGuire et al., 2021). Lending evidence to the arguments that contend that supporting employee wellness can lead to an organization's business goals, Gopinath and Mitra (2017) noted that 97% of companies recognize that wellbeing influences organizational outcomes but fail to act on data that human sustainability is essential for workplace success. These observations were supported by statistics that estimate that one third of business outcomes are negatively affected by employee stress and anxiety, with half of employees arguing that employers are not promoting wellness effectively (Gopinath & Mitra, 2017).

Bierema (2020) noted that employee and organizational wellness have not traditionally been at the forefront of HRD and argued that organizations risk profits and sustainability if they do not promote wellbeing. Bierma questioned how HRD can support organizational wellness with new models for research and leadership? These data points, coupled with the arguments for HRD to more strongly emphasize an ethics of care, may signal the need to align wellness promotion with the foundations of HRD, which have historically been positioned as fundamental to the discipline's longevity. Doing so may strike a balance between arguments for securing foundational knowledge bases and areas of practice while also positioning HRD as agile, evolving, multidisciplinary and contextual while being rooted in a commitment to care.

The following discussion seeks to position the foundational disciplines of HRD as vehicles to both reflect the traditions of the discipline while also positioning HRD as rooted in agility, ethics and care for those who practitioners serve. To do so, the foundations of HRD are summarized, while integrating data related to the analysis of HRV self-regulation contained within this inquiry, thus honoring HRD's foundations, positing the field as dynamic and interdisciplinary, and making a business case for an ethics of care.

HRV self-regulation in organizations teaches participants to enhance their ability to decrease stress, improving resilience capacity and ability to self-regulate emotions. Evidence suggests that building capacity in these areas leads to improved health and wellbeing outcomes for the individual, which subsequently improves social, environmental, and systems outcomes. These areas of growth align with key aims and foundations of the discipline of HRD, which include psychological theory, economic theory, and system theory (Swanson, 2001).

HRD and Economics Theory

Economics theory was positioned as a key discipline of HRD as it focused on human capital development as a means for economic development supporting the goals of the organization (Wang & McLean, 2007). The three primary economic theories in support of HRD were scarce resource theory, sustainable resource theory and human capital theory. Scarce resource theory recognized that resources (money, raw materials, time, personnel) are scarce and that decision makers must justify how these resources will be leveraged in order to support the strongest returns on investments. Sustainable resource theory explained that given the scarcity of resources, investments should prioritize concerns for long-term versus short-term goals. Human capital theory posited that expenditures on education, training and medical care are investments in human capital, which are not simply costs, but investments with returns that can be calculated (Swanson et al., 2001). Informed by the economic theories, Swanson proposed the following economic propositions for HRD:

> (1) HRD must justify its own use of scarce resources; (2) HRD must add value to creating sustainable long-term economic performance; (3) HRD must add short-term and long-term value from investments in the development of knowledge and expertise in individuals and groups of individuals. (Swanson & Holton, 2009, p. 105)

When the HRD economic propositions are evaluated against the previous analyses of HRV self-regulation in the workplace, the intersection of HRD and wellness becomes evident. If personnel resources are indeed scare and if a goal of economic theory seeks to identify and secure efficient and effective utilization of resources in a competitive environment, and given the data supporting physiological and psychological gains for employees when HRV interventions are utilized, then investing in the health of human capital assets could lead to the sustainable health of the individual and the subsequent performance and economic health of the organization.

HRD and Psychological Theories

The disciplines of social and organizational psychology have sought to understand behavior of individuals in organizations and have included inquiries such as understand behavior and mental processes in system environments. Swanson (2001) explained that the essence of psychological theory aligns with the foundational human emphasis of HRD and includes technical and sociological interactions of both humans and systems. Swanson included three primary psychological theories in support of HRD: gestalt psychology, behavioral psychology, and cognitive psychology. Gestalt psychology is a holistic view of humans which distinguishes itself from more mechanistic and segmented conceptualizations of humans. Gestalt psychology informs us that there is meaning in the configurations of the whole, which we do not observe from isolated parts. Behavioral psychology explains that individuals respond to circumstances given their capacity, personal history and the range of forces working upon them. Cognitive psychology contends that human beings organize their lives around goal directed behavior or purposes and cognitive psychology attempts to integrate gestalt and behavioral psychology and may include domains such as learning, perception, language and problem solving (Swanson et al., 2001). Swanson and Holton (2009) proposed the following psychological propositions for HRD:

> (1) HRD must clarify the goals of individual contributors, work process owners, and/or organization leaders; (2) HRD must develop the knowledge and expertise of the individual contributors, work process owners and organization leaders; (3) HRD must harmonize the goals and behaviors among individual contributors, work groups, work process owners, and organization leaders. (p. 107)

When the HRD psychological propositions are evaluated against the previous analyses of HRV self-regulation in the workplace, the intersection of HRD and wellness becomes evident. If HRD as a field is required to develop the knowledge and expertise of it workers in a way that harmonizes goals and behaviors in a complex system, and given the data related to the efficacy

of HRV interventions in relation to mental health, cognitive functions, behavioral outcomes and system performance, then it is argued that HRV interventions are an effective resource in the psychological development of the organization's members and will subsequently impact organizational learning, performance and the system's ability to dynamically respond to challenges and opportunities.

HRD and Systems Theory

Systems theory includes group and individual variables functioning both in time and over time and seeks to integrate the complex and dynamic nature of systems interactions including variable such as the organization, the environment, group and individual qualities (Swanson, 2001). Swanson (2001) included three fields of system theory as foundations for HRD: (a) general systems theory, (b) chaos theory, and (c) futures theory. General systems theory integrates processes, outputs, and feedback and recognizes the paradoxical nature of systems when noting the inability of a single theory to reach a satisfactory level in theory building, but rather a spectrum of theories that would perform a function of "gestalt." Chaos theory positions the study of phenomenon as one of becoming, as opposed to being, while noting the chaotic nature of phenomena as both seemingly random and lacking in structure, but that with an understanding of a system's conditions, predictions can be made about the behavior of the system. Futures theory seeks to liberate people's insights to plan for the future in uncertain conditions. Swanson and Holton (2009) proposed the following systems propositions for HRD:

> (1) HRD must understand how it and other subsystems connect and disconnect from the host organization system; (2) HRD must help its host organizational system retain its purpose and effectiveness given the chaos it faces; (3) HRD must help its host organizational system shape alternative futures. (p. 109)

When the HRD systems propositions are evaluated against the previous analyses of HRV self-regulation in the workplace, the intersection of HRD and wellness becomes evident. If

organizational performance requires an understanding of complex systems which helps the host organization to retain purpose and effectiveness in agile environments and HRV interventions help to facilitate coherent appraisal, cognitive, behavioral and system performance in the face of chaotic conditions, then HRV self-regulation can help to support human, team and organizational performance in the face of uncertain futures.

While the debate about the need for identifying foundational disciplines for the field of HRD continues, it was suggested that analyzing HRD in relation to HRV self-regulation has illustrated the value of investing in the wellbeing of employees. Through the lenses of economic, psychological, and systems theories, HRV self-regulation tools have demonstrated efficacy in supporting an organization's ability to unleash expertise at all levels of the organization. To recognize the value of foundations of HRD while simultaneously highlighting the dynamic, interdisciplinary and evolving nature of HRD, this analysis sought to reflect the traditions of the discipline while supporting the shift of HRD to be more rooted in an ethics of care.

Conclusions

The consequences associated with organizational stress can be harmful to the individual employee's physical and mental health while simultaneously generating costs to the organization in the form of absenteeism, organizational dysfunction, healthcare costs and inability to meet organizational goals. Stress management and resilience building interventions utilizing HRV self-regulation have shown promising results for mental and physical health as well as organizational outcomes. This study investigated if HRV self-regulation interventions can also support employee and organizational wellness during the COVID-19 pandemic.

Based on this study's findings, recommendations for future research, application, theory building, and implications for HRD were offered. Specific recommendations included further

refinement of conceptual/theoretical frames, measurement variables and assessment tools, including objective measures of HRV into research designs as well as alternate methodologies and methods. Recommendations for practice focused on providing evidenced based wellness interventions (such as HRV self-regulation training), and reinforcing the organizational culture to support a range of wellness needs to strengthen social systems, which serve as protective and mediating factors in times of stress. These recommendations will position HRD professionals as agile and dynamic leaders who implement organizational wellness to both support business objectives while reinforcing a culture of care.

While the debate remains about the need for identifying foundational disciplines for the field of HRD, it was suggested that analyzing HRD in relation to HRV self-regulation has illustrated the value of investing in the wellbeing of employees. Through these lenses, HRV self-regulation tools have demonstrated efficacy in supporting an organization's ability to unleash expertise at all levels of the organization. To recognize the value of foundations of HRD while simultaneously recognizing the dynamic, interdisciplinary and evolving nature of HRD, this analysis sought to reflect the traditions of the discipline while supporting the shift of HRD to be more rooted in an ethics of care.

In presenting his icon of the three-legged stool of the foundational disciplines of HRD (economics, psychology, system theory), Swanson reminded us that our discipline is founded by a "rug of ethics" which "serves as a filter through which the integrity of both HRD and the host organization can be maintained" (Swanson, 2001, p. 305). Given the costs associated with stress in the workplace, leaders in the organization may question, what are optimal tools to secure in an environment characterized by unpredictability, change, stress and renewed commitment to supporting a culture of care? The outcomes reviewed in this analysis provide strong evidence

that supporting employee wellbeing (in this case with an HRV self-regulation training) is a secure investment with evidence supporting mental health, physical health, a strong field environment, ability to perform work related tasks, and measurable benefits to the organization. Given these dynamic times and HRD's renewed commitment to ethical care for all community members, one may ask what would be a more ethical investment than supporting wellbeing for all organizational team members?

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APPENDIX A: HRV ANALYSIS

Heart Rate Variability (HRV) has been defined as "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para.1). Interbeat intervals or IBIs inform HRV and reflect the time intervals between consecutive heartbeats (Shaffer & Ginsberg, 2017). A healthy system that is characterized by complexity and chaos, can be observed in the oscillations of a healthy heart within these IBIs and subsequent HRV. This illustrates that, "a healthy heart is not a metronome" (p. 258) and that these complex and ever changing rhythms reflect the heart's ability to adjust to both physiological and psychological challenges and opportunities (Shaffer & Ginsberg, 2017). Ideal levels of HRV (not too high and not too low) indicate optimal performance, executive function, ability to self-regulate and resilience capacity (Shaffer & Ginsberg, 2017).

This variability is a result of both branches of the autonomic nervous system (parasympathetic and sympathetic) engaging in both afferent and efferent (ascending and descending) neural activity between the heart and the brain. These pathways, along with chemical, mechanical, electrical and physical influences interact to produce cardiovascular responses and adjustments to internal and external variables, demands and opportunities. Even at rest, both branches of the autonomic nervous system remain engaged and are reflected in HRV as autonomic balance. Thus, HRV serves as a significant indicator of overall health and ability of the organism to dynamically respond to a variety of circumstances (McCraty, 2015). Additionally, low HRV is a strong predictor of adverse health outcomes in both cardiac patients as well as the general public (Nunan et al., 2010).

HRV analysis represents an effective and efficient way of assessing a range of clinical outcomes (both physiological and psychological). As such, the development of a number of automated devices allows cardiologists to assess HRV. This has led to ambiguity regarding the significance and interpretation of HRV measurement outcomes. "Measures of HRV are more complex than generally appreciated and there is a potential for incorrect conclusions and for excessive or unfounded extrapolations" (Task Force of the European Society Electrophysiology, 1996, p. 354). As such, a task force was commissioned to develop appropriate standards of measurement, define psychological and physiological correlations, clinical applications and associated terms and definitions. The task force consisted of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology and was comprised of clinical providers, physiologists, mathematicians and engineers (Task Force of the European Society Electrophysiology, 1996). The resulting report highlighted two primary methods for measuring HRV as time-domain methods and frequency-domain methods (Task Force of the European Society Electrophysiology, 1996).

A subsequent analysis (Nunan et al., 2010) conducted after the 1996 Task Force report analyzed 44 studies of short-term HRV measures and included over 21,000 participants. Findings suggested that there were a number of factors that contributed to measurement discrepancies. They found:

> Values for short-term HRV measures from the literature were lower than Task Force norms. A degree of homogeneity for common measures of HRV in healthy adults was shown across studies. A number of studies demonstrate large interindividual variations (up to 260,000%), particularly for spectral measures. (p. 1407)

Below are the task forces finding for standardizations for measurements, followed by suggestions for improved short-term HRV methods and analysis offered by Nunan et al. (2010).

Time-Domain Measures

McCraty (2015) confirmed that while HRV can be assessed with a range of methods and variables, time-domain and frequency domain are the most common. It is explained that time-domain methods are arguably the simplest methods of analysis (Task Force of the European Society Electrophysiology, 1996). Specifically, time-domain measures consist of continuous ECG (electrocardiogram) cardiac measures (QRS complex) coupled with NN intervals (normal-to-normal intervals) resulting from pace making functions in the heart (sinus-node depolarization), resulting in instantaneous heart rate which can be used to calculate several time-domain variables (Task Force of the European Society Electrophysiology, 1996).

Shaffer and Ginsberg (2017) explained that time-domain HRV measures include 24 hour, short-term (ST approximately 5 minutes) and ultra-short-term (UST, less than 5 minutes). Long term measures better illustrate a wider range of conditions and stimuli (including circadian rhythms), thus shorter values (ST, UST) are not directly comparable with 24 hour measures (Shaffer & Ginsberg, 2017). Shaffer and Ginsberg (2017) define time-domain measures of HRV as:

> The amount of variability in measurements of the interbeat interval (IBI), which is the time period between successive heartbeats. These values may be expressed in original units or as the natural logarithm (Ln) of original units to achieve a more normal distribution. (p. 2)

McCraty (2015) noted that while time-domain measures are the simplest to quantify and allows comparable data across researchers (if collected under matching conditions) there are limitations to the measures. Specifically, time-domain measures do not allow for assessing a number of outputs including: "autonomic dynamics or determine the rhythmic or oscillatory activity generated by the different physiological control systems" (p. 21). The following is a brief review of the most common time-domain measures:

SDNN

The SDNN measurement represents the changing dynamics of all factors that influence HRV. SDNN is defined as the "the standard deviation of the normal-to-normal (NN) sinus-initiated interbeat-intervals measured in milliseconds" (McCraty, 2015). In short term, resting HRV recordings (particularly with deep-breathing or slow-paced breathing protocols) variation in HRV is primarily informed by vagally or parasympathetic mediated activity ("vagally mediated"; McCraty, 2015; Shaffer & Ginsberg, 2017). Age adjusted SDNN values which are low may indicate an increased risk for a number of health outcomes (McCraty, 2015) including myocardial infarction (Wolf et al., 1978). Longer term (24 hour) recordings reflect activity in both branches of the automatic nervous system and are highly correlated with ultra-low frequencies and total power and can reflect additional cardiac responses to a wider range of environmental influences including circadian rhythms (Shaffer & Ginsberg, 2017). It is reported that 24 hour recordings of SDNN values represent the optimal standard for cardiac risk and are associated with both morbidity and mortality (Electrophysiology Task Force of the European Society of Cardiology the North American Society of Pacing, 1996).

The SDNN Index

The SDNN index measures the factors influencing HRV in a 5-minute interval, where 24-hour recordings are divided into 288, 5 minute segments (Shaffer & Ginsberg (2017) and measures autonomic influences on HRV. The SDNN index is defined as the "the mean of the standard deviations of all the NN intervals for each 5-minute segment" (McCraty, 2015, p. 21). The SDNN index is correlated with very-low frequency (VLF) power for 24-hour measurements (Shaffer & Ginsberg, 2017).

RMSSD

Measures of RMSDD are correlated with self-regulatory capacity (high-frequency power) and cognition and as such, are especially applicable for mental health providers. A number of terms are associated with RMSD such as vagally mediated, vagal tone and vagal activity all of which refer to the above mentioned parasympathetic mediated activity (HeartMath® Inc., 2019). RMSSD is defined as "the root mean square of successive differences between normal heartbeats" (McCraty, 2015, p. 22). This calculation is first derived from "each successive time difference between heartbeats in milliseconds. Each of the values is then squared and the result is averaged before the square root of the total is obtained" (McCraty, 2015, p. 22). There is a strong correlation between measure of high frequency variations in heart rate and short-term variation (Electrophysiology Task Force of the European Society of Cardiology the North American Society of Pacing, 1996).

Frequency-Domain Measures

Frequency-domain measures consist of four components: ultra-low frequency (ULF), very-flow frequency (VLF), low-frequency (LF) and high-frequency (HF) and reflect the different HRV rhythms operating at various frequency ranges (Shaffer & Ginsberg, 2017). Produced by spectral analysis, these measures offer benefits beyond time-domain measures as frequency and amplitude data within the HRV waveform are provided. The height or power of the peak is associated with measures of stability of the rhythm, while frequency is a measure of the time period of the rhythm (McCraty, 2015). McCraty (2015) explained that "Spectral analysis provides information about how power is distributed (the variance and amplitude of a given rhythm) as a function of frequency (the time period of a given rhythm)" (McCraty, 2015, p. 18).

These frequency domains are each informed by physiological sources and are associated with physiological and psychological health outcomes (McCraty, 2015).

High-Frequency Band

The high frequency (HF) band (0.15-0.40Hz) is referred to the respiratory band as it is associated with heart rate variations due to the respiratory cycle (respiratory sinus arrhythmia) and is generally recorded over a minimum of 1 minute time recording (Shaffer & Ginsberg, 2017). The variations in respiratory cycle reflect parasympathetic or vagal activity associated with the sinus arrhythmia. Heart rate is increased during inhalation as vagal outflow is inhibited; while vagal function is restored during exhalation (Hopkins & Ellenberger, 1994).

These complex processes and measures of HF reflect cardiac health, emotional self-regulation capacity, stress/anxiety and executive functions. It was further described that low HF power is explained by low parasympathetic activity rather than reduced sympathetic functioning that is correlated with reduced amount of HRV in aging (McCraty, 2015).

Low-Frequency Band

The low frequency (LF) band has been referred to as the baroreceptor (short term blood pressure regulation) range and is measured between 0.04 and 0.15 hertz and recorded over at least a two minute time period (Shaffer & Ginsberg, 2017). This range corresponds to rhythms which occur between seven and 25 seconds and primarily reflects baroreceptor activity while at rest (Malliani et al., 1994; McCraty, 2015).

The vagus nerves function as a major pathway for heart-brain neural signals (both afferent and efferent) and also facilitate baroreflex signals. Decreased baroreflex sensitivity (baroreflex gain) is associated with self-regulation capacity and ageing and is “calculated as the beat-to-beat change in HR per unit of change in BP” (McCraty, 2015, p. 19). Models have

demonstrated that the optimal/natural cardiovascular resonance frequency in humans and other mammals is generated by heart-brain/baroreflex feedback loops and have been observed at approximately 0.1 hertz (10 second rhythm) and is illustrative of the state of coherence previously reviewed (Baselli et al., 1994; DeBoer et al., 1987; McCraty, 2015). Further, "When the cardiovascular system oscillates at this frequency, there is a distinctive high amplitude peak in the HRV power spectrum around 0.1 hertz" which illustrates a delay in the above mentioned feedback loop (McCraty, 2015, p. 19). Increased cardiac resonance or coherence can indicate increased range of variability for both blood pressure and heart rate which subsequently increases afferent vagal signals and is reflected in more ordered patterns of activity (McCraty, 2015).

Slow respiration rates at or below 8.5 breaths per minute, (or approximately one breath every seven seconds) can improve vagal activity which can generate rhythms which "crossover" into the LF band. This can also be accomplished with while taking a deep breath or sighing (McCraty, 2015). "The sympathetic nervous system does not appear to have much influence in rhythms above 0.1 hertz, while the parasympathetic system can be observed to affect heart rhythms down to 0.05 hertz (20-second rhythm)", which demonstrates that these influences are primarily vagally mediated (McCraty & Shaffer, 2015, p. 49). Consistent HRV self-regulation practices (taught in the Resilience Advantage intervention) can improve baroreflex gain, indicating qualities of neuroplasticity within the baroreflex and intrinsic cardiac nervous systems (McCraty & Shaffer, 2015).

Very-Low-Frequency Band

The very-low-frequency band has the highest correlation with all-cause mortality as compared to other HRV frequency-domain measures (Shaffer & Ginsberg, 2017). VLF is defined

as “the power in the HRV power spectrum range between 0.0033 and 0.04 hertz which equates to rhythms or modulations with periods that occur between 25 and 300 seconds” (McCraty, 2015, p. 19). A minimum recording period of five minutes is required for the VLF band and can be assessed over 24 hour recordings as well (Shaffer & Ginsberg, 2017). Shaffer and Ginsberg (2017) summarized previous research that indicated that there is uncertainty regarding which physiological mechanisms influence VLF, but that this frequency-domain measure is highly predictive of health outcomes. Their summary indicated that low VLF is associated with arrhythmic death, PTSD, inflammation and low testosterone (Shaffer & Ginsberg, 2017). McCraty (2015) summarized previous research on the mechanisms associated with VLF and noted that traditionally this domain is not as well defined as other HRV measures, despite its predictive qualities. Data indicated that long-term regulation capacity, specifically the mechanisms in the autonomic nervous system related to thermoregulation, blood pressure regulation (renin-angiotensin system), physical activity and the stress response influence VLF.

Research on heart transplant populations (Kember et al., 2001) suggests that several feedback/feedforward loops are activated by afferent cardiac neural activity, extrinsic cardiac ganglia (second order parasympathetic neurons) and the spinal column all of which influence VLF rhythm (McCraty, 2015). “Thus, the VLF rhythm appears to be produced by the heart itself and is an intrinsic rhythm that appears to be fundamental to health and wellbeing” (McCraty, 2015, p. 21). McCraty (2015) summarized that VLF is intrinsically generated in the cardiac nervous system and outputs (amplitude and frequency) are influenced by efferent activity produced by the sympathetic nervous system. Stress, physical activity, emotional stressors and other stimulants influence resting VLF and increase efferent sympathetic activation (Bernardi et al., 1996; McCraty et al., 2009).

Normalized Coherence

Normalized coherence reflects the stability and degree of coherence in the HRV pattern. Thus, a coherent HRV pattern is observed as "a stable regular repeating rhythm resembling a sine wave at a single frequency between 0.032 - 0.26 Hz (2 -15 cycles per minute). The more stable and regular the heart rhythm frequency, the higher the coherence score" (HeartMath® Inc., 2019, para. 16). Normalized coherence is calculated by "measuring the power spectral density (PSD) around the largest peak in the coherence range and dividing it by the PSD total power. Normalized coherence ranges from 0 – 100" (HeartMath® Inc., 2019, para. 16). Coherence is associated with entrainment where "Entrainment reflects a harmonious balance between the two branches of the autonomic nervous system within the body. This internal state of heightened physiological efficiency enhances health and promotes optimal performance (Childre et al., 2002, p. 1).

Studies conducted since the Task Force recommendations have provided insights for improved HRV assessment, stronger normative data, and more insights related to discrepancies in HRV analysis (Nunan et al., 2010). Nunan et al.'s (2010) summary suggests the following:

The measure-by-measure analysis performed for those studies reporting discrepant values revealed a number of underlying factors including:

1. Moderate to high level of participant habitual physical activity;
2. The use of paced breathing protocols, particularly when performed in participants with moderate to high physical activity levels;
3. Where younger participants are measured, values for HRV are typically higher;
4. Poor reporting and/or performance of RR interval error recognition, removal, and/or correction procedures;

5. The use of differing frequency bandwidths and normalization methods for LF and HF spectral measures;
6. Wide variation in HRV measures between healthy participants of the same study;
7. The misclassification of participants as healthy;
8. A failure of studies to recognize the normality/abnormality of values obtained in healthy participants. (pp. 114–1415)

Nunan et al. (2010) recommended updates to current standards for HRV measurement and suggested that HRV technology manufacturers pay particular attention to providing HRV analysis procedures for their technology products.

APPENDIX B: HRV AND EXERCISE PHYSIOLOGY

Along with the increasing study of HRV in relation to several clinical (both psychological and physiological), and performance domains, research related to finesses and physiological performance and the role of HRV is also on the rise (Makivić et al., 2013). Data illustrates that measures of HRV change both during and after exercise, and are influenced by age and gender, which has led to efforts to incorporate HRV data in improving the efficacy of both physical training and recovery. Specifically, changes to the ANS are mirrored in HRV data which provides insight into improving the efficacy of a range of training variables including: recovery, exercise intensity, training loads and performance (Makivić et al., 2013).

To measure the impact of aerobic exercise on HRV in two populations comprised of healthy adults and patients with acute myocardial infarction (AMI)/heart attack, researchers measured HRV parameters while participants where at rest and during exercise. Data led the researchers to conclude that aerobic exercise does impact HRV in both populations but does so in different patterns. The authors argue that this data contributes to the understanding of the role of exercise in both healthy and clinical populations (Torres et al., 2008).

A recent study (Chen et al., 2011) investigated the efficacy of HRV and measures of the parasympathetic branch of the autonomic nervous system to reflect recovery in a sample of weightlifters. Data indicated that parasympathetic power as seen in HRV outcomes was able to reflect measures of recovery post-training in the weightlifters.

Additional research on parasympathetic function (as measured by HR recovery time constant and HRV) on two types of exercise [repeated sprint (RS) and high-intensity intermittent training (HIT)] was conducted to determine the efficacy of both aerobic and anaerobic energy

systems. The population of healthy adolescent males were divided into the two groups which received 9 weeks of respective fitness training. Data indicated that the HIT group was more efficient than the RS group in improving parasympathetic function as well as measures of physical performance. The authors also concluded that HR recovery time constant, was more sensitive to training than measures of HRV (Buchheit et al., 2008).

HRV analysis and self-regulation have been linked to several performance-based outcomes. For example, a recent study investigated HRV measures of 14 moderately trained runners while at rest, while exercising and during recovery. Findings indicated that changes in HRV were measured in both maximal aerobic speed and 10k running performance. Participants who increased their 10k run time during the training intervention demonstrated improvements in HRV. Overall results of the study led the authors to conclude that HRV measures demonstrate utility in predicting aerobic training and recovery for endurance running performance (Buchheit et al., 2010).

Additional performance outcomes were measured in a study which investigated the use of an HRV training intervention with a population of both male and female basketball players (college level and above) who scored high in trait anxiety. Variables measured pre-and post the intervention (for a control group, placebo group and a treatment groups) included: "Anxiety, coping self-efficacy, heart rate variability, respiration rate, and performance (dribbling, passing and shooting)" (Paul & Garg, 2012, p. 131). In relation to the HRV training group, results demonstrated improvements in each measure as well as improved ability to deal with anxiety. These results led the authors to conclude that there may be an association between HRV training and performance (Paul & Garg, 2012) which highlights the psycho/physiological interaction.

Other studies have demonstrated efficacy in relation to HRV in several performance domains. A sample includes: improvements in psychological stress, and sports performance in collegiate golf (Lagos et al., 2011); improvements in balance beam performance in collegiate athletes with declines in competition scores when HRV training was withdrawn (Shaw et al., 2012); improved individual assessment of fitness and freshness (in relation to overtraining) and readiness to perform in elite endurance athletes (Plews et al., 2013).

Data suggests that changes in the ANS can be measured in corresponding HRV outcomes. Specially, these changes are measured during and after exercise and are influenced by age and gender. These changes are both mediated and measured in HRV data and can lead to improving the efficacy of both physical training and recovery. The studies reviewed provide a small overview of the literature in support of HRV assessment and interventions in the exercise physiology domain, specifically in relation to recovery, intensity, training loads and psychological and physiological performance.

APPENDIX C: RESULTS FOR HRV AND/OR HEARTMATH® TRAINING INTERVENTIONS IN THE WORKPLACE

Table C.1

Summary of Empirical Research on HRV and/or HeartMath® Training Interventions as an Independent Variable in the Workplace Including Outcome Variables and Associated Significant and Non-Significant Findings

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
Study 1 Trousselard et al. (2014)	Organizational restructuring/ research laboratory; *n* = 9	ANOVA*	Psychological Measures		
			-State anxiety		$F(2.8) = 0.33$, $p = 0.723$
			-Perceived stress	$F(2.8) = 8.12$, $p = 0.01$	
			-Sleep restoration	$F(2.8) = 6.32$, $p = 0.01$	
			-Falling asleep	$F(2.8) = 4.54$, $p = 0.04$	
			-Physical wellbeing	$F(2.8) = 7.89$, $p = 0.01$	
			-Mood wellbeing		
			-Joy of going to work		$F(2.8) = 3.21$, $p = 0.08$
			-General activation	$F(2.8) = 6.85$, $p = 0.01$	
					$F(2.8) = 3.54$, $p = 0.06$
			HRV assessments		
			-Mean NN int. (ms)		
			-SDNN		
			-SDSS		
			-pNN50		$F(2.8) = 1.23$, $p = 0.88$
			-RMSS		
					$F(2.8) = 3.25$, $p = 0.08$
			Sleep		
			-Number of arousals		$F(2.8) = 1.14$, $p = 0.40$
			-Total time analyzed		
			-Sleep period		$F(2.8) = 0.89$, $p = 0.41$
			-Wake time during		

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
			sleep period		$F(2.8) = 1.67$, $p = 0.23$
			-Total sleep time		
			-Sleep latency in first 60 seconds of sleep		$F(2.8) = 0.19$, $p = 0.76$
			-Sleep efficiency referred to sleep period		$F(2.8) = 0.024$, $p = 0.88$
			-Time in REM % of total sleep time	$F(2.8) = 24.18$, $p = 0.001$	$F(2.8) = 0.027$, $p = 0.87$
			-Time in S1 % of total sleep time		$F(2.8) = 1.65$, $p = 0.26$
			-Time in S2 a % of total sleep time		$F(2.8) = 0.02$, $p = 0.89$
			-Time in S3 % of total sleep time		$F(2.8) = 0.033$, $p = 0.86$
			Endocrine Measures		
			-Salivary enzyme alpha-amylase concentration	$F(2.8) = 5.89$, $p = 0.04$	$F(2.8) = 1.66$, $p = 0.26$
			-Salivary chromogranin A		
			-Urinary cortisol excretion		$F(2.8) = 1.21$, $p = 0.32$
					$F(2.8) = 0.75$, $p = 0.42$

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
					$F(2.8) = 0.15$, $p = 0.71$
					$F(2.8) = 2.79$, $p = 0.08$
					$F(2.8) = 3.24$, $p = 0.16$
Study 2 McCraty et al. (2003)	Global Information Technology Company, $n = 36$	ANCOVA**		Treatment/Control Mean/SEM	Treatment/Control Mean/SEM
			Systolic BP		
			- Change, mm Hg	-9.0 ± 3.0; -5.7 ± 3.1, $p < 0.05$	
			- Adjusted change, mm Hga	-10.6 ± 2.1; -3.7 ± 2.4, $p < 0.05$	
			Diastolic BP		
			- Change, mm Hg		-5.5 ± 2.3; -4.9 ± 2.3, *ns*
			- Adjusted change, mm Hga		-6.3 ± 1.2; -3.9 ± 1.4, *ns*
			POQA	Effect size/*p*	Effect size/*p*
			-Stress symptoms	-0.36, <0.05	
			-Anger		-0.42, *ns*
			-Resentfulness		-0.07, *ns*
			-Anxiety		-0.32, *ns*
			-Depression		-0.37, *ns*

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
			-Fatigue		-0.23, *ns*
			-Positive Outlook	0.60, <0.01	
			-Easygoingness		0.40, *ns*
			-Peacefulness	0.74, <0.05	
			-Spouse or partner support		0.44, *ns*
			-Workplace satisfaction	0.64, <0.05	
			-Value of contribution	1.35, <0.01	
			-Time pressure		0.24, *ns*
			-Supervisor relations		0.44, *ns*
			-Communication effectiveness		0.43, *ns*
			-Freedom of expression		-0.11, *ns*
			-Goal clarity		0.05, *ns*
			-Job challenge		0.45, *ns*
			-Intention to quit		-0.21, *ns*
			BSI		
			-Somatization		-.022, *ns*
			-Obsessive-compulsive		-.039, *ns*
			-Interpersonal sensitivity		-.032, *ns*
			-Depression	-0.74, <0.05	
			-Anxiety		0.24, *ns*
			-Hostility		-0.52, *ns*
			-Phobic anxiety	-0.17, <0.05	
			-Paranoid ideation		-0.40, *ns*
			-Psychoticism		-0.05, *ns*
			-Global severity index	-0.44, <0.05	

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
			-Positive symptom distress index		-0.43, *ns*
			-Positive symptom total		-0.28, *ns*
		Correlational analysis	Reduced stress symptoms/reduced systolic BP	$R = 0.44$, $p < 0.05$	
			Reduced depression with		
			-increased value of contribution	$R = -0.43$, $p < 0.05$	
			-increased job challenge	$R = -0.39$, $p < 0.05$	
			-reduced fatigue	$R = 0.47$, $p < 0.01$	
			-reduced intention to quit	$R = 0.47$, $p < 0.01$	
			Increased positive outlook with		
			-Reduced anger	$R = -0.49$, $p < 0.01$	
			-Reduced depression	$R = -0.43$, $p < 0.05$	
			-Increased value of contribution	$R = 0.57$, $p < 0.01$	
			-Increased workplace satisfaction	$R = 0.63$, $p < 0.01$	
			Increased value of contribution		
			-Improved supervisor relations	$R = 0.57$, $p < 0.01$	
			-Increased workplace satisfaction	$R = 0.63$, $p < 0.01$	

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
			-Decreased intention to quit	$R = -0.43$, $p < 0.01$	
			Increased workplace satisfaction		
			-Increased job challenge	$R = 0.77$, $p < 0.01$	
			-Improved supervisor relations	$R = 0.63$, $p < 0.05$	
			-Decreased intention to quit	$R = -0.64$, $p < 0.01$	
			BSI/POQA		
			-Anxiety scales	$R = 0.738$, $p < 0.01$	
			-Depression scales	$R = 0.695$, $p < 0.01$	
			-POQA Stress/BSI Somatization	$R = 0.788$, $p < 0.01$	
Study 3 Barrios-Choplin et al. (1997)	Three levels of telecommunications (Motorola) Employees (executive, software engineers, factory workers) $n = 48$	*t*-test	POS (Groups 1 & 2, Managers and software engineers)		
			-Contentment	-2.80, $p < 0.05$	
			-Happiness		-0.44, *NS*
			-Care		-1.01, *NS*
			-Nervousness	3.83, $p < 0.01$	
			-Tension		1.10, *NS*
			-Anxiety		1.29, *NS*
			-Burnout		1.58, *NS*
			-Angry		1.76, *NS*
			-Physical stress	2.52, $p < 0.05$	
			-Communication		-1.72, *NS*
			-Goal clarity		-1.09, *NS*
			-Job satisfaction		1.86, *NS*

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
			POS (Groups 3, factory workers)		
			-Contentment		-0.52, *NS*
			-Happiness		-1.31, *NS*
			-Care		-1.80, *NS*
			-Nervousness		1.38, *NS*
			-Tension	2.75, $p < 0.05$	
			-Anxiety	2.10, $p < 0.05$	
			-Burnout		1.59, *NS*
			-Angry		1.54, *NS*
			-Physical stress		1.23, *NS*
			-Communication	-2.49, $p < 0.05$	
			-Goal clarity		-1.54, *NS*
			-Job satisfaction	-2.46, $p < 0.05$	
			BP (hypertensive employees, $n = 5$)	Pre/Post Delta Systolic -18.5 Diastolic -9	
		ANOVA			
			Factory workers vs managers/engineers		
			-improved happiness	$F = 0.035$, $p < 0.05$	
			Managers/engineers vs factory workers		
			-improved communication	$F = 0.0014$, $p < 0.05$	
			-improved job satisfaction	$F = 0.0062$, $p<0.05$	

Study authors	Population & sample	Statistical analysis	Measurement variables	Significant findings	Non-significant findings
		Wilcoxen signed-rank test	HRV		
			-HR (bpm)		z = 1.35, *NS*
			-SD (msec)	$z = 2.42$, $p<0.05$	
			-LF		z = 1.79, *NS*
			-HF		z = 1.60, *NS*
			-Total power	$z = 2.17$, $p<0.05$	

Note. *Among one or more time-points (pre-intervention/baseline, middle intervention, end of intervention)
**Covariates: age, gender, body mass index, and medication status

APPENDIX D: INFORMED CONSENT FORM

SCHOOL OF EDUCATION
ORGANIZATIONAL LEARNING, PERFORMANCE & CHANGE
209 Education Building
450 W Pitkin St.
1588 Campus Delivery
Fort Collins, Colorado 80523-1588
(970) 491-6317
soeinfo@colostate.edu

INFORMED CONSENT FORM TO PARTICIPATE IN A STUDY ON WORKPLACE WELLNESS

You are invited to participate in a study being conducted by Erin Cunningham Ritter, a student in the Organizational Learning, Performance and Change doctoral program at Colorado State University. The purpose of the study is to analyze the effects of Heart Rate Variability (HRV) self-regulation (HeartMath®) trainings on employee's mental and physical health as well organizational outcomes. Heart rate variability is defined as "a measure of the naturally occurring beat-to-beat changes in heart rate/heart rhythms. It serves as a critical method for gauging human health and resiliency" (HeartMath® Institute, 2015, para.1).

Participation should take approximately five hours to complete.

PARTICIPATION

Participation in this research study is voluntary and will not affect or influence any form of job evaluation. The decision to participate in this study is entirely up to you. You may refuse to take part in the study at any time without affecting your relationship with the investigator of this

study. Your decision will not result in any loss or benefits to which you are otherwise entitled. You have the right to withdraw completely from the study at any time.

BENEFITS & RISKS

Evidence suggests that participation in the training workshops may improve physical health, mental health and organizational quality and that these potential benefits outweigh potential risks associated with this study. There is the risk that some questions may cause emotional discomfort.

CONFIDENTIALITY

The POQA-R4 Assessment tool is a 52-question survey owned by the HeartMath® Institute. Demographic questions on the survey include: gender, age, marital status, employment status, level of education, hours worked per week, number of years in the organization, and number of years in the current job. Only the research team at HeartMath® can access the raw data collected. Each participant assessed is given a Login-ID specific to that study group. They use that code to enter the online survey which is located on the HeartMath® Server. Each participant is either given or assigned a Study Id or instructed to use a 4-digit pin code that they make up and keep secret for both the time-1-pre and time-2-post responses.

The researchers are the only ones that can export that group's data to an Excel Spreadsheet to analyze. The identity of the participants is therefore kept anonymous. The reports rendered only contain aggregate graphs and scale data – no original raw responses are included. These are the data that will be shared with the primary researcher of this study.

Your responses are strictly confidential. When the data and analysis are presented, you will not be linked to the data by your name, title or any other identification item. The consent form will be stored on a locked computer and only accessible to the study primary investagor.

The data will be stored in a secure and locked location for three years after which the data will be destroyed.

INCENTIVE FOR PARTICIPATION

Each participant who completes all pre and post assessments and attends all four workshops, will be entered to win 1 of 8 gift cards for $25.

CONTACT

If you have further questions or concerns about your rights as a participant in this study, contact the Office of Research Compliance at (970) 491-1553 or RICRO_IRB@mail.colostate.edu. If you have questions concerning the study, contact the principal investigator, by email at erinslc1@gmail.com or the Responsible Faculty Dr. Thomas Chermack or by email at Thomas.Chermack@ColoState.EDU.

ELECTRONIC CONSENT

Please select your choice below. You may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that

- You have read the above information
- You voluntarily agree to participate
- You are 18 years of age or older

☐ Agree

☐ Disagree

X _____

APPENDIX E: IRB APROVAL

PROTOCOLS
Cunningham Ritter, Erin Sage Law

The protocol listed below has been approved by the CSU IRB BMR Fort Collins on Tuesday, June 15th 2021.

PI: Chermack,Thomas

Submission Type and ID: Initial 2048

Title: The Effects of a Heart Rate Variability Self-Regulation Training Intervention on Physiological/Psychological Health and Organizational Outcomes

Approval Date: Tuesday, June 15th 2021

Continuing Review Date: no date provided

Expiration Date: Friday, June 14th 2024

The CSU IRB (FWA0000647) has completed its review of protocol 2048 The Effects of a Heart Rate Variability Self-Regulation Training Intervention on Physiological/Psychological Health and Organizational Outcomes. In accordance with federal and state requirements, and policies established by the CSU IRB, the committee has approved this protocol under Expedited review.

Any additional comments regarding this approval are included below. If you have additional questions about this please contact RICRO IRB Staff.

Please note:

- This protocol will need to undergo Continuing Review and approval prior to no date provided.
- Any additional changes to this approved protocol must be obtained prior to implementation of those changes, by submitting an amendment request to the CSU IRB for review/approval.

Good luck in your research endeavors!

Initial review has been completed on June 15, 2021. Approval has been approved to recruit with the approved recruitment and consent procedures. Review was conducted under expedited review category 7. Continuing review is not required in accordance with [.109(f)(1)(i) expedited. The study was assessed as being in accordance with 45 CFR 46.111. The IRB has determined that the consent process fulfills the requirements of 46.116 and is documented per 46.117. RISK LEVEL: No More than Minimal SPONSOR: None

Attachments

Consent	Informed Consent.docx
Recruitment Materials	Recruitment email.docx
Letter of Cooperation	Research Partnership Agreement.msg
Methodology Section	Methods Section IRB.docx