BUILDING COHERENCE AND INCREASING EMOTION REGULATION FLEXIBILITY TOWARDS RESILIENCE: AN EXPERIMENTAL STUDY IN SINGAPORE

Doctoral Project

Presented to the Faculty

School of Behavioral Sciences

California Southern University

in partial fulfillment
of the requirements
for
the degree of

DOCTOR

OF

PSYCHOLOGY

by

Yih Shyang Sim

February 18, 2020

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Title of Doctoral Project: Building Coherence and Increasing Emotion Regulation Flexibility Towards Resilience: An Experimental Study in Singapore

Doctoral Project Committee:

Daniel Levinson, Ph.D.

Signed: ____ ___________
Project Chair Date

Rebecca Wardlow, Ed.D.

Signed: ____ _________
Committee Member Date

Brian Cesario, Ph.D.

Signed: ____ _________
Committee Member Date

Rollin McCraty, Ph.D.

Signed: ____ _________
External Committee Member Date

Gia Hamilton, Psy.D.

Signed: ____ _________
Dean, School of Behavioral Sciences Date

ACKNOWLEDGMENTS

This doctoral project would not have been possible without the guidance, support, and insights of my Chair, Dr. Daniel Levinson. His unwavering support of this project was a great motivator from beginning to end and was always ready to offer wisdom, advice, and inspiration. I want to extend my heartfelt appreciation to my Committee Members, Dr. Rebecca Wardlow and Dr. Brian Cesario. A special mention to Dr. Rollin McCraty, Director of Research at the HeartMath Institute, who is also my external committee member, and Jackie Waterman from the HeartMath Research Center, for their valuable guidance in advising on the Heartmath System, HRV measurements and the analyses of the POQA-R4.

A big thank you to Dr. Adrian Low for his recommendation of the HeartMath System. It has served as the foundation of this doctoral project and has also profoundly changed my clinical practice, and his help in linking me up with Dr. McCraty. And also, Dr. Janet Lau for helping me in connecting with Dr. Dan to chair my project. Without these two Drs, I would not have been able to embark on research that was profoundly resonated with my heart.

Most importantly, I want to thank my spouse, Audrey, who has been tireless in her support, love, and commitment to me and my efforts as I pursued this doctoral degree. I want to also thank my family for their years of understanding and encouragement. This has been one of the most important journeys in my life, and I could not have done it without their unswerving support and encouragement. I owe everyone here the deepest of gratitude.

ABSTRACT

Although numerous agencies in Singapore have recently taken active steps in promoting the importance of emotion regulation and resilience building, there is a paucity of publication on such intervention programs. The purpose of this quantitative experimental study, the first in Singapore, was to examine the effectiveness of the HeartMath System (HMS). Thirty-four healthy participants from all walks of life in Singapore participated and were randomly assigned to the intervention group and the wait-list group. All participants completed the pre- and post-assessments, and the intervention group received a 2.5-hour workshop and practiced the HMS for 13 days. The findings were examined with a 2x2 mixed factorial MANOVA, univariate analyses, paired sample t-tests, and a Pearson correlational coefficient analysis between HRV measurements, POQA-R4, SOC-13, and ZTPI scores. Results showed significant multivariate interactions in HRV ($p < .001$), SOC-13 ($p < .05$), and ZTPI ($p < .05$) measures, all with very large effect sizes. Significant condition x time univariate interactions were observed in five 5-minute resting HRV, three 3-minute stress-preparation HRV, Relational Tension, Total SOC, SOCMA, BTP, PF, and PN, all with very large effect sizes. There were noticeable directional changes and very large effect sizes observed in POQA-R4. Correlational analyses revealed that participants with higher HRV, SOC, and BTP experienced reduced stress and increased resilience. The current findings support the use of the HMS, a research-based resilience-building program consisting of simple, practical techniques that Singaporeans can use “in-the-moment” and “on-the-go,” to help them build coherence and increase emotion regulation flexibility towards resilience.

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OVERVIEW OF THE STUDY

The building and strengthening of resilience have been considered as the key pillar and priority of Health 2020, the World Health Organization (WHO) European policy framework for health and well-being, and the United Nations Sustainable and Development Goals (United Nations, 2015; WHO, 2017a, 2017b). Substantial evidence reported by several systematic reviews and meta-analyses (e.g., Chmitorz et al., 2018; Gheshlagh et al., 2017; Joyce, Shand, Tighe, Bryant, & Harvey, 2018; Lee et al., 2013) demonstrates that the concept of resilience is expedient for the development and delivery of 21st-century health services and public health programs (WHO, 2017b).

According to Berk (2014), emotion regulation is essential to human development across the life span from toddlerhood to older adulthood. Individuals who possess the ability to alter their emotional responses can effectively meet the demands of life and achieve overall well-being (McCraty & Zayas, 2014). With the growing body of research on resilience, this study has examined not only what constitutes emotion resilience and how it can be developed and enhanced but also has explored how individuals can establish a new baseline of resilience in order to respond flexibly to environmental demands. Salutogenic interventions such as emotional management techniques and the shifting of individual time perspective were explored on their effectiveness in obtaining physiological and psychological coherence leading towards better clinical outcomes and positive well-being.

Background of the Problem

Resilience has a vast potential that could have a profound impact on health where it has received enormous attention in the political and clinical arenas, which call for more extensive effort to implement more health promotion strategies. For instance, resilience has been identified as an essential consideration for the health and welfare of people by the Medical Research Council, and the Economic and Social Research Council in the United Kingdom (Windle, Bennett, & Noyes, 2011).

In Singapore, the Ministry of Education (MOE; 2008) introduced the Social Emotional Learning (SEL) model, a preventative approach to promote capability and mental wellbeing of young students in Singapore schools. The SEL model has been implemented as a primary intervention across all educational levels and an overarching framework guiding all other school-based initiatives that promote fostering and strengthening their capacity. Furthermore, the SEL movement has highlighted the importance of investing more attention in the emotional domain of schooling by acquiring the knowledge of the impact of emotions on the school outcomes of young students (Chong & Lee, 2015; Hoffman, 2009). Despite the effort to promote resilience in schools, the peak of 27 youth suicides was reported in 2015, which raised the red flag among parents, educators, and healthcare providers. Additionally, the Samaritan of Singapore (SOS) recently reported that there were 361 reported suicides in 2017 and 397 in 2018. There was a rise in suicide rate from 7.74 deaths per 100,000 Singapore residents in 2017 to 8.36 in 2018, indicating a 10% increase in one year. SOS also reported that suicides among boys aged 10 to 19 had set a record high (Channel News Asia, 2019). With that, Singapore's first national study, The Singapore Youth Epidemiology and Resilience (YEaR) was commenced on April 2019 that is set to reach out to 12,000 youths with the aim to estimate the prevalence of mental health conditions in youths aged 10 to 18, including the gauge of their emotional resilience (TODAY Singapore, 2019).

According to the Cigna 360 Well-Being Survey – Well and Beyond (Cigna Corporation, 2019) which collated about 13,200 responses from over 24 countries, 92% among the 502 respondents in Singapore reported higher work stress as compared to the global average of 84%, of which 13% reported that the stress as unmanageable. One study (Ee & Chang, 2010) that examined the resiliency of graduate trainee teachers in Singapore found that 34.9% demonstrated average resilience and 65.1% have below average resilience. The researchers suggest the need for more intervention programs on resilience for teachers, with the emphasis in addressing emotional competencies, such as self-regulation, self-assessment, motivation, empathy, and social skills in a systematic way.

During the last few years, other than the MOE, several agencies in Singapore have taken active steps to promote knowledge of and skills in obtaining resilience and emotion regulation, including primary care physicians (e.g., Cheng & Tan, 2016), children (e.g., Kuah, Tan, Tan, Santiago, & Rahim, n.d.), children's residential group homes (e.g., Pat-Horenczyk, Sim, Schramm-Yavin, Bar-Halpern, & Tan, 2015), and the general community (e.g., Changi General Hospital, n.d.). Mindfulness-based practices, one of the most studied and validated interventions have been integrating into Singapore schools, where some schools have incorporated the practice into their Social and Emotional Learning (SEL) programs, to promote health and well-being (Khng, 2018). However, despite the extensive effort of implementing these programs to the diverse community, the published intervention programs on resilience and emotion regulation in Singapore are scarce. Hence, there is a need for further examination of more evidence-based interventions on emotion regulation that could be introduced as a nationwide movement to achieve resilience and well-being.

Statement of the Problem

There is a lack of agreed consensus upon the definition of resilience (Fletcher & Sarkar, 2013; Masten, 2011). Despite the rich research literature on this construct, resilience is generally considered as a multifaceted phenomenon that is determined by the presence or absence of diverse resilience-promoting resources such as optimism, social support, active coping (Smith et al., 2008). Interestingly, with recent increasing attention on the use of emotion regulation as the main target of treatment to various psychological problems, there is also a lack of agreement on its definition, as demonstrated in different studies (Mazaheri, 2015).

Although there are inconsistencies in both definitions, it is crucial to recognize the connection between resilience and emotion regulation. In a systemic review of the scientific literature on psychological resilience, Meredith et al. (2011) highlight that despite the 122 definitions of resilience that had been proposed by prior researchers, a conclusive delineation of resilience, regardless of whether it is a trait or an outcome, leads to an experience of significant adversity. Such experience of adversity is intrinsically emotional where individuals need to be able to recognize the emotional experience and consider ways to cope with their emotions in order to possess the ability to “bounce back” from a stressful event (Kay, 2016).

A recent Gallup poll, which was conducted in 2011, surveyed 148 countries and areas, it concluded that Singapore was ranked the least emotional country in the world, with 36% reported feeling either positive or negative daily. In other words, residents in Singapore were least likely to account for feeling both positive and negative emotions (Gallup, 2012). Other than down-regulating negative emotions, the up-regulating of positive emotions can build personal resources, expand thought-action repertoire, and improve coping, that is essential for cultivating the capacity for and demonstration for resilience (Fredrickson, 2001; Tugade & Fredrickson, 2004). Furthermore, Tugade and Fredrickson (2007) posit that individuals can increase resilience in challenging times by adopting strategies that sustain and develop positive emotions.

According to research, psychophysiological coherence has been found to be associated with sustained positive emotions such as appreciation, care, and compassion (McCraty, 2004; McCraty, Atkinson, Tomasino, & Bradley, 2009; McCraty, Barrios-Choplin, Rozman, Atkinson, & Watkins, 1998; McCraty, Bradley, & Tomasino, 2004; McCraty & Childre, 2004; McCraty & Tomasino, 2006a, 2006b). Additionally, activation of pleasant subjective feelings, heartfelt emotions and attitudes not only play a critical role in rupturing the stress cycle through effectively transforming stress at its source which is characterized by negative perceptions, feelings, emotions that are caused by a perceived challenge or threat (McCraty & Tomasino, 2006a, 2006b), but also demonstrate improvements on physiological, psychological, and social functioning (Fredrickson, 2002; McCraty, Atkinson, Tiller, Rein, & Watkins, 1995).

All these are achievable with the acquisition of physiological coherence, also referred as heart coherence or cardiac coherence, which is embodied by increased synchronization between the activity of heart and brain (McCraty et al., 2009; McCraty & Childre, 2004). Research has shown that programs promoting heart-based coherence building techniques, which encompass the use of tools and technologies to cultivate positive emotions and physiological coherence have helped individuals to reduce their most fundamental source of stress responses. They also improve their capacity to recognize and self-regulate their responses to stressors in both personal and work contexts (Lackey, 2014; McCraty & Atkinson, 2012; McCraty, Atkinson, Lipsenthal, & Arguelles, 2009; Weltman, Lamon, Freedy, & Chartrand, 2014). Based on research, the coherence building program has shown promising results in helping individuals to achieve long-term health and wellbeing. However, there were only a handful of studies that have investigated the effectiveness of this program in Asia, such as Malaysia (Sarwari & Wahab, 2018a, 2018b; Senik & Wahab, 2013), Hong Kong (Low, 2018), and Singapore (Morris, 2010).

Purpose of the Study

The purpose of this quantitative experimental study was to examine the effectiveness of the HeartMath self-regulation skills and coherence-building program (Institute of HeartMath, 2014) on both physiological and psychological measures, which are related to improved emotion regulation flexibility and personal resilience for Singaporeans. It is believed that this improvement will enhance their health and well-being. The current study was designed not only to explore the relationship between the delivery of the coherence-building program and psychophysiological coherence that are crucial to achieving resilience, but also to examine the interplay between these factors in relation to the sense of coherence (SOC; Antonovsky, 1993) and the balanced time perspective (BTP; Zimbardo & Boyd, 1999, 2008) as all these factors have been associated with emotion regulation and resilience.

The author aimed to determine whether the HeartMath coherence-building program not only has the potential to increase personal psychophysiological coherence, denoting the synchronization between the brain and heart (McCraty, 2011); but also whether there are effects on several factors. These include a person's SOC, where one has the ability to integrate and balance the emotional valance of experiences in order to develop and sustain health and well-being (Bachem & Maercker, 2016); and a person's ability to achieve a BTP. This refers to an optimal configuration of the various time perspectives where such balance has been found to be positively associated with well-being (Zhang, Howell, & Stolarski, 2013; Zimbardo & Boyd, 1999). The research questions to be addressed in this study were:

1. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase psychophysiological resilience, as measured by Heart Rate Variability (HRV) and Personal and Organizational Quality Assessment (POQA-R4)?
2. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase the sense of coherence?
3. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days facilitate a balanced time perspective?
4. What are the factors that may improve emotion regulation flexibility?
5. How does the HeartMath coherence-building program compare with other strategies for building resilience?

Theoretical Framework

This study has examined the effectiveness of the coherence-building program which is based on the HeartMath System developed by the Institute of HeartMath (IHM; 2014). This has served as the main conceptual framework on the acquisition of resilience. With stress and resilience both encompassing physiological and psychological components (Carlson & Birkett, 2017; Fletcher & Sarkar, 2013; Kirschbaum, Klauer, Filipp, & Hellhammer, 1995), HRV was used to determine the physiological aspect as it is a psychophysiological marker of emotion regulation. HRV has been identified as an objective measure of neurocardiac function that determines the heart-brain connections and the autonomic nervous system (ANS) dynamics (Beauchaine, 2001; McCraty, 2011).

The outcomes of HRV were further cross-examined with a subjective self-reported stress questionnaire, the Personal and Organizational Quality Assessment - Revised 4 Scale (POQA-R4; Barrios-Choplin & Atkinson, 1996; Institute Of HeartMath, 2011). The POQA-R4 is an empirically validated and normed assessment that provides a broad outline of the participants' emotional experience; it includes the measuring of the four factors: Emotional Vitality scale (positive factors that enhance performance); Organization Stress scale, Emotional Stress scale, and Physical Stress scale (negative factors that impede performance).

The SOC is a construct at the heart of the salutogenic model (Antonovsky, 1987) that predicts effective coping measures in confronting stressful events. It is delineated as a global orientation that expresses the extent to which an individual has an enveloping, enduring, yet a dynamic feeling of confidence with the following three elements. Firstly, there is a conviction that the stimuli arising from one's internal and external environments in the course of living are structured, predictable, and understandable (comprehensibility – cognitive component). Secondly, there is confidence that resources are available for one to meet environmental demands (manageability – behavioral component). Last, there is confidence that these demands are deemed as challenges, worthy of investment, and engagement (meaningfulness – motivational component). According to the model, individuals with strong SOC are more likely to appraise stimuli as non-stressors, which insulates them from experiencing potentially harmful effects of stress. They possess the capacity to select flexibly the most appropriate coping strategy that allows them to enjoy greater health. Further, it has been suggested that the strength of SOC has direct physiological consequences that affect health status (Antonovsky, 1987; Lindstrom & Eriksson, 2005, 2006). This notion aligns with an early study which has specifically linked vagally mediated HRV to one's sense of coherence (Nasermoaddeli, Sekine, & Kagamimori, 2004).

According to research, the perceptions of the past, present, and future play an important role in people's well-being (Bryant, 2003; Diener, Suh, Lucas, & Smith, 1999; Durayappah, 2011; Kim-Prieto, Diener, Tamir, Scollon, & Diener, 2005). Zimbardo and Boyd (2008) posit that adopting moderate attitudes toward the past, present, and future promotes health, while extreme attitudes propel predictably towards unhealthy patterns of living. The five attitudes toward time, or time perspective, which include the Past-negative (PN), Past-positive (PP), Present-fatalistic (PF), Present-hedonistic (PH), and Future (F), contribute to emotion regulation. Achieving a temporal balance or a balanced time perspective, which is represented by moderately high scores on PP, PH, and F, as well as a low PN and PF, is crucial to psychological well-being (Zimbardo & Boyd, 1999, 2008). In other words, with attitudes that can flexibly interlock the various time perspectives depending on situational needs, demands, and values, a BTP is central to good health (Boniwell & Zimbardo, 2004).

Significance of the Study

According to the Lancet Commission report (Patel et al., 2018), the collective failure to address the rising mental disorders worldwide could cost the global economy up to US$16 trillion between 2010 and 2030. The recently published Singapore Mental Health Study (SMHS) that was conducted in 2016 by the Institute of Mental Health (IMH; 2018) found that 13.9% of Singaporeans have a lifetime prevalence of mental illness, an increase from 12% reported in the 2010 study. As discussed in the onset, 92% Singaporeans reported higher work stress, of which 13% reported the stress as unmanageable, as indicated in the Cigna 360 Well-Being Survey – Well and Beyond (Cigna Corporation, 2019). Furthermore, the SMHS survey found that 78.4% of people with mental illness did not seek help; albeit a decrease from 82.1% in 2010 (IMH; 2018), nonetheless attention is still warranted.

With the abovementioned, the current study has examined the HeartMath coherence-building program with non-clinical participants in which its interventions have demonstrated improvements in personal stress, energy factors which have helped people to increase their well-being, quality of life and potential effectiveness (e.g., Lackey & Hector, 2014). Additionally, the treatment outcomes research in clinical populations with the use of HeartMath interventions have demonstrated substantial improvements in chronic conditions, such as chronic pain (Berry et al., 2014), perinatal depression (Beckham, Greene, & Meltzer-Brody, 2013), anxiety in patients with remitted schizophrenia (Trousselard et al., 2016), and anxiety in patients with eating disorders (Scolnick, Mostofsky, & Keane, 2014). Hence, it is noted that the HeartMath program consists of interventions that are beneficial for both clinical and non-clinical populations in Singapore.

The central theme of this study was about obtaining balance and coherence in both psychological and physiological aspects of resilience. Based on the concept of salutogenesis, it is crucial for people to lead a healthy life and cultivate one's mind and body towards a coherent and optimal mode of functioning (Antonovsky, 1987). The author posited that learning self-regulation techniques that are taught in the coherence-building program enables a physiological shift to a more coherent state that activates higher-order thought processes (Institute Of HeartMath, 2014). This shift, in turn, facilitates one to flexibly interconnect the various time perspectives (e.g., ability to stay in the present, savoring the past-positive and plan for the future instead of being stuck in the past-negative or present fatalistic; Zimbardo & Boyd, 2008). The acquisition of these qualities enables an onset of a repatterning process in the neural architecture that establishes coherence as new, stable baseline reference or norm, in which individuals will be equipped with increased intuitive awareness and adaptability needed towards adverse conditions (McCraty & Childre, 2010).

With continued and accelerated rise of stress and mental illness in society, the HeartMath coherence-building program (2014) provides simple, practical techniques that Singaporeans can use “in-the-moment” and “on-the-go” helping them to build the capacity and flexibility needed to prepare for, recover from and adapt to stress and adversity. As such, the practice of coherence-building techniques promotes greater balance and self-directed control in both mental and emotional faculties which give practitioners higher capacity to comprehend the situation, manage adversities with resources, and perceive its meaningfulness (Antonovsky, 1987; McCraty & Childre, 2010). Hence, these evidence-based techniques not only add to people’s repertoire of coping strategies but also as an additional therapeutic framework for Singapore agencies who work with either or both clinical and non-clinical populations.

Limitations and Delimitations of the Study

Several limitations relating to this study were observed. The first limitation may be attributed to the small sample size of forty, mostly younger and less culturally diverse participants. The small sample size was also due to logistical reasons, although a large effect size was expected (Clark-Carter, 2010; Field, Edwards, Edwards, & Dean, 2018). Another limitation was that while HRV is an objective measurement of stress and physiological coherence, the assessment of HRV will be conducted at different parts of the day. The variations of participants’ time of water and food consumption, traveling distance to researcher’s office, climatic conditions or personal encounters on the day may heavily influence their HRV (Quintana & Heathers, 2014; Ren et al., 2011; Wu et al., 2013).

This study was susceptible to an occurrence of cross-contamination effects between the treatment and control groups which can impede a meaningful-group analysis because even if participants were randomly assigned to one of the two groups, they may have already known each other when they signed up for the study. Hence, there was a high chance of contact between both groups which may attenuate the treatment contrast (Keogh-Brown et al., 2007; Magill, Knight, McCrone, Ismail, & Landau, 2019).

Limitations relating to the use of self-reported questionnaires in this study, including the POQA-R4, SOC, and ZTPI, are noted. The aggregate data obtained through the pre- and post-surveys may not wholly represent participants' feelings, attitudes, or behaviors which may be attributed to the tendency for them to respond in a socially acceptable manner, demonstrating a social desirability bias. Further, an acquiescent or a non-acquiescent bias may occur where participants with the former may respond "yes," and the latter may respond "no" regardless of the content of the question (Demetriou, Ozer, & Essau, 2015).

The researcher has established several delimitations for the current study. First, this study was set to research resilience in the salutogenic approach, focusing on helping Singaporeans to learn effective and practical coping strategies so that they can obtain positive adaptation in the face of stress and adversity and maintain their health. Second, according to a literature search, the current study is the first to examine the efficacy of HeartMath System, consisting of coherence building tools and technologies, in relation with HRV, POQA-R4, SOC, and ZTPI in Singapore. There are numerous instruments which have been used to study resilience. The current research has selected several measures that specifically determine the practicing of the coherence-building techniques demonstrates multiple positive outcomes. These include, first, one's ability to generate physiological coherence (HRV). Second, one's proficiency to mobilize available and appropriate resources to cope with stress (SOC). Third, one's capacity to obtain a flexible temporal emphasis of mostly positive time orientations and less of the negative. And fourth, it also leads to an increase of vitality and a decrease in stress (POQA-R4). The last delimitation was to examine the non-clinical population, and therefore, only healthy subjects were recruited for the current study.

Definitions and Key Terms

Coherence: A term that implies a correlation, connectedness, consistency in the system, and efficient energy utilization. In the context of physiology, these implications suggest that coherence describes the degree of coupling, synchronization and harmonious interaction between one or more physiological oscillatory systems, such as respiratory rhythms, heart rhythms, and blood pressure oscillations (McCraty, Atkinson, Tomasino, & Bradley, 2009; McCraty & Childre, 2010).

Cross-Coherence: The modes of the oscillating systems that occurs when one or more body's oscillatory systems become entrained and oscillate at the same frequency. In other words, cross coherence is a result of an increased coherence in a single system that is coupled to other systems, which can pull the other systems into entrainment or coherence (McCraty & Childre, 2010).

Emotional Coherence: A well-balanced state of sustained, self-modulated positive emotion that is considered as a primary driver of the beneficial changes in physiological function that engender improved performance and overall well-being (McCraty et al., 2009; McCraty & Childre, 2010).

Emotion Flexibility: The ability to implement emotion regulation strategies with various degrees of variability that are synchronized with changes in the environment (Aldao, Sheppes, & Gross, 2015).

Heart-Brain Interaction: Research has shown that heart and brain communicate in a dynamic, ongoing, two-way dialogue where each organ is constant influence over one another.

Research also demonstrates that the heart communicates with the brain and body through nervous systems (neurological), hormones (biochemical), pulse waves (biophysical), and electromagnetic fields interactions (energetic). The heart-brain connection is one of the outcomes of cross-coherence (Institute of HeartMath, 2001; McCraty & Childre, 2010; Pribram, 1986).

Heart Rate Variability (HRV): Derived from electrocardiogram (ECG) or pulse wave recordings, HRV is a measurement of the naturally-occurring beat-to-beat changes in heart rate that reflects heart-brain interactions and autonomic nervous system (ANS) dynamics (McCraty et al., 2009). There are two types of methods used to analyze HRV. One approach is the time-domain analysis that quantifies the amount of variability in measuring the long-term interbeat intervals (IBIs) where the collection of its data is primarily observed from a 24-hour Holter monitor. The other method is the frequency-domain analysis, which includes the measurements that utilize the power spectrum of the short-term (about 5 minutes) IBIs. The Task Force Of The European Society Of Cardiology And The North American Society Of Pacing And Electrophysiology (1996) divided these IBIs into four primary frequencies: ultra-low-frequency (ULF, <0.0033 Hz), very-low-frequency (VLF, 0.0033-0.04 Hz), low frequency (LF, 0.04-0.15 Hz), and high-frequency (HF, 0.15-0.4 Hz) bands. While there is disagreement on the inference of the ULF power, very slow-acting biological processes are associated, such as the circadian rhythms (Shaffer, McCraty, & Zerr, 2014). The VLF demonstrates a strong association with arrhythmic death (Bigger et al., 1992) and PTSD (Shah et al., 2013), the LF is induced by both sympathetic and vagal activity (Bernstone & Cacioppo, 1999), and the HF is an index of vagal tone (Eckberg, 1983). HRV is highly reflective of stress and emotions and has been considered as an essential indicator of psychological and emotional resilience, and behavioral flexibility that allows one to possess the ability to effectively adapt to contextual demands (McCraty et al., 2009; McCraty & Childre, 2010).

Physiological Coherence: A term that is used interchangeably with cardiac coherence and heart coherence. It is a state characterized by a shift in autonomic balance toward increased parasympathetic activity, increased entrainment between different body's systems and improved heart-brain synchronization. Based on the measurement of HRV analysis, an individual achieves physiological coherence when one's heart rhythm becomes more ordered, at the heart rate oscillations around 0.1 Hz in the LF band (10-second rhythm). Physiological coherence is considered as the state of optimal function (Institute of HeartMath, 2001; McCraty et al., 2009).

Resilience: The Institute of HeartMath (2014) defines resilience as "the capacity to prepare for, recover from and adapt in the face of stress, challenge or adversity" (p. 2). In this context, the term *capacity* is the key to resilience, as it refers to the amount of energy people have stored in an inner battery – energy that is available to use mentally, emotionally, and physical. A high level of resilience denotes a fully charged inner battery which embodies a greater capacity to remain one's composure, and able to take charge of one's reactions and perceive things more clearly. In other words, a person can obtain greater ability to self-regulate and take charge of one's emotions in the moment when one can intelligently manage of one's energy expenditures and recharge one's inner battery. Hence, when one has more energy, one is more resilient.

Salutogenesis: In contrast to the pathogenesis, which denotes the origins and risk factors, salutogenesis signifies to a scholarly orientation centering on the study of the origins of health and assets for health. In addition, salutogenesis conceptualizes a healthy/dis-ease continuum and elucidates salutary factors that actively promote health (Antonovsky, 1996; Mittelmark & Bauer, 2017).

Time Perspective: It is the often non-conscious personal attitude that individuals divide the continual flow of personal and social experiences into temporal categories, or time frames that help to give order, coherence, and meaning to events. Every individual uses time perspectives not only in encoding, storing, and recalling experiences, but also in feeling and being, as well as in shaping expectations, goals, contingency, plans, and in imaging scenarios (Zimbardo & Boyd, 1999, 2008).

Organization

Chapter one has provided an overview and the background of the current study. Chapter two was centered on a comprehensive review of the literature on resilience and several other theoretical frameworks that support the acquisition and sustainability of resilience, such as HRV, physiological coherence, sense of coherence, and time perspectives. Chapter three has discussed topics, such as the research design, assessment tools, and the details specifically on how the study was conducted. The research results were presented in chapter four. The interpretation of the findings, as well as the implications and recommendations for future research, were discussed in chapter five.

CHAPTER TWO

LITERATURE REVIEW

Stress is ubiquitous and a reality of everyone's daily lives, which has been collectively studied on its short-term and long-term consequences by scholars and researchers in the field of medicine, neuroscience, psychology, mental health, and sociology (Southwick, Bonanno, Masten, Panter-Brick, & Yehuda, 2014). There is substantial research on resilience for the past few decades, and it has gone through several stages, for instance, a shift from identifying protective factors to understanding underlying protective processes. For the last two decades, the Institute of HeartMath has been researching the psychophysiology of stress, emotions, and heart-brain interactions, and advanced tools and technologies to help people to build and sustain resilience. To date, there are over 300 peer-reviewed or independent studies utilizing HeartMath techniques or technologies have been published. While research on the use of HeartMath tools and technologies have demonstrated improvements in people's resilience and emotional well-being, outcomes on the utilization of these evidence-based resilience-building resources with the Singapore population is less understood.

The goal of this literature review is to extensively summarize the definition of resilience and its development from a historical to a modern biopsychosocial perspective. The review is followed by a discussion on the diverse aspects of resilience and emotion regulation that emerged from a comprehensive, interdisciplinary perspective, such as neurobiology, heart rate variability, sense of coherence, and time perspective theory. Finally, the discussion centers on the evidence-based coherence-building tools and technologies that are derived from the theories and research developed and conducted by the Institute of HeartMath.

Search Strategy

The search strategy for this study was based on an electronic search in databases with keywords to establish a literature review component outline. The databases used for the search were EBSCO, Frontiers, ProQuest, and PubMed Central. Google Scholar was also utilized to expand the search repertoire. Keywords used, but not limited to *biofeedback, coherence, emotion, emotion regulation, HeartMath, heart rate variability, resilience, stress, self-regulation, salutogenesis, self-regulation, sense of coherence, time perspective.* All keywords were searched with and without *Singapore.* Sources of information found in these databases comprised of independent and peer-reviewed journal articles, books, dissertations, theses, conference proceedings, and government reports. Other than the older sources that were included to discuss the historical perspectives of the theoretical concepts, the majority were limited to publications within the last five years.

Resilience

The study of resilience emerged during the 1970s where researchers examined the capability of children who were exposed to significant adversity where they sought to understand and prevent the development of psychopathology, which endorsed the notion of resilience as resistance to stress (Masten, 2001). Since then, a few decades of research on resilience has brought several paradigms shifts in its emphasis. For instance, during the 1990s, there was a shift from the identification of protective factors, which include positive emotions and the self-regulation competency, to a study of how individuals overcome adversity and an investigation of the psychosocial factors of resilience in adults who were exposed to trauma (Bonanno, Romero, & Klein, 2015; Cai et al., 2017; Conger & Conger, 2002; Luthar, Cicchetti, & Becker, 2000).

This shift endorsed a pathogenic based approach, characterizing low levels of distressing symptoms as resilience (Casella & Motta, 1990).

Recently, there was a paradigm shift from the pathogenic responses to adversity back to the salutogenic capacities for successful adaptation (Fletcher & Sarkar, 2013; Idan, Eriksson, & Al-Yagon, 2017). According to a recent meta-analysis (Lee et al., 2013) from 33 studies centering on the relationship between psychological resilience and its relevant variables, resilience demonstrates as a type of positive factor; hence leading to a stronger correlation between positive factors and resilience as compared to the correlation between risk factors and resilience. Furthermore, Lee and colleagues found that resilience is strongly associated with positive affect and optimism leading to higher self-esteem and self-efficacy, which in turn functions as a protective process against risk factors such as anxiety, depression, post-traumatic stress disorders, and other psychiatric disorders. In other words, resilience protects people against adversity. With that, maximizing protective factors serves as an important clinical implication for mental health practitioners to enhance their clients' subjective sense of well-being (Perez, Espinoza, Ramos, Coronado, & Cortes, 2009).

Defining Resilience

The term *resilience*, according to the Merriam-Webster dictionary, is initially derived from the field of physics which it is defined as "the capability of a strained body to recover its size and shape after deformation caused by compressive stress." In addition, resilience is also described in a medical perspective as "an ability to recover from or adjust easily to misfortune or change" (Resilience, n.d.). Resilience is a multifaceted phenomenon which is established by the presence or absence of diverse resilience-promoting resources such as optimism, social support, active coping (Smith et al., 2008). It is also known as a construct that propels a rich research literature, and there are abundant and diversified definitions of resilience (Fletcher & Sarkar, 2013; Masten, 2011). In other words, there is an absence of a single agreed-upon definition of resilience in the clinical or scientific literature (Southwick, Litz, Charney, & Friedman, 2011). Such occurrence has caused not only confusion on the conceptualization of resilience, but also the distinctions between the assessments and antecedents of resilience (Britt, Shen, Sinclair, Grossman, & Klieger, 2016).

In their review summarizing and critiquing the resilience-related traumatic stress literature, Layne and colleagues (2007) found that the term, resilience, has been used incorrectly, inconsistently, imprecisely, and/or in an oversimplified way. There is a lack of precision and numerous inconsistencies in using this term, and it has been used to describe at least eight distinct meanings. Such findings are consistent with later research where Meredith et al. (2011) learned that there are 122 definitions of resilience proposed by prior researchers. According to their research, Meredith and colleagues (2011) tracked the diversified delineations of resilience and classified them along a continuum of three main types of definitions. First is *basic*, denoting resilience as a process or capacity that develops over time. Second is *adaption*, signifying the definitions of resilience featuring the concept of "bouncing back," adapting, or the ability to return to a baseline following experiencing adversity or trauma. Third is *growth*, indicating growth as part of the characteristic of resilience after experiencing adversity or trauma.

Amongst the three categories, the type of definition that emphasizes *basic* consists of 24 definitions, *growth* has 18 definitions, and *adaptation* entails 80 definitions (Meredith et al., 2011).

Some examples that represent the *basic* type where resilience is considered as a process or capacity include:

> [Resilience] is more than just a personality trait; it is the product of the person, his or her past experiences, and current life context. (Lepore & Revenson, 2006, p. 40)
>
> A common phenomenon arising from ordinary human adaptive processes. (Masten, 2001, p. 234)
>
> A dynamic process influenced by protective factors, conceptualized as the specific skills and abilities necessary for the process of resilience to occur. (Dyer & McGuinness, 1996, p. 277)

The examples that characterize resilience as the *growth* type include:

> The process of cognitive adaptation to threat…restores many people to their prior level of functioning and inspires others to find new meaning in their lives. (Taylor, 1983, p. 1171)
>
> The strength that people and systems demonstrate that enable them to rise above or recover from adversity. (van Breda, 2008, p. 481)

The examples that deliberate resilience as the *adaptation* type include:

> The ability to maintain a state of normal equilibrium in the face of extreme unfavorable circumstances. (Bonanno, 2004, p. 20)
>
> Resilience may be briefly defined as the capacity to recover or bounce back, as is inherent in its etymological origins, wherein 'resilience' derives from the Latin words salire (to leap or jump), and resilire (to spring back). (Davidson et al., 2005, p. 43)
>
> [Resilience] encompasses psychological and biological characteristics, intrinsic to an individual, that might be modifiable and that confer protection against the

> development of psychopathology in the face of stress. (Hoge, Austin, & Pollack, 2007, p. 142)

Meredith and colleagues (2011) found that most of the definitions emphasize adaptation (*n* = 80), albeit various definitions entail positive growth as a requirement for resilience. In their review, Fikretoglu and McCreary (2012) also noted that most definitions of resilience individuals who have gone through significant adversity demonstrated signs of positive adaptation. Although it has been observed that most definitions highlight adaptation as the main requirement of resilience, its definition provided by the American Psychological Association (APA) includes both basic and adaptation types. With that, APA defines resilience as "the process of adapting well in the face of adversity, trauma, tragedy, threats or significant stress" and the ability to "bouncing back" from difficult experiences (Comas-Diaz et al., n.d., para. 4).

Allostasis, Allostatic Load, and Resilience

Before commencing a discussion on how neurobiological elements impact on resilience to stress, it is crucial to gain an understanding of how the regulation of physiological states are vital to ensure survival (Feder, Charney, & Collins, 2011). This dynamic and adaptive regulation of physiological response to environmental stressors (e.g., "fight or flight" mechanism) is vital to reduce the risk of stress-related psychopathology, such as posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) (Haglund, Nestadt, Cooper, Southwick, & Charney, 2007; Heim & Nemeroff, 2009; McEwen & Gianaros, 2010).

According to Sterling and Eyer (1988), the process of such regulation underlying resilience maintains the homeostasis of the physiological states in response to a stressor is called "allostasis." This active process of possessing "the ability to achieve stability through change" (p.636) implicates the autonomic nervous system (ANS), hypothalamic-pituitary-adrenal (HPA) axis, and the cardiovascular, metabolic, and immune systems to protect the body and brain during exposure to physical and behavioral stressors, notably when rapidly mobilized and terminated (McEwen & Gianaros, 2011; Sterling & Eyer, 1988). Active promotion of adaptation to stress is made possible through the physiologic mediators of allostasis including adrenaline from the adrenal medulla, glucocorticoids from the adrenal cortex, and cytokines from cells of the immune system (McEwen, 2003; McEwen & Wingfield, 2003). In his work focusing on allostasis, Schulkin (2004) introduced cytokines, glucocorticoids, catecholamines, and dehydroepiandrosterone (DHEA) as the four most common allostasis mediators.

When the essential survival allostasis deviates from the optimal internal environment (e.g., physiologic mediators are incessantly elevated without efficient shutting off) and takes a toll on the body and brain, the cost of this allodynamic adaptation to stressors is known as "allostatic load" (McEwen, 1998a, 2003; McEwen & Stellar, 1993). Allostatic load results from a state of chronic stress, or a high frequency of intermittent stress, which activates the neuroendocrine stress response at a prolonged and high rate. Such conditions result in the effects of overuse and dysregulation of the mediators of allostasis that causes increased failures to engage the allostatic systems when needed can lead to wear and tear (McEwen, 2006; McEwen & Stellar, 1993; Ramsay & Woods, 2014; Ullmann et al., 2019). This load arises at the cellular and supracellular levels across multiple physiological systems over the life-course (McEwen & Wingfield, 2003; Picard, Juster, & McEwen, 2014). All these can cause individuals to have anxiety, depression, and altered, health-damaging personal behaviors such as overeating (Dallman, Pecoraro, & Akana, 2003), sleep loss (McEwen, 2006), smoking, and excessive drinking (Anda et al., 1990; Dube, Anda, Felitti, Edwards & Croft, 2002; Juster et al., 2011; Obasi et al., 2015).

It has been described extensively in the literature that unremittingly increased allostasis can lead to disease. For instance, the MacArthur Successful Aging Study (Seeman, McEwen, Rowe, & Singer, 2001), a longitudinal study collected data on 1189 older men and women aged 70-79, including a baseline survey and ten biomarkers where baseline allostatic load (AL) scores were created to compare with risk factors. Out of the ten biomarkers that function across a range of regulatory systems, such as the HPA axis, sympathetic nervous system, cardiovascular system, and metabolic processes; four of the components are primary mediators (e.g., cortisol, noradrenaline, adrenaline, and DHEA), and six of which are secondary mediators of allostatic load. Findings demonstrated that individuals with higher baseline AL scores predict increased risk for 7-year mortality as well as deteriorations in cognitive and physical functioning (Seeman et al., 2001). In addition, a recent study utilized data from the 2003 Scottish Health Survey (SHeS) involving 4,488 men and women concluded that high allostatic load which denotes more considerable physiological wear and tear across multiple physiological systems is associated with an increased risk of death (Robertson, Beveridge, & Bromley, 2017). These results suggest that allostatic load or the cumulative biological burden of frailty indicate the association with worse health outcomes. Also, it is an imperative factor for examination, particularly in the face of life stress to assess how the body adapts to these events (Seeman et al., 2001).

In his review paper on the stress response and development of allostatic load as evinced in Figure 1, McEwen (1998a) elucidates that an individual's genetic, behavior, and experiences can influence one's perception of stress. The physiological and behavioral responses are activated when the brain identifies an experience as stress, which subsequently steers to allostasis and adaptation. The aggregation of the allostatic load and the overexposure to mediators of neural, endocrine, and immune stress raise the risk of adversely affect various organ systems, leading to disease. In other words, the coordination of allostasis is dependent on how the brain evaluates threats (e.g., amygdaloid, hippocampal, and prefrontal cortical regulation) (Herman et al., 2005; McEwen, 2007), and produces behavioral and physiological responses to stress (McEwen, 1998a). In addition, real or perceived threats to homeostasis can galvanize the sympathetic-adrenal-medullary (SAM) axis to release catecholamines that lead to the secretion of corticotropin from the pituitary. This, in turn, facilitates the release of cortisol from the adrenal cortex; and the hypothalamic-pituitary-adrenal (HPA) axis mediates the secretion of glucocorticoids to mobilize energy substrates necessary for fight-or-flight responses (McEwen, 1998a; Sapolsky, Romero, & Munck, 2000).

Researchers have found that the chronic-activation of both SAM- and HPA-axis can initiate a “domino effect” on interconnected biological systems, including inflammatory process as well as other endocrine systems (e.g., thyroid, DHEA), leading to an overcompensation and eventually a collision, steering the organism susceptible to stress-related diseases (Korte, Koolhaas, Wingfield, & McEwen, 2005; McEwen, 1998b; Wilkinson & Goodyer, 2011). Furthermore, both catecholamines and glucocorticoids act in concert to foster the formation of memories from events that are potentially dangerous so that the individual can take preventive actions in the future (Roozendaal, 2000). Figure 2 demonstrates how catecholamines and glucocorticoids affect cellar events, and Figure 3 shows the pathological allostatic states that are ingrained in biopsychological antecedents incorporated within the model of the allostatic state that posits a sequential chain of dysregulation in mediators across multiple systems (McEwen, 1998a, 2006). The perceived stress and the mobilization of these allostatic fight/flight response mechanism and an allostatic freezing/passive response mechanism are primarily fashioned by individual differences (genes, development, and experience) in how the brain interprets situations that produce behavioral (coping, health habits, and personal lifestyles) and physiological responses, that are based on one's historical (environmental stressors, major life events, trauma/abuse) factors that ultimately ascertain one's resiliency to stress (McEwen, 1998a, 2002; Ullmann et al., 2019).

Within the allostatic load model, resilience is an essential concept because it has been associated with positive outcomes for individuals who would have experienced situations that could produce pathological conditions (Luthar & Cicchetti, 2000; Masten & Coatsworth, 1998). Researchers have also suggested that the outcomes of successful allostatic mechanisms in the neuroendocrine, immune, and central nervous systems can lead to resilience. Hence, resilience is an example of successful allostasis and the capacity to minimize allostatic load, and the brain maintains substantial resilience in the face of stress (Feder, Charney, & Collins, 2011; Malta, 2012; McEwen, 2002).

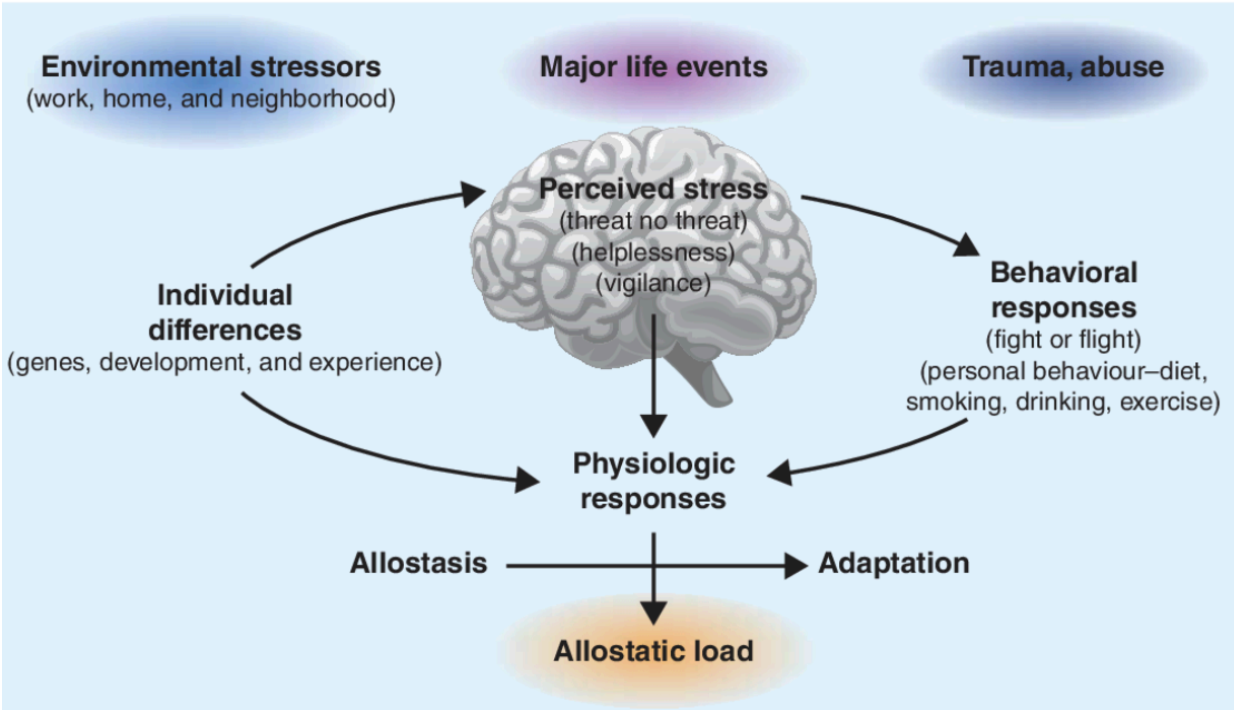

Figure 1. The Allostatic Load Model. The perception of stress is influenced by one's experiences, genetics, and behavior. When the brain perceives an experience as stressful, physiologic and behavioral responses are initiated, leading to allostasis and adaptation. Over time, allostatic load can accumulate, and the overexposure to mediators of neural, endocrine, and immune stress can have adverse effects on various organ systems, leading to disease. From "Protective and Damaging Effects of Stress Mediators," by B. S. McEwen, 1998a, New England Journal of Medicine, 338, p. 172. Copyright 1998 by Massachusetts Medical Society. Reprint with permission.

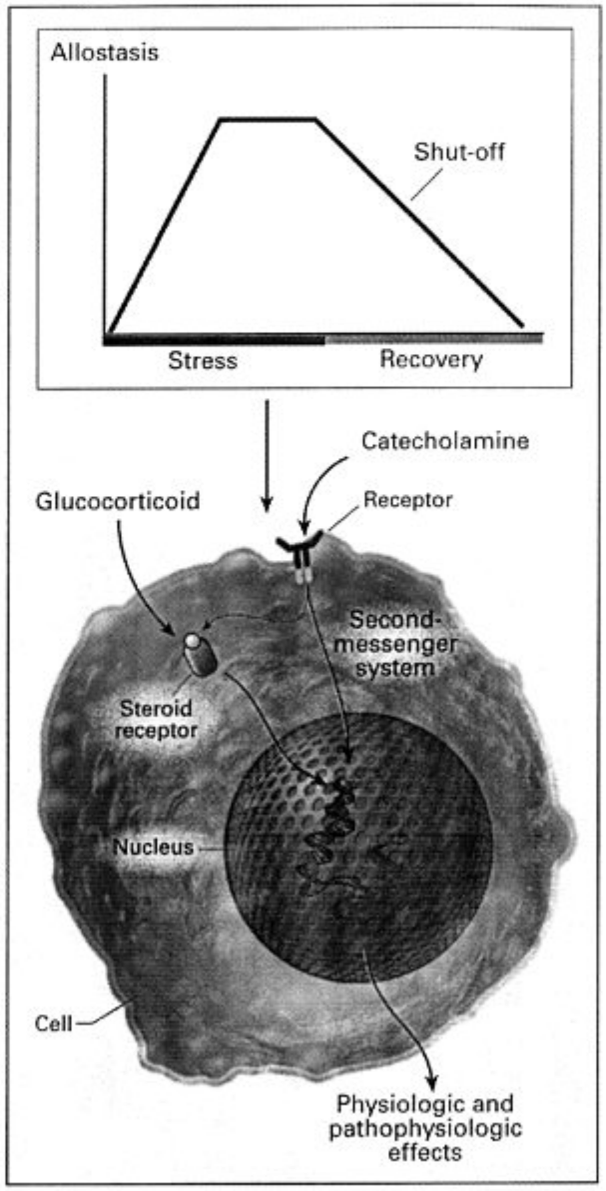

Figure 2. Allostasis in the ANS and the HPA Axis.
Allostatic systems respond to stress (upper panel) by initiating the adaptive response, sustaining it until the stress ceases, and then shutting it off (recovery). Allostatic responses are initiated (lower panel) by an increase in circulating catecholamines from the autonomic nervous system and glucocorticoids from the adrenal cortex. This sets into motion adaptive processes that alter the structure and function of a variety of cells and tissues. These processes are initiated through intracellular receptors for steroid hormones, plasma-membrane receptors, and second-messenger systems for catecholamines. Cross-talk between catecholamines and glucocorticoid-receptor signalling systems can occur. From "Protective and Damaging Effects of Stress Mediators," by B. S. McEwen, 1998a, New England Journal of Medicine, 338, p. 173. Copyright 1998 by Massachusetts Medical Society. Reprint with permission.

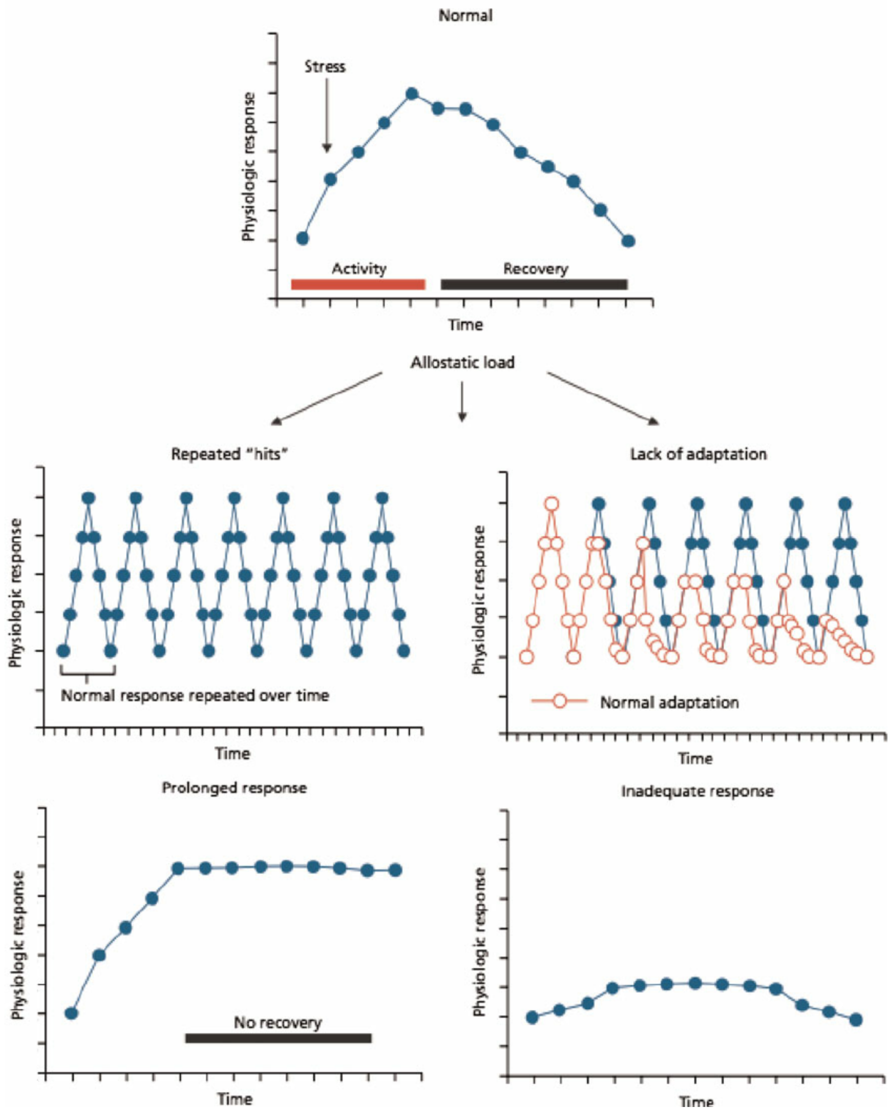

Figure 3. Four Types of Allostatic States. The top panel illustrates normal allostatic responses, in which a response is initiated by a stressor, sustained for an appropriate interval, and then turned off. The remaining panels illustrate four conditions that lead to allostatic load, namely, repeated "hits," lack of adaptation, prolonged response, and inadequate response. From "Protective and Damaging Effects of Stress Mediators," by B. S. McEwen, 1998a, New England Journal of Medicine, 338, p. 174. Copyright 1998 by Massachusetts Medical Society. Reprint with permission.

Neurobiology Perspectives of Resilience

According to a study of 102 healthy adults (Santarnecchi et al., 2018), findings demonstrated significant association between the tendency to espouse different coping styles (e.g., avoidant, problem-focused, social support seeking) and functional connectivity profiles of regions that are belong to the default mode (DMN) and anterior salience (AS) networks. As researchers have struggled to operationalize resilience on a neurobiological level, this is one of the several studies that have endeavored to determine the neural correlates of adaptive coping with stress. Other researchers focused on the ability to recover from mental illness with or without treatment instead of emphasizing on the psychiatric symptoms (Nitschke et al., 2009), and some were driven to determine the capacity to experience stress without developing mental illness (Conrad & Hammen, 1989; New et al., 2009).

In their article focusing on resilience for military readiness and preparedness, Nindl et al. (2018) posit that a physiologically resilient soldier not only would be capable of good decision making under stress but also will feel happy and motivated. It has been known that psychologically resilience has implications not only for mental health but also, it is considered a critical requirement for performance (e.g., military readiness). However, it has been found that it is the physiological mechanisms and neurochemistry that determine psychological performance (Nindl et al., 2018). For instance, insulin-like growth factor 1 (IGF-1) and brain-derived neurotrophic factor (BDNF) are some of the numerous trophic factors that promote brain neurogenesis and synaptogenesis that help to improve psychological resilience, including cognition, mood, and pain thresholds (Friedl et al., 2016). With that, it is crucial to note that an appropriate response to stress, for instance, the efficiency of the neurocircuitries in activating and terminating the reaction to stress that is regulated by intricate negative feedback systems in the brain and the rest of the body, can sustain mental health in the face of adversities (Rutten et al., 2013).

It is imperative to note that the above discussion sheds only a tip of the iceberg on the neurobiological concept of resilience. Several researchers have highlighted that the concept of resilience has to be regarded as the interaction of multiple neurochemical elements within a complex cellular network in the human brain instead of seeing it as the interaction of a single neurochemical element (Ozbay, Fitterling, Charney, & Southwick, 2008; Russo, Murrough, Han, Charney, & Nestler, 2012; Southwick, Morgan, Vythilingam, Krystal, & Charney, 2003). A host of neurobiological factors have found to be associated with resilience to stress (Charney, 2004; Haglund et al., 2007; Southwick, Vythilingam, & Charney, 2005). Despite advances from past research, there is still inadequate understanding in the neurobiological processes ascertaining the brain's capability to develop resilience to stress (Friedman et al., 2014). Hence, it is crucial to examine the complexity of these interacting elements, such as a vast number of neurochemical (e.g., BDNF, neuropeptide, DHEA, cortisol, corticotrophin-releasing hormone, allopregnanolone, galanin) that are found to correlate to the acute stress response as well as to the resilience to stress (Charney, 2004; Feder et al., 2011; Melcangi & Panzica, 2014; Southwick et al., 2003).

In addition, several systems have been considered as imperative in studying the neurobiology of resilience include the hypothalamic-pituitary-adrenal axis (HPA), the sympathetic-adrenal-medulla (SAM) axis, the autonomic nervous system (ANS), the noradrenergic and dopaminergic systems, serotonergic system; as well as brain regions include the amygdala, hippocampus, and prefrontal cortex (Ali & Pruessner, 2012; Feder et al., 2011; Laird, Krause, Funes, & Lavretsky, 2019; Russo et al., 2012; Wu et al., 2013).

Hypothalamic-Pituitary-Adrenal (HPA) Axis. The HPA axis is the primary mechanism, consists of a complex set of brain interactions between the hypothalamus, the pituitary gland, and the adrenal gland, plays a crucial role in coordinating the body's response to stress in both human and animals (Haglund et al., 2007; Herman & Cullinan, 1997; Jones & Moller, 2011; Tsigos & Chrousos, 2002). When an organism perceives or experiences a psychologically or physically stressful situation, the hypothalamus releases two neuropeptides known as the corticotrophin-releasing hormone (CRH) and arginine vasopressin (AVP) from the paraventricular nucleus (PVN) into the hypothalamic-hypophyseal portal system (the connection between the hypothalamus and anterior pituitary) that activates another polypeptide hormone called the adrenocorticotrophic hormone (ACTH). The ACTH, in turn, stimulates the adrenal cortex, resulting in the synthesis of two steroid hormones, glucocorticoids (cortisol in humans, and corticosterone in rats and mice) and DHEA into their stress response (Goel, Workman, Lee, Innala, & Viau, 2014; Jones & Moller, 2011; McEwen, 2007; Pariante & Lightman, 2008; Rosenfeld et al., 1971). While the exertion of these hormones can be influenced broadly and potently throughout the body and brain, changes in their functions can cause huge implications for physical health and psychological well-being (Kamin & Kertes, 2017).

Glucocorticoids. The glucocorticoids travel throughout the body rousing nearly every tissue and organ to redirect energy resources and maintain homeostasis required to respond to normal diurnal changes in metabolism to cope with stressors (Feder et al., 2011; Herman et al., 2016; Sapolsky et al., 2000). Within this process, the glucocorticoids work in concert with norepinephrine and epinephrine to promote the adaptation to stress, which is classically known as the "fight-or-flight" response. The glucocorticoids will increase transiently and then ultimately revert to its baseline levels result from the negative feedback processes occurring in the brain and pituitary (Goel et al., 2014). However, when glucocorticoids are chronically hyper-secreted, the initial benefits of the HPA axis activation would be inverted into increased vulnerability to diseases (Faye, McGowan, Denny, & David, 2018; Feder et al., 2011), such as hypertension, immunosuppression, insulin resistance, osteoporosis, dyslipidemia, truncal obesity, atherosclerosis, cardiovascular disease (Whitworth, Williamson, Mangos, & Kelly, 2005), anxiety and depressive disorders (Carroll et al., 2007), and PTSD (Handwerger, 2009).

Cortisol. Sustained exposure to the anomaly high levels of cortisol, "the most abundant endogenous glucocorticoid in man" (Oakley & Cidlowski, 2013, p. 3), can be detrimental, causing a neurodegeneration of hippocampus leading to memory and learning deficits, as well as suppressing growth, reproduction, and immune process that lead to allostatic load. According to a recent meta-analysis of 354 studies involving 18,374 subjects across both depressed and control groups, approximately two-thirds of the depressed patients have reported higher cortisol levels (Stetler & Miller, 2011). Conversely, short-term secretion of cortisol is protective and has a significant regulatory effect on the hippocampus, amygdala, and prefrontal cortex. Also, cortisol is an anti-inflammatory hormone that is responsible for preventing widespread damages in the tissues and nerves that are caused by inflammation (Heim, Ehlert, & Hellhammer, 2000). Hence, cortisol has a vital role in the stress response where it promotes adaptation, arousal, vigilance, and memory formation (Browne, Wright, Porter, & Svec, 1992; Fiorentino, Saxbe, Alessi, Woods, & Martin, 2012; Gold, Drevets, & Charney, 2002; Karlamangla, Singer, McEwen, Rowe, & Seeman, 2002).

Corticotrophin-Releasing Hormone (CRH). Comparable to cortisol, CRH also plays an important role in the acute stress response, involving both the brain and the gut (Stengel & Tache, 2010). It is a 41-amino acid peptide hormone and neurotransmitter encoded by the CRH gene that regulates hormones of the HPA axis, which is activated within seconds after experiencing acute stress. CRH has been associated with increased arousal, motor activity, activated fear behaviors, and reduced reward expectations (Claes, 2004). Research has found that chronically high levels of CRH has been linked to early stress (Heim & Nemeroff, 2001), mood disorders (Holsboer, 2000), major depressive disorders (Nemeroff, 2002), PTSD (Baker et al., 1999; Bremner et al., 1997), and irritable bowel syndrome (Kano et al., 2017).

According to several animals and human studies, resilience has been associated with rapid activation of the stress response and its proficient termination (de Kloet, Joels, & Holsboer, 2005). Additionally, resilience has been linked with the brain's ability to moderate stress-induced increases in CRH and cortisol through an elaborate negative feedback system, involving an optimal functioning and equilibrium of glucocorticoid and mineralocorticoid receptors (Charney, 2004; de Kloet et al., 2005; de Kloet, Derijk, & Meijer, 2007).

Dehydroepiandrosterone (DHEA) and DHEA Sulfate (DHEA-S). DHEA and its sulfated metabolite, dehydroepiandrosterone sulfate (DHEA-S) (collectively referred to as DHEA[S]) are anabolic androgens, simultaneously with cortisol, are secreted by the adrenal cortex to mediate short- and long-term stress responses and facilitate physiological and behavioral regulations essential for maintaining homeostasis (Chahal & Drake, 2007; Goel et al., 2014; Kamin & Kertes, 2017; Rosenfeld et al., 1971; Theorell, 2008). While the adrenals are responsible for the circulation of cortisol in the body, they produce approximately 80% of DHEA, with the remainder that is produced by the brain, ovaries, and testes (de Peretti & Forest, 1978; Labrie, Martel, & Balser, 2011). DHEA has been deemed to be the most abundant circulating steroid hormones present in humans (Morgan, Rasmusson, Pietrzak, Coric, & Southwick, 2009; Taylor, 2013). However, levels of DHEA are age-dependent, where its peak is reached during early adulthood, and its decline increases with age (Parker, Mixon, Brissie, & Grizzle, 1997). DHEA has been demonstrated to exercise antiglucocorticoid and antiglutamatergic effects (Browne et al., 1992; Yehuda, Brand, Golier, & Yang, 2006), as well as exert antioxidant and anti-inflammatory effects (Rasmusson, Vythilingam, & Morgan, 2003).

A recent study found that individuals who reported higher perceived stress at work had significantly lower levels of DHEA as compared to non-stressed individuals, suggesting lower levels of DHEA may establish the link between psychological stress, ill health, and accelerated aging (Lennartsson, Theorell, Rockwood, Kushnir, & Jonsdottir, 2013). These findings are consistent with early studies demonstrating that lower levels of DHEA are associated with several disease states, such as low-back pain and slow rehabilitation in women (Hasselhorn et al., 2001; Schell, Theorell, Hasson, Arnetz, & Saraste, 2008), depression (Goodyer, Herbert, & Altham, 1998), and mortality of cardiovascular disease in elderly men (Ohlsson et al., 2010).

Research has found that elevated DHEA-to-cortisol ratio levels may offset the adverse effects of high cortisol on mood (Goodyer et al., 1998; Kaminska, Gijsbers, & Dubrovsky, 2000). For instance, early research suggests that DHEA or the DHEA to cortisol ratio is associated with resilience. According to the study, the elevation of DHEA responses to ACTH was found in individuals with PTSD and negatively correlated with the severity of symptoms. The findings suggest that DHEA release may buffer acute stress symptoms and/or sustaining performance. Consistent with this study, several military studies demonstrated that soldiers with increased DHEA or higher DHEA-to-cortisol in the blood performed better under acute stress during rigorous military training. Further, the soldiers have also reported lower dissociate symptoms and have shown superior physical and psychological military performance, suggesting that high values of DHEA may exert a protective and regenerative role against stress, which indicating higher resilience (Morgan et al., 2009; Morgan et al., 2004; Taylor, 2013; Theorell, 2008).

More recent evidence has shown that DHEA antagonizes effects of cortisol (Buoso et al., 2011; Pinto et al., 2015) and DHEA has been found to reduce activity in regions (e.g., right amygdala and hippocampus) associated with the activation of negative emotion and enhances activity in regions (e.g., rostral anterior cingulate cortex) associated to regulatory control of emotion (Sripada et al., 2013). Hence, DHEA has been considered as a mechanism underpinning biological resilience to stress, a link to a wide range of health outcomes (Charney, 2004; Feder et al., 2011; Pfau & Russo, 2015).

Autonomic Nervous System (ANS). Other than the HPA axis, the ANS is one of the two major bodily systems that determine the body's responses to stress (Cacioppo. 1994), where both are widely regarded as the key to health and well-being (Sapolsky et al., 2000). Comparable to the HPA axis, chronic and uncontrolled activation of the ANS, also known as *dysautonomia*, can be a result of chronic inflammation and cause a series of pathological health conditions, such as insomnia, hypertension, fatigue, heart disease, diabetes, Parkinson disease, rheumatoid arthritis (Compare, Zarbo, Shonon, Van Gordon, & Marconi, 2014; Gehrman, Harb, Cook, Barilla, & Ross, 2015; Goldstein, Robertson, Esler, Straus, & Eisenhofer, 2002; Koopman, van Maanen, Vervoordeldonk, & Tak, 2017).

A division of the peripheral nervous system, the ANS is composed of two tonically active systems known as the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS), which controls a variety of involuntary bodily processes, including respiration, heart rate, and digestion, as well as other visceral activities that maintain homeostasis. Both systems are antagonistic by their functions. In other words, the increased activity of one system induces the simultaneous decreased of activity of the other. Under certain conditions, one system takes dominance over the other. For instance, the SNS predominates during exercise and exerts “fight-or-flight” reactions during adverse events (Boron, 2011; McCorry, 2007).

Conversely, the PNS prevails during quiet and resting states. The distinctions between both are the former initiates an increase of blood flow that is well-oxygenated and rich in nutrients to the tissues in order to get the body prepared for strenuous physical activity. Whereas the latter sets to a state of conservation and storing of energy, and initiate regulation of basic body functions such as digestion and urination (Boron, 2011; McCorry, 2007).

When an individual is experiencing a challenging situation, the mobilization fostered by the SNS and the deactivation of the PNS is considered adaptive. However, protracted activation of SNS is metabolically costly and may lead to wear and tear on the body (Koopman et al., 2017; McEwen, 1998b). Hence, the PNS is an important system that serves to counter the sympathetic response and decreases inflammatory responses (Sloan et al., 2007). McEwen (2007) considers the modification and compensation from both SNS and PNS set an example of mutuality in the regulation of allostatic systems.

Sympathetic-Adrenal-Medullar (SAM) Axis. The SAM axis is a component of the SNS. Together with the HPA axis, they are two distinct but interrelated stress response systems initiated from the hypothalamus, where both works in concert to mediate the physiological response to stress (Ali & Pruessner, 2012; Cannon, 1915). Although both systems are activated during the stress response where they involve the adrenal gland and its secretions are released into the bloodstream, the SAM axis role of stress can be simply described a “fight/flight,” and the role of the HPA axis is more complex (Gunnar & Quevedo, 2007). Also, in contrast to the HPA axis where its activation consists of a longer-term hormonal response that is observed with an estimated duration of 15-20 minutes following an onset to stressor, the SAM axis is designed for an immediate response to stress (Dickerson & Kemeny, 2004; Piazza, Almeida, Dmitrieva, & Klein, 2010).

SAM axis acts instantly to acute stress via the SNS to activate a range of physiological and behavioral responses such as increases in heart rate, blood pressure, respiration frequency, and heightened vigilance that are mediated by catecholamines, predominantly epinephrine (EPI; 80%) and some norepinephrine (NE; 20%) from adrenal medulla and NE sympathetic nerve terminals (Bitsika, Sharpley, Sweeney, & McFarlene, 2014; Goldstein, 1987, Gordon, Gwathmey, & Xie, 2015; Smeets, 2010). Also, the activation of the SAM axis leads to a decrease in heart rate variability (Bali & Jaggi, 2015). While the activation of HPA axis is observed to have more chronic longer-term effects, the acute, short-term effects in the SAM axis is a result of the reflex PNS (Herman & Cullinan, 1997; Ulrich-Lai & Herman, 2009). The SAM axis denotes the SNS-stimulated release of the abovementioned catecholamines from the adrenal medulla (Piazza et al., 2010).

Catecholamines and Noradrenergic Systems. During an acute stress event, a catecholaminergic hormone that is regulated by the SNS known as the EPI which is among the first hormones secreted from the adrenal medulla to produce the short-term “fight-or-flight” stress response, including dynamic exercise. The two-minute half-life of EPI highlights the generally short-term effect of stress response is distinguished from the cortisol that induces of a long-term stress response albeit they are both the key hormones in the fight-or-flight response (Herman et al., 2005; Ives & Bertke, 2017; Stojadinovic, Gordon, Lebrun, & Tomic-Canic, 2012; Tidgren, Hjemdahl, Theodorsson, & Nussberger, 1991). As one of the two primary catecholamines, EPI can activate and deactivate sympathetic adrenergic receptors within the cardiovascular system. This is due to its capacity to stimulate all major adrenergic receptors, including α1, α2, β1, and β2 receptors where it could increase heart rate and contractility, and increase blood pressure and glucose release. It is important to note that EPI functions to initiate fight-or-flight response by increasing the oxygen and glucose supplies to the brain and skeletal muscle via cardiac output and vasodilatation (Gordon et al., 2015; Piazza et al., 2010).

Like cortisol, several studies that involved animals and humans' subjects have suggested that EPI is an essential hormone for memory consolidation and it has been found to selectively enhance memory for emotionally arousing stimuli (Abercrombie, Speck, & Monticelli, 2006; Cahill & Alkire, 2003; Dornelles et al., 2007). As Gerard (1961) noted, "[E]pinephrine…is released in vivid emotional experiences, such an intense adventure should be highly memorable" (p. 30). Hence, EPI has been associated with long-term memory of events that produce strong emotions such as fear (Ouyang, Young, Lestini, Schutsky, & Thomas, 2012). In a recent study on mice, researchers found that contextual fear memory was strengthened by peripheral EPI one day after fear acquisition, by acting specifically on peripheral β2-adrenoceptors (Alves, Lukoyanov, Serrao, Moura, & Moreria-Rodrigues, 2016). These adrenoceptors are located on vagal afferents that project to the nucleus of the solitary tract in the brain stem (Williams, Men, Clayton, & Gold, 1998). On the other hand, deficient in EPI has shown to reduced contextual fear learning (Alves et al., 2016; Toth, Ziegler, Sun, Gresack, & Risbrough, 2013). As such, EPI is suggested to be a crucial mediator of long-term consolidation of fear memory and even old memories (Oliveira, Martinho, Serrao, & Moreira-Rodrigues, 2018).

Under stress situations, NE is released from the brainstem nuclei and locus coeruleus and modulates the fight-or-flight response along with EPI from the adrenal medulla (Krystal & Neumeister, 2009). While EPI is responsible for expediting mobilization of metabolic resources and orchestrates the fight-or-flight response, NE is accountable to protect the organism from the perceived threat (Cannon, 1915; Jansen, Nguyen, Karpitskiy, Mettenleiter, & Loewy, 1995). NE functions to mobilize the brain and body for action by increasing heart rate and blood pressure, increasing plasma glucose levels from energy stores, and slowing digestion and gastrointestinal motility (Piazza et al., 2010). These processes help individuals to possess cognitive alertness and vigilant concentration during stress (Southwick et al., 1999). However, high levels of NE are associated with cardiovascular disease, high blood pressure, anxiety, depression, and chronic disease including diabetes (Montoya, Bruins, Katzman, & Blier, 2016; Schroeder & Jordan, 2012; Thomas & Marks, 1978).

According to a research, findings demonstrated that abnormal regulation of brain NE systems had been observed in patients with PTSD where they exhibited symptoms such as re-experiencing, hyperarousal, increased diastolic blood pressure, diaphoresis, and tachycardia (Southwick et al., 1999). Later studies have shown that NE activity in the cell bodies of the locus coeruleus (LC) and its projections to the prefrontal cortex (PFC), amygdala, hippocampus, hypothalamus, periaqueductal gray matter, and the thalamus are considered to have significant relationships with fear and stress responses, in particularly PTSD (Chandler, Gao, & Waterhouse, 2014; O'Donnell, Hegadoren, & Coupland, 2004; Phan, Britton, Taylor, Fig, & Liberzon, 2006; Pissiota et al., 2002; Shin, Rauch, & Pitman, 2006).

The LC is a primary noradrenergic nucleus in the pons of the brainstem that secretes NE during stress (Kiernan, 2005). Its projection system is responsible for modulating arousal, sensory processing, motor behaviors, and executive functions; and is associated with several neuropsychiatric disorders (Berridge & Waterhouse, 2003; Chandler et al., 2014). The LC is also responsible for the excitation of the HPA and SAM axes which inhibits the PNS and neurovegetative function, including eating and sleep, resulting in a state of arousal. In order to allow the instinctual fight-or-flight responses to dominate, the PFC is inhibited, which in turn, switching off the more complex cognition of the forebrain (Charney & Bremner, 1999). Furthermore, the NE levels in the PFC have been found to, in part, regulate the dopaminergic response to stress. For instance, while high levels of NE are associated with mesolimbic dopamine signaling and active coping strategies, low levels of NE lead to mesocortical dopamine signaling and passive coping strategies (Feder et al., 2011). Additionally, active coping is characterized by low HPA axis reactivity and high SAM axis reactivity, whereas passive coping (e.g., freezing) is associated high HPA reactivity to a stressful situation (Korte et al., 1992; Fokkema, Koolhaas, & Van der Gugten, 1995).

During an acute stress situation, the activation of the LC-NE system is implicated in a varied range of normal behavioral and physiological responses such as arousal (Sara, 2009; Snyder, Wang, Han, McFadden, & Valentino, 2012). Along with the HPA axis, they facilitate the encoding and relay of aversively charged emotional memories that are inaugurated in the amygdala (Feder et al., 2011). The amygdala, an important structure in the limbic system has been associated with emotion. Studies have demonstrated that stimulation or lesion of the amygdala can trigger or decrease autonomic responses such as fear and anxiety (Carlson & Birkett, 2017). Additionally, hyperactivity in the amygdala has been reported in anxiety disorders (Drevets, 2000), and major depression (Sheline et al., 2001). An enlarged amygdala demonstrates acute depression (Frodl et al., 2003) and reported in children of chronically depressed mothers (Lupien et al., 2011). Similar to the LC, the amygdala can also inhibit the prefrontal cortex, and stimulates the hypothalamic CRH release and brainstem autonomic centers, ensuing the increased activity of the HPA axis and LC (Gold et al., 2002). Conversely, brain imaging studies have also shown the successful down-regulation of negative emotions that are mediated by the prefrontal cortex impeding amygdala responses (Buhle et al., 2014).

These factors demonstrate the complex relationship between the LC-NE systems and neuronal factors influencing the synaptic release and firing frequency (Strawn & Geracioti Jr, 2008). As discussed above, the LC-NE systems send widespread projections to several regions. In relation to learning and memory, there is a link between LC-NE and both amygdala and PFC. Studies have shown the LC-NE sends strong efferent projections to the medial PFC (mPFC) and amygdala (basal, lateral, and central nuclei) (Arnsten, 2009; Fallon, Koziell, & Moore, 1978). The LC-NE system has distinct effects on learning and memory. This involves the amygdala that is implicated in emotional associative learning where emotional memory formation to aversive or rewarding sensory stimuli that determines adaptive behavioral responses (Duvarci & Pare, 2014; Herry & Johansen, 2014; Janak & Tye, 2015). This also includes the mPFC, which is imperative for facilitating cognitive flexibility, which possesses the ability to switch to new behavioral strategies for optimizing adaptive behavior (Arnsten, 2009, 2011).

Research has shown that there are strong interactions between the LC-NE system and both SAM and HPA axes that may determine the structural basis for emotional arousal (Berridge & Waterhouse, 2003; Valentino & van Bockstaele, 2007). Also, it has been found that the axes' hyperreactive state can lead to stress-related diseases, particularly PTSD (Borodovitsyna, Joshi, & Chandler, 2018). Studies have proposed that emotion regulation strategies (e.g., mindfulness) can buffer central (amygdala) and peripheral (HPA and SAM axes) stress-response-cascades (Creswell & Lindsay, 2014; Huang et al., 2019). Contemplative practices like mindfulness may alter SAM-axis activation by reducing SNS activation and its main stress hormones, such as the catecholamines containing EPI and NE. These allow an increased PNS activation that acts as a vagal brake that counteracts the SNS fight-or-flight responses (Thayer & Lane, 2000). Additionally, stress-induced HPA axis activation can also be decreased and lead to the lower reactive secretion of glucocorticoids, most notably cortisol (Brown, Weinstein, & Creswell, 2012; John, Verma, & Khanna, 2011). Hence, learning practical emotion regulation skills can enhance regulation in both SAM and HPA axes. They can lead to a decrease in allostatic load and the development of psychopathology as well as to promote lifelong stress resilience.

Polyvagal Theory Perspective. Instead of the commonly known pair of antagonistic systems in the ANS, consisting of the SNS and PNS, the polyvagal theory (PVT) identified a third subsystem known as the social engagement system (SES) that yields physiological states associated with safety and affiliation, which is exclusive to mammals. In other words, there is a third nervous system, a SES along with the well-known duo, the SNS (flight-or-flight response) and the PNS (relax response) of the ANS function to support adaptive behaviors in response to safety and threat in the environment (Porges, 1995, 2001, 2007, 2009a, 2011). Discussions in the literature have been centered on the “balance theories” derived from the paired-antagonism model consists of the SNS and PNS. PVT challenges this dualistic notion, but instead, proposes that the ANS reacts to real-world challenges with its phylogenetically hierarchical states and not as the balance between the SNS or PNS (Porges, 2010). In PVT, it describes the sensitivity of this ANS to features of safety and highlights that encountering cues of safety can foster the autonomic responses toward resilience (Porges, 2015). PVT is based on the neurophysiological foundation that builds on an evolutionary and functional understanding of the nervous system. The theory demonstrates how autonomic state and behavior interface that can provide new insights into the biobehavioral reactions and physiological experiences associated with emotion regulation and adaptive behaviors (Porges, 1995, 2001, 2007, 2009a, 2011).

An individual's adaptive responses to the environment, according to the theory, is based on a phylogenetically ordered response among the three subsystems of the ANS, in evolutionary order from oldest to newest: dorsal vagus complex ([DVC]; immobilization; e.g., feigning death, vasovagal syncope, and behavioral shutdown), SNS (mobilization; e.g., fight-or-flight behaviors), and ventral vagus complex ([VVC]; social communication; e.g., facial expression, vocalization, listening), respectively. The PVT asserts that the DVC and VVC are the core components of the PNS. Hence, it is through the action of these nerves; the PNS is both a system of connection and a system of immobilization (Porges, 2011). Further, the activation of the SNS that mobilizes and the DVC that immobilizes upon the evaluation of risk in the environment is dependent on the neuroception, a neural circuit that detects threat beneath the cognitive level (Porges, 2009a).

The term neuroception, in PVT, denotes the neural surveillance mechanisms in the brain that evaluate the level of threat in the surrounding environment. Neuroception serves to detect safety, danger, and threat to life. First, an initial assessment about safety is evaluated by the meaning-making amygdala and associated circuits when information enters into the senses, which occurs below the level of consciousness. If the environment is perceived as safe, neurobiologically adaptive responses will be activated to promote defensive behaviors. For instance, the myelinated branch (runs from the brainstem to heart) of the tenth cranial nerve, the

VVC, inhibits the fight-or-flight response of the SNS and the freeze response of the DVC (Kolacz & Porges, 2018; Porges, 2001, 2007).

If there is a neuroception of danger, the SNS fight-or-flight response will be instinctively activated, and the SES will be attenuated. Further, if the situation aggravates and the amygdala assesses that it is exceptionally life-threatening, the DVC (the unmyelinated branch vagus that runs from stomach to brainstem) gets galvanized to a freeze response, a primitive form of defense. Fundamentally, each system is involved in basal functions for organism maintenance under normal homeostatic conditions while each of these systems can be engaged to regulate metabolic resources when necessary under threat conditions. Based on its phylogenetically ordered response hierarchy, which is consistent with the Jacksonian principle of dissolution (Jackson, 1884), the newer systems are primary responders, whereas the older systems are engaged upon persisting threats (Kolacz & Porges, 2018; Porges, 2001, 2007).

According to the PVT perspective, an individual's openness to connection, curiosity, and change can be made possible through the activation of a VVC state and a neuroception of safety (Dana, 2018). This higher-level and newer neural system enable individuals to seek social engagement for safety and lowering anxiety. However, the nervous system of individuals, particularly with PTSD, are always in the state of hyperarousal in scanning for threats in the environment. This subconscious detection for safety is a critical component when positive social experiences are compromised. Individuals would perceive the environment as unsafe, and the ventral vagus would then be shut down. It will then be automatically taken over by the SNS to mobilize the fight or flight mode. As the mobilized fight-or-flight responses were unsuccessful in protecting oneself, the individual's dorsal vagus, the oldest and primitive nervous system and the lowest hierarchy of the three systems, would be activated to initiate immobilized defense responses. The individual will crash into a freezing state. This is a tonic immobility response or a behavioral shutting down due to one's perception of fighting or escape is impossible. In other words, the failure in fighting back or escape from the perceived situation could lead one living a perpetual dorsal vagal state, freezing into a state of learned helplessness, collapse, and dissociation. This is an adaptive function of the body uses to survive the traumatic experience (Dana, 2018; Porges, 2007; 2009a, 2011).

Research has shown that PTSD has been posited as insufficiency in the autonomic adaption, a demonstration of incongruity in physiological and environmental demands (Williamson, Heilman, Porges, Lamb, & Porges, 2013). This adaption is an autonomic disposition that functions to optimize defense reactions to danger and life threat, and hence, a fight-or-flight state should be adaptive in an environment that is congruent with the physiology. However, when incongruity becomes chronic, especially in the case of PTSD, there is a pathological resetting of the ANS (Williamson, Porges, Lamb, & Porges, 2015). The traumatic experience can interrupt the process of developing the autonomic circuitry of a safe connection and diverts the growth of regulation and resilience. For instance, individuals who have experienced trauma may experience intense and extreme responses such as panic attacks upon hearing screeching tires sounds or a loud bang of the closing doors, could impair one's ability to regulate and stay safe in relationships (Dana, 2018; Porges, 2007, 2009a, 2011).

The VVC, on the other hand, if active, the individual's SES is activated. The individual would be able to relate with other people openly and engagingly, as well as acquire effective emotion regulation. Additionally, this activation of VVC enables individuals to have increased awareness and responsiveness to facial expressions, voice prosody, gestures, and movements. It has been proposed that social affiliation and emotion regulation are emergent properties of the regulatory functions of the VVC (Porges, 2001, 2007, 2011). Porges (2011) added that the neuropeptide oxytocin, which is found to support emotional and autonomic processes, has its role in an individual's social behavior and emotional well-being in the presence of others. According to this aspect, individuals can be activated with immobility without fear, where Carter (2017) posits it as a crucial biobehavioral enabler promoting opportunities to express attachment. As such, the secretion of oxytocin and the activation of its receptors signaling psychological safety provide a platform for individuals to exhibit positive social behaviors and passive coping in the face of challenges.

In comparison to the DVC, a phylogenetically older branch that is originated in the dorsal motor nucleus (DMX; unmyelinated) which is also called the vegetative vagus, is associated with passive reflexive regulation of visceral functions; the VVC is a newer branch that is originated in the nucleus ambiguous (NA; myelinated), also known as the smart vagus, is associated with the active processes of attention, emotion, communication, motion, as well as promotes calm behavioral; states by reducing the influence of the SNS on the heart (Porges, 2011). In addition, the development of the myelinated vagus is deemed as critical in the development of the face-heart connection, which links social behavior and autonomic regulation (Porges & Furman, 2011). Hence, this smart vagus that activates the SES presents not only interpersonal attunement that involves a heartfelt connection with another person, but also demonstrates an increase in cardiac vagal tone that is mediated through the VVC (Lucas, Klepin, Porges, & Rejeski, 2018).

The myelinated VVC is the dynamic brake on heart rate (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). It is "an active vagal brake that supports rapid behavioral mobilization, as well as the capacity to physiologically stabilize an individual utilizing interoceptive visceral awareness, as well as social interaction" (Porges, 2011, pp. xiii-xiv). In other words, the vagal brake modulates visceral states and allows individuals to rapidly engage and disengage with other individuals to foster self-soothing behaviors and calm behavioral states. For instance, healthy infants that exhibit transitory behavioral states such as crying is an example of disengagement of vagal brake and whereas self-soothing indicates a reengagement of the vagal brake (Porges, 2009b, 2011). The vagal tone is a component of the PNS that is related to affect and affect regulation (Porges, 1991; Porges, Doussard-Roosevelt, & Maita, 1994). It is an index of autonomic flexibility, which is associated with positive emotions and social connectedness (Kok & Fredrickson, 2010). Functionally, high vagal tone prompts the vagus to act as a restraint or brake limiting heart rate, whereas low vagal tone removes the vagal brake (Porges, 2009b, 2011).

According to research, the higher level of vagal tone has been associated with social and psychological well-being, such as sympathy (Fabes, Eisenberg, & Eisenbud, 1993), prosocial behavior (Eisenberg et al., 1995), decreased maladaptive coping (El-Sheikh, Harger, & Whitson, 2001), trait positive emotionality (Oveis et al., 2009), increased cognitive performance, and better emotional and health regulation (Thayer, Hansen, Saus-Rose, & Johnsen, 2009). In addition, the core index of vagal activities is heart rate variability, where numerous studies have demonstrated that elevated heart rate variability is associated with greater emotion regulation during stress (Quintana, Guastella, Outhred, Hickie, & Kemp, 2012; Vögele, Sorg, Studtmann, & Weber, 2010).

Resonance frequency breathing, as proposed by Lehrer (2013), can effectively increase vagal tone by performing slow-paced breathing at the resonance frequency. In accord with Lehrer’s notion, McCraty and Childre (2010) add that slow-paced breathing combined with positive emotions, such as appreciation or care can promote personal, social, and global health.

With that, individuals practicing deep abdominal, rhythmic breathing and rhythmic movement can induce activation of VVC and its medullary nucleus to regulate autonomic stress-reactivity, as well as initiate feedbacks that are sent to the solitary nucleus from visceral vagal afferents that promotes bottom-up regulation of primal stress reactivity (Brown & Gerbarg, 2005; Loizzo, 2016; Shannahoff-Khalsa, 2007).

In sum, VVC can be made more accessible to individuals through mind-body practices, which affects both top-down and bottom-up processes that promote optimal neural regulation of the ANS and related endocrine and immune systems. These could help individuals to expand their threshold of tolerance to other neural systems, and to alter the relationship and response to the phylogenetically older branches, such as SNS and DVC, which increase the capacity towards autonomic flexibility (Cottingham, Porges, & Lyon, 1988; Eckberg, 2003; Kok & Fredrickson, 2010; Porges, 2017; Porges & Carter, 2017). As such, the improvement of neural regulation of SES via the VVC can efficiently downregulate fight-or-flight behaviors, which leads to resilience in dealing with disruptions and adversities (Porges, 2015).

Interpersonal Neurobiology Perspective. Interpersonal neurobiology (INPB; Siegel, 1999, 2012) is a consilient, cross-disciplinary approach to explore and understand the science of human behavior. One of the premises in INPB is "the mind is a self-organizing, emergent process that is both embodied and relational and that regulates, as well as arises from, the flow of energy and information within us and between us" (Siegel & Solomon, 2013, p. 2). Siegel (2012) further defines this fundamental principle and proposes the concept of the triangle of well-being: the mind as an emergent process that arises from the system of energy and information flow within and between people; the brain as the embodied neural mechanism that shapes the flow of energy and information; and the relationships in our lives which indicate the interpersonal sharing as the exchange of energy and information between two or more people. In other words, the triangle of well-being signifies the unique aspects of energy and information flow. It is apparent that, in interpersonal neurobiology, the concept of energy and information flow is shared across the three aspects of well-being, and it is shared through movement across time, within and between people.

Siegel (2012) posits that energy is a flow of a fundamental part of our lives, representing the aspect of reality that changes across time. The reality, in this sense, refers to the actuality that is realized as a result of a potential. In other words, energy is the movement from one potential to another potential being realized - energy is the actualization of possibility – moving from openness (infinite possibility, zero probability) to probability (enhanced likelihood) to certainty (100% probability) as represented in the model of the plane of possibility. It is common in relationships where individuals can sense the physical exchange of energy patterns as they flow (across time) as felt realities. These energy patterns are created by attuned communication between people through awareness.

When individuals direct important energy patterns in their awareness, they can create and interpret "energy information," as information is a pattern of energy with symbolic value. Further, if this information is in awareness, people acquire a capacity to reflect on its meaning and the consciousness to make choices in responding to the situation. For instance, learning the terms, "energy" and "information" in this course provides a platform for individuals to learn these words with richer meanings in a context that opens up possibilities in helping others to achieve better well-being. These terms form symbolic representations that connect other individuals and the individual, linking one's internal bodily state and relational life that promotes the sharing of energy and information flow that creates integration. With that, the individual can create a fuller sense of our identity and allow one to have the freedom to develop and pursue harmony in one's lives and move toward health and vitality (Siegel, 2012).

In a physiological context, the brain is considered as the embodied mechanism of the energy and information flow in the body. It is an embodied whole, consisting of a system not only residing in the skull but encompassing the extended nervous system that is intricately and intimately interwoven with the physiology and the bodily processes. Hence, the brain is a system denoting a massively interconnected system which is embodied by the internal somatic and embedded in the external relational processes that shape the flow of energy and information. The INPB's goal is to nurture and cultivate linkage on the differentiation areas of the system and emancipate its impediments to integration. Hence, it is imperative to learn about the parts of this system in order to work toward the aim to differentiate the functioning of the system and promote the linkage of the prefrontal cortex, limbic area, brainstem, body proper, and the neural signals from the social world (Siegel, 2012).

Relationships depict the exchanging of energy and information flow consisting of the patterns of interaction between two or more people. In INPB, patterns of energy encompass symbolic meaning or information that flow through our neural circuits and are shared in our social relationships. Depending on one's synaptic shadows of the past, which may be perceived as either positive or negative, one would approach communication with others according to that experience. These experiences that shape our brain's structure can lead an individual to either enhance or impair the integration and direct one to be open or withdraw from the "me emerging from we" (Siegel, 2012). With that, Siegel (2012) asserts that when functional and healthy, the three aspects of energy and information flow represented by the mind is regulation, relationships are sharing, the brain is the embodied mechanism of the flow, are linked through the process of integration.

The interpersonal aspect of INPB suggests that this consilient theory is heavily rooted in attachment theory (Ainsworth, Blehar, Waters, & Wall, 1978; Ainsworth & Bowlby, 199l; Bowlby, 1969), an overarching conceptual framework that is initially developed to understand the need for security and safety, and the effects on individuals who are experiencing separation, loss, and trauma. The theory suggests that the development of the child's internal working model of security is profoundly shaped by the early relationships between the caregiver and the infant that form a continuum of emotion regulation which imprints lasting influences on interpersonal and emotional functioning while it is also changeable throughout their lifespan (Cassidy, 1994; Siegel, 2012).

Based on the early relationships with one's caregiver, the child's attachment style is shaped accordingly and falls into one of the categories within the attachment classifications. It has been found that the child-attachment figure relationship has four general groupings within a spectrum of secure versus insecure: secure, avoidant, ambivalent, and disorganized (Siegel, 2012). A child with the insecure-avoidant attachment signifies the emotional distanced relationship with one's caregiver who was not attuned to the child's internal needs and feelings. During the separation from the caregiver, this child would not appear to be distressed and would actively avoid or ignore the caregiver. The child would grow up to possess a dismissing narrative where one would be unable to embrace the full range of emotional experience in one's inner and interpersonal lives, as an outcome of impaired integration across the hemispheres (Siegel, 2012).

A child with the insecure, anxious/ambivalent attachment often displays clingy and dependent behavior, but later reject the interaction with the caregiver upon one's return. This child would exhibit distress at the separation, and because of the child's insecurity, it is difficult for one to be comforted even after the caregiver provided the attention to the child. This is the outcome of the inconsistent level of attunement to the child's needs from the caregiver. The child develops an insecure preoccupied attachment state of mind into one's adult years where they would be preoccupied with their past that propels them to have a strong need for their partners to validate their worthiness. A child with a disorganized attachment exhibits no systematic strategy to manage the return of one's caregiver, due to unpredictable, frightening, and hostile caregiving. This disorganized relationship generates a move-away/move-toward dilemma for the child to experience intense fear without resolution. Hence, the child would have significant difficulties with emotion regulation and eventually have a high chance of generating an internal sense of fragmentation and the developmental outcome of dissociation. With the biological paradox that was induced during childhood, the child may develop unresolved trauma and grief into one's adulthood (Siegel, 2012).

In a secure attachment, the child is seen to have parents that are attuned to one's internal needs and feelings. With that, a child may display distress at separation from one's caregiver but can be easily soothed and comforted upon the caregiver's return. This child could view the caregiver as a secure base from which to explore and make sense of their world. The child would bring an autonomous-free attachment into one's adulthood where one possesses the capacity of mentalization in which it is the mindsight ability to be mindful of the mind of oneself and others which paves the way toward integration (Siegel, 2012). Interdisciplinary researchers have found that child-parent attachment development has a profound effect on individuals. For instance, a child who experiences secure attachment will have stimulation on one's neural factor levels with significant meaning that increases higher capacity to build social connection and brain development, such as neuro-regulation (catecholamine), neuropeptide (oxytocin), and neuroactive steroid (hydrocortisone) (Buchheim et al., 2011; Carter, 2017; Schore, 2001; Wismer Fries, Ziegler, Kurian, Jacoris, & Pollak, 2005). A secure attachment also demonstrates to protect against the hyperactivation of both HPA and SAM axes (Frigerio et al., 2009; Johnson, Mliner, Depasquale, Troy, & Gunnar, 2018; Monaco et al., 2017).

According to the INPB perspective, integration is the primary mechanism of health and well-being. Integration is the heart, the essence, and the ultimate mechanism underlying health and well-being with the linkage of differentiated parts of a system. Hence, healing is the process of integration. In INPB, differentiation denotes how the subsets of a collection of elements in the system can be specialized, unique in their growth, and individualized in their development. Linkage signifies the interaction and connection of the subsets to each other, which involve the sharing of energy and information flow. With integration, it supports the linkage of differentiated parts into a functional whole, the whole which is greater than the sum of the parts (Siegel, 2012).

Integration starting with the brainstem by learning its functions can significantly enrich an individual's insights into the energy that drives one's behaviors such as fighting against others, fleeing from danger, or freezing in a state of helplessness. For instance, being threatened by a gangster may put one into one of the states where one may blame oneself for being timid. The awareness of the individual's reactive and impulsive behaviors are signals that one's brainstem receives via the body proper upward through the spinal cord and the vagal nerve to keep one safe from perceived threats. These can, in turn, activate the cortical to override neural mechanisms to turn off the automatic pilot mode. With that, the individual would not only create a linkage between the brainstem and the prefrontal cortex but also obtained deep insights into one's behaviors that help to reduce self-blame and thus enhance self-compassion (Siegel, 2012).

The limbic area of the brain is involved with the integration of a wide range of primary mental processes, such as the appraisal of meaning, the creation of emotions, and the processing of social signals. For instance, when a person places one's full focus on a thing, it is the result of the limbic appraisal that has determined that this thing is important and worth the attention. With the input from the brainstem, the person could experience emotions such as joy, sadness, or anger. Motivational drives and memories will be created and encoded where the person may either continue or discard one's attention towards this thing. Residing above the brainstem and the limbic area is the cortex which is also known as the neocortex or cerebral cortex. The cortex is a neural system that facilitates complex information-processing functions such as perception, thinking, and reasoning, in which its neural processes and the creation of neural maps enable people to represent things from the outer world (Siegel, 2012).

The goal towards health is to obtain vitality and harmony, which is emerged from integration, which substantially facilitates the coordination and balance of a system, and empowers individuals to become more differentiated and interconnected across time. In other words, individuals can move towards a flexible, adaptive, coherent, energized, and stable (FACES) flow of healthy life through the movement of an integration system. However, deviating away from integration, invites chaos and rigidity. This means that the chaos and rigidity are results from the areas of the individual's life where integration was impaired. Chaos and rigidity lead to blockage in integration and impairment on the development of the mind, which can be observed as a various form of mental dysfunction as described in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013; Siegel, 2012; Siegel & Solomon, 2013).

The collection of elements in the system such as the water molecules in a cloud, the functions of the mind, the regions of the brain, and the people in a family, are systems that are non-linear, open to influences from outside of themselves, and capable of entering chaotic states. It has been suggested that complex systems as a natural drive toward integration, an important implication due to its self-organization flow that maximizes complexity leading to integration and creating harmony with a sense of coherence. Hence, when energy and information flow are directed toward integration, health can be attained (Siegel, 2012).

Mindsight is the reflective ability that can help to rewire and transform the neuronal connections in the brain to obtain a more integrated and harmonious way of functioning. A person with this ability can perceive the inner world of both oneself and others, to sense and shape energy and information flow of the triangle of well-being, and to monitor and modify the flow toward integration. The triangle of well-being is the foundation of the mindsight, a kind of focused attention that enables one to observe not only the internal workings of one's own mind but also the connection between mind, brain, and relationships. Hence, this connection is the triangle of well-being where people can be empowered to make a shift of their lives from un-health to health which is more enriching and the ability to create a more flexible way of living (Siegel, 2012). Siegel (2010) posits how an individual can use the lens of mindsight to see the nature of how the world works. After all, we do not live in a unitary realm of a single truth. Our lives are incredibly complicated, and each of us may see the world through a distorted lens which disallows us to be able to dive into our own mental sea. In other words, each of us has a unique mental sea, entailing both wonderful and adverse memories and experiences. Hence, internal education is an essential element in a mindsight-skill approach, along with time-in practices that teach people on the nature of mental activities, how relationships can impact our well-being, and understanding the brain as a source of internal processing (Siegel, 2012).

Siegel (2012) suggests that people can achieve attunement, which denotes the way people focus on the internal emotional and bodily states in an open and receptive fashion. Through the use of mindsight, people are capable of being open to their inner world as well as of the inner world of others. Attunement has two forms. First, is the internal attunement where a person observes oneself in an open, receptive, and caring way based on the here-and-now experience. With internal attunement, it creates an internal resonance and a state of safety that activates our self-engagement system, paving the way for us to become open to ourselves and ready to become our own best friend (Siegel, 2010, 2012). The second form is interpersonal attunement depicting how one person is attuned in an open and empathic way to another person's internal state. This type of attunement between two persons creates an interpersonal resonance; intersubjectivity denotes the link of experience between the two subjective inner worlds together (Siegel, 2012). With these two aspects of attunement, individuals develop the capacity to develop loving-kindness, where they can hold a positive stance towards their own inner world and the inner subjective experience of other individuals. By directing thoughts of loving-kindness towards oneself and towards others enable individuals to shape the flow of energy and information within the mind and to link differentiated regions in the cortex (Lutz, Brefczynski-Lewis, Johnstone, & Davidson, 2008; Villamil, Vogel, Weisbaum, & Siegel, 2019). Additionally, Kok and

Fredrickson (2010) demonstrate that loving-kindness can cultivate prosocial behavior and leads to higher vagal tone, which is consistent with PVT's concept of SES (Porges, 1991, 2001, 2011).

The mindful awareness practice, in INPB, is a highly integrative attention training in which an activation of the prefrontal cortex is required, particularly the middle prefrontal cortex which plays a significant role in many of the integrating processes, such as insight, attuned communication, emotional balance, body regulation, flexibility of response, fear modulation, empathy, morality, and intuition (Siegel, 2012; Siegel & Solomon, 2013). Research has shown that, with repeating practice, the mindful awareness practice could initiate and fortify regions of the brain responsible for attention and emotional regulation, such as the anterior cingulate cortex (ACC), which serves as the communication pathway between the limbic regions and the PFC (Fox et al., 2016; Lippelt, Hommel, & Colzato, 2014; Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008). Also, these integrative states facilitate the default mode network (DMN) to reduce differentiation, decrease its excessive neural firing, and enable its functions toward more balanced influences with the brain's other networks (Brewer et al., 2011). This way of developing the regulation and reflective skills of mindsight, consisting monitoring with more depth and modifying with more specificity toward integration activates the very circuits that underlie empathy and compassion, as well as that, create resilience and well-being. As such, the embodied and relational mind becomes stronger, healthier, more flexible, and more resilient (Siegel, 2010, 2012).

Heart Rate Variability (HRV)

The heart possesses extensive communication with the brain and body. With these communications that are mediated by the flow of neural signals through the efferent and afferent pathways of the SNS and PNS of ANS, they can generate and amplify the short-term (beat-to-beat) changes in heart rate. The beat-to-beat changes that denote the heart rate changes with every heartbeat are called heart rate variability (HRV) or heart rhythm pattern (McCraty et al., 2009), as shown in Figure 4. Although the investigation of HRV began in the 1960s and 1970s where HRV was already used as an index of the physiological control system, it was McCraty, and his colleagues (1995) were the first to discover the critical link between emotional states and the rhythms of the heart. In other words, HRV, the rhythmic pattern of heart activity can reflect the subjective activation of distinct emotional states. Hence, HRV is a primary non-invasive tool serving as a valid physiological indicator of emotional experiences and a valid measure of neurocardiac function that reflects heart-brain interfaces and ANS dynamics (McCraty et al., 2009). Research has shown that HRV is associated with psychological resilience and autonomic and behavioral flexibility, which is representative of people's capacity to adapt to varying environment demands effectively and to execute cognitive tasks entailing the utilization of executive functions (Beauchaine, 2001; Bernston, Norman, Hawley, & Cacioppo, 2008; Gao, Borlam, & Zhang, 2015; McCraty & Zayas, 2014; Thayer et al., 2009).

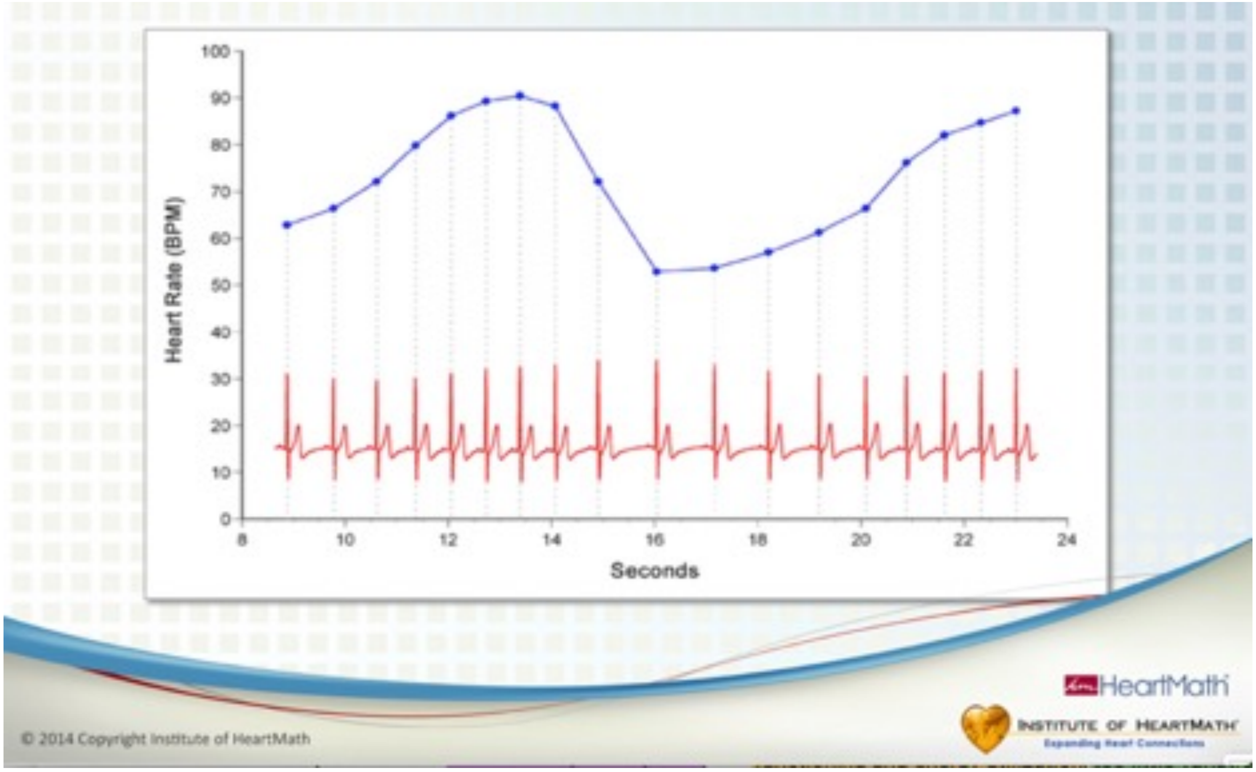

Figure 4. Heart Rate Variability. HRV is a measure of the normally occurring beat-to-beat changes in heart rate. The electrocardiogram (ECG) is shown on the bottom and the instantaneous heart rate is shown by the blue line. The time between each of the heartbeats (blue line) between 0 and approximately 13 seconds becomes progressively shorter and heart rate accelerates and then starts to decelerate around 13 seconds. This pattern of heart-rate accelerations and decelerations is the basis of the heart's rhythms. From "Science of the Heart: Exploring the Role of the Heart in Human Performance," by R. McCraty, Institute of HeartMath, p. 13. Copyright 2015 by Institute of HeartMath. Reprint with permission.

While it is a widespread notion for many years that the normal resting sinus rhythm of the heart is monotonously regular like a metronome, findings from recent research have rejected this notion. That is, the rhythmic pattern of a healthy heart under resting conditions is highly irregular (Shaffer, McCraty, & Zerr, 2014) because the inter-beat intervals (IBIs) of the heart fluctuates markedly resulting from the irregularities in the initiation of the cardiac impulse in the atrium (Abeysekera, 1988). As shown in Figure 4., HRV is used to measure the variation in the duration of the beat-to-beat changes in heart rate that is derived from electrocardiogram (ECG) or pulse wave recordings (McCraty et al., 2009). The most commonly used approaches to analyze HRV, as well as foetal HRV (FHRV), are frequency domain as a power spectral density (PSD) analysis and time domain analysis, where both measures characterize the distribution of IBIs, which denotes the time between two subsequent heartbeats (Romana et al., 2016; Shaffer et al., 2014; Task Force, 1996). These IBIs are known as the “RR interval” that are derived from a single R peak in the QRS complex that marks a heartbeat (Guyton & Hall, 2011).

Frequency Domain Analysis. The frequency domain (PSD) accounts for the periodic oscillations of the heart rate signal that is decomposed at different frequencies and amplitudes, and provides information on the numerical values about their relative intensity (termed variance or power) in the heart’s sinus rhythm (Eckberg, 1997; Malliani, Pagani, Lombardi, & Cerutti, 1991; Task Force of The European Society of Cardiology And The North American Society Of Pacing And Electrophysiology, 1996). The most frequently used measure to perform a power spectral analysis is the non-parametric method, the fast Fourier transformation (FFT), which is a rapid and straightforward method, characterized by discrete peaks for the several frequency components (Sztajzel, 2004). The FFT will transform the RR intervals that are stored in the computer into bands with different spectral frequencies (Hertz [Hz]). With that, the power spectrum comprises of frequency bands ranging from 0 to 0.5 Hz, which they are classified into four primary frequencies: ultra-low-frequency (ULF), very-low-frequency (VLF), low-frequency (LF), and high-frequency (HF) bands (Sztajzel, 2004; Task Force, 1996).

The PSD analysis incorporates the measurements that utilize the power spectrum of the short-term (about 5 minutes) IBIs. The PSD analysis has advantages over the time domain measures as it could provide data on both frequency and amplitude of specific rhythms that are depicted in the HRV waveform. PSD provides a means to quantify the various oscillations over any given period in the HRV recording, such as how power is distributed (the height of the peak at any given frequency stating the amplitude and stability of a given rhythm) as a function of frequency (the time period of a rhythm occurs) (Shaffer et al., 2014).

High-Frequency Band (HF). The HR band ranges from 0.15 Hz to 0.4 Hz, which is comparable to rhythms with periods that take place between 2.5 and 7 seconds (Task Force, 1996). HF is an index of vagal tone or PNS (Eckberg, 1983), and it is also commonly called the respiratory band as it communicates to the heart rate variations that is connected to the respiratory cycle known as respiratory sinus arrhythmia (RSA) (McCraty & Shaffer, 2015; Shaffer et al., 2014). According to Eckberg (1983), RSA can be measured by capturing the HF as the PNS functions using signaling mechanisms that can alter heart rate in phase with respiration. In other words, HF is respiration-mediated, and it is determined by the frequency of breathing (Sztajzel, 2004).

Low-Frequency Band (LF). The LF band ranges from 0.04 to 0.15 Hz, which is comparable to rhythms with periods that take place between 7 and 25 seconds (Task Force, 1996). Many researchers had previously considered this range as the “baroceptor range” or “mid-frequency band” because of its primary reflection of baroceptor activity while at rest (Malliani, 1995). LF is modulated by both the SNS and PNS, which led to researchers advocate the notion that LF is a combination of both nervous systems, whereas others interpret it as a measure of sympathetic modulations (e.g., high LF). However, sympathetic activations in LF may result from physical activity or emotional stress reactions (McCraty & Shaffer, 2015).

The majority has acceded that the LF is a mixture of both autonomic inputs (Ernst, 2017; Malliani et al., 1991; Sztajzel, 2004; Task Force, 1996). Although the LF/HF ratio reflects the global sympathetic/vagal balance and can be used as a measure of this balance (Sztajzel, 2004), research has challenged this notion and contended that in resting conditions, the LF reflects baroreflex activities rather than cardiac sympathetic innervations (Eckberg, 1983; MacKinnon, Gevirtz, McCraty, & Brown, 2013; Porges, 2007; Svensson & Thoren, 1979). Researchers have emphasized that the baroreflex is primarily vagally mediated (Keyl, Schneider, Dambacher, & Bernadi, 2001). These baroceptor activities are part of the afferent neurological activities relaying information from the heart to the brain via the vagal nerves (McCraty & Shaffer, 2015). The calculation of a baroreflex gain is described as the beat-to-beat change in heart rate per unit of change in systolic blood pressure (Bowers & Murray, 2004). With that, it has been found that decreased baroreflex gain is associated with aging and hypertension (Matthews, Sebzda, & Wenner, 2019; Piccirillo et al., 2001).

According to Shaffer, McCraty, and Zerr (2014), the SNS does not appear to generate rhythms much above 0.1 Hz, whereas the PNS can produce heart rhythms down to 0.05 Hz. Researchers have observed that vagally mediated activity can easily produce oscillations in the heart rhythms that cross over into the LF region during slow respiration rates below seven breaths per minute (Ahmed, Harness, & Mearns, 1982; Brown, Beightol, Koh, & Eckberg, 1993; Lehrer et al., 2003; Tiller, McCraty, & Atkinson, 1996). Early research has shown that the PNS contributes to at least 50% of the LF variability while the SNS, at best, simply contributes 25% to this variability (Randall, Brown, Raisch, Yingling, & Randall, 1991). Additionally, Porges (2007) suggests when individuals perform slow-paced breathing at the resonance frequency (0.1 Hz, 10-seconds rhythm or six breaths per minute), the LF encompasses the aggregated influence of both myelinated and unmyelinated vagal pathways on the heart, reflecting total cardiac vagal tone.

Very-low-frequency Band (VLF). The VLF band ranges from 0.0033 to 0.04 Hz, which is comparable to rhythms with periods that take place between 25 and 300 seconds (Task Force, 1996). The VLF band is considered to be a significant factor of physical activity and has been regarded as a marker of sympathetic activity (Sztajzel, 2004), and may be influenced by the renin-angiotensin-aldosterone system (RAAS), a critical regulator of blood volume and systemic vascular resistance (Cody, 1997). The low VLF is not only related to chronic inflammation in numerous studies (Carney et al., 2007; Lampert et al., 2008; Stein et al., 2008), but also holds a strong association with arrhythmic death (Bigger et al., 1992) and PTSD (Shah et al., 2013). However, there are major disagreements about the VLF band concerning FHRV among researchers. Some researchers ascertain the VLF ranging from 0 to 0.03 Hz, while others identify it in the range from 0 to 0.04 Hz or from 0 to 0.05 Hz (Cesarelli et al., 2011; Goncalves et al., 2013; Groome, Mooney, Bentz, & Singh, 1994; Zhuravlev, Rassi, Mishin, & Emery, 2002).

The VLF has been used as a predictor of prognosis (Gunther et al., 2012; Guzzetti et al., 2005; Hadase et al., 2004), and nocturnal VLF may be a predictor of infection after acute stroke (Gunther et al., 2012). In addition, while individuals with sleep-disordered breathing may trigger exaggerated values for VLF power (Shiomi, Guilleminault, & Sasanabe, 1996), healthy individuals may activate an increase in VLF power during their sleep and peaks before waking which implies the association with the morning cortisol peak (Huikuri et al., 1994; McCraty & Shaffer, 2015; Singh, Cornelissen, & Weydahl, 2003).

Ultra-low-frequency Band (ULF). The ULF and falls below 0.0033 Hz (333 seconds or 5.6 minutes). In contrast to the analysis of VLF, LF, and HF characteristics require to the short-term recordings of duration at about five minutes; the ULF band can only be assessed with a longer 24-hour and longer recordings (Kleiger, Stein, & Bigger, 2005). While there is disagreement on the inference of the ULF power, very slow-acting biological processes are associated, such as the circadian rhythms (Shaffer, McCraty, & Zerr, 2014).

Time Domain Analysis

Among the various methods that are used to evaluate variations in heart rates, the simplest to perform is the time domain measures, which computes the changes in heart rate intervals between adjacent normal R waves (normal-to-normal intervals [NN]) over the period of time (Kleiger, Stein, Bosner, & Rottman, 1992; Task Force, 1996). The time domain reports the cardiac system activity (Wang & Huang, 2012) and quantifies the amount of variability in measuring the long-term IBIs where the collection of its data is primarily observed from a 24-hour Holter monitor. The standard deviation of normal-to-normal (SDNN), the SDNN index, and the root mean square of successive differences (RMSSD) are the three commonly used time domain measures to report the activity of the cardiac system (McCraty & Shaffer, 2015; Shaffer et al., 2014). However, in this research, the SDNN, RMSSD, and MHRR will be used to measure HRV.

Standard Deviation of all the Normal-to-Normal (SDNN). The SDNN is the sinus-initiated IBIs measured in milliseconds that reflects the ebb and flow of all the factors contributing to HRV as well as circadian rhythms responsible for variability in the period of recording (Sztajzel, 2004; Umetani, Singer, McCraty, & Atkinson, 1998). A key component of SDNN magnitude (about 30% to 40%) is ascribed to the difference between day and night in NN intervals. Hence, SDNN is calculated over a 24-hour period suggesting that HRV is not a stationary process. It also entails both short-term high-frequency variations and the lowest frequency components presented in a 24-h period (Bilchick & Berger, 2006; Kleiger et al., 2005; Task Force, 1996).

In 24-hours recordings, the SDNN is highly correlated with ULF and total power (Umetani et al., 1998). According to reading from short-term resting recordings, the main source of the variation is parasympathetically-mediated RSA, particularly with slow, deep breathing protocols (McCraty & Shaffer, 2015; Shaffer et al., 2014). In ambulatory and longer-term recordings, SDNN is found to be highly correlated with LF power, which primarily reflects sympathetic activity with a low parasympathetic component (Otzenberger et al., 1998; Shaffer et al., 2014). Recent studies have found that SDNN is associated with mortality in sepsis despite after adjusting for possible confounding factors (Chen et al., 2008; De Castiho, Ribeiro, Da Silva, Nobre, & De Sousa, 2017).

Evidence has shown that SDNN is a good physiological indicator of valence (Kemp, Quintana, & Gray, 2011). For instance, along with HF and LF, research has found that SDNN was significantly reduced in adolescent psychiatric female patients with anxiety disorders and/or major depression disorder compared with health controls (Blom, Olsson, Serlachius, Ericson, & Ingvar, 2010). Conversely, individuals with positive affect were observed to have higher SDNN levels as compared to those with negative affect (Geisler, Vennewald, Kubiak, & Weber, 2010; Jercic, Hagelback, & Lindley, 2019). In a recent review, Kim, Cheon, Bai, Lee, and Koo (2018) reported that the SDNN increases when HRV is large and irregular. Hence, SDNN is deemed as an index of physiological resilience against stress.

Root Mean Square of Successive Differences (RMSSD). The RMSSD is the root mean square of successive differences between normal heartbeats, reflecting the beat-to-beat variance in heart rate. The RMSSD is the primary time domain measure used to evaluate the vagally mediated changes reflected in HRV (McCraty & Shaffer, 2015; Shaffer et al., 2014). The RMSSD is correlated with HF power (e.g., during sleep in men; Otzenberger et al., 1998) and it reflects self-regulatory capacity (Shaffer et al., 2014). However, the influence of respiration rate on RMSSD is indeterminate (Penttila et al., 2001; Schipke, Arnold, & Pelzer, 1999). The

RMSSD is found to have more considerable influence from the PNS than SDNN. For example, studies have shown that lower RMSSD values are correlated with a decrease in the parasympathetic activity of the heart (Dimitriev, Dimitriev, Karpenko, & Saperova, 2008), while the increase in the RMSSD demonstrates an increase in parasympathetic activity (Caruso et al., 2016).

The most commonly used analytical approaches for assessing HRV are the time domain analysis and frequency domain or PSD analysis. While low HRV indicates a monotonously regular heart rate, and it is associated with impaired ANS functions leading to lower ability to cope with internal and external stressors (Kim et al., 2018), higher HRV is associated with psychological flexibility and allostatic resilience (Young & Benton, 2018). HRV is highly reflective of stress and emotions and has been considered as an essential indicator of psychological and emotional resilience, and behavioral flexibility that allows one to possess the ability to effectively adapt to contextual demands (Beauchaine, 2001; McCraty et al., 2009; McCraty & Childre, 2010). Hence, HRV is more than an assessment of heart rate. It is one of the key indicators of an individual's psychophysiological coherence (Lloyd, Brett, & Wesnes, 2010).

Research in recent years has shown substantial support for HRV biofeedback training for a variety of disorders and performance development (Gervitz, 2013). The self-regulation techniques developed by the Institute of HeartMath (IHM; 2014) are designed for individuals to improve psychophysiological coherence by observing their HRV via IHM's biofeedback technologies, an objective measurement of regulatory processes involved in cognitive function and affective stability (Bradley, McCraty, Atkinson, & Tomasino, 2010; McCraty et al., 2009; Porges, 1991; Thayer, Hansen, Saus-Rose, & Johnsen, 2009).

Heart-Brain Connection

The implication of the bi-directional communication between the heart and brain has been identified for more than a century (Lane et al., 2009a; Park & Thayer, 2014). During the early 20th century, French physiologist Claude Bernard was the pioneer to examine the different connections between the peripheral organs, including the heart, and the brain (Thayer & Lane, 2009). According to a statement written by Darwin (1872/1999) who highlighted the work of Claude Bernard:

> When the mind is strongly excited, we might expect that it would instantly affect in a direct manner the heart; and this is universally acknowledged and felt to be the case. Claude Bernard also repeatedly insists, and this deserves especial notice, that when the heart is affected it reacts on the brain; and the state of the brain again reacts through the pneumo-gastric (vagus) nerve on the heart; so that under any excitement there will be much mutual action and reaction between these, the two most important organs of the body (pp. 71-72).

Darwin (1872/1999) noted that Bernard put a strong emphasis on how the heart and brain interact, where this interface is done through the pneumo-gastric nerve, which is nowadays widely received (Thayer & Lane, 2009). According to research, cognitive, affective, and physiological regulation have been found to be associated with vagally mediated cardiac function (Lane et al., 2009a, 2009b; Nugent, Bain, Thayer, & Drevets, 2007; Porges, Doussard-Roosevelt, & Maita, 1994; Pu, Schmeichel, & Demaree, 2010).

Later researchers investigated the interactions between the heart and brain and found that the heart interacts with the brain in fashions that has a significant impact on how people perceive and respond to the world. For instance, according to (Lacey & Lacey, 1977, 1978), the heart was observed to have its peculiar logic that regularly deviated from the domination of the ANS. The heart appears to behave like an organism with a mind of its own which also sends meaningful messages to the brain with the capacity that not only ensures the brain to understand these messages, but also to obey them. These messages from the heart to the brain could affect an individual's perceptions and behavior, as well as facilitate or inhibit the brain's neural activity. In their work with cats, Gahery and Vigier (1974) observed that the stimulation of vagus nerve caused a reduction in the brain's electrical response to about half its normal rate, suggesting that the heart, ANS and all of the related physiological responses do not solely move in concert according to the brain's response to any given stimulus or challenge. This notion implies that the ANS and the exchange between the heart and brain appear to be more complex.

Groundbreaking research in neurocardiology led by Armour (1991) has observed that the heart acts autonomously of the signals directed from the brain as it has its own extensive, complex intrinsic nervous system, encompassing over 40,000 neurons. Based on this discovery, Armour (1991) contented that the complexity of this system is notable enough to qualify it as a "little brain" in its own right, where he calls it as the "little brain in the heart." This was the inception of the concept of a functional "heart-brain," which possess the ability to sense, regulate, and encode information internally (McCraty, 2015). This concept suggests that the heart-brain possesses both short-term and long-term memory functions and can operate independently of the cranial brain.

In contrast to the generally well-known notion that suggested the efferent (descending) neural pathways in the ANS are responsible for the regulation of the heart, research has shown that the majority of fibers in the vagus nerves (80-90%) are afferent (ascending), of which many of these afferent pathways are related to the heart than any other organ (Berthoud & Neuhuber, 2000; Cameron, 2002). This suggests that the heart sends more neural information to the brain than the brain sends to the heart. There are emerging evidence showing that these afferent signals sent from the heart to the brain has a significant and consistent influence in the activities of the frontocortical areas and motor cortex, and affecting the psychological processes underlying people's perceptual sensitivity, attention level, and emotion processing (Lane, Reiman, Ahern, & Thayer, 2001; McCraty, Atkinson, Tomasino, & Bradley, 2009; McCraty & Shaffer, 2015; Montoya, Schandry, & Muller, 1993; Schandry & Montoya, 1996; Svensson & Thoren, 1979). In addition, research has found that the heart transmits information to the brain and body at least four different pathways. First is through ascending pathways in the ANS (neurologically). Second is through the pulse wave (biophysically). The third is through the secretion of hormones and neurotransmitters (biochemically). Last is through the electromagnetic field created by the heart (energetically) (McCraty, 2004; McCraty, Atkinson, & Bradley, 2004; McCraty et al., 2009; Pribram, 1986). Furthermore, in relation to the energetic aspect, the heart generates 100 times stronger than that of the brain (McCraty, personal e-mail, August 10, 2019), which can be measured several feet away from the body in all directions (McCraty, 2004; Stroink, 1989). Being the most potent and perpetual generator of rhythmic information in the body, as well as possessing such extensive communication with the brain and body, the heart unequivocally holds a profound involvement in influencing how people think, feel, and respond to the world (McCraty et al., 2009).

Coherence

Just as many approaches that place their emphasis on a particular premise to obtain resilience, well-being, and health, such as sense of coherence (salutogenesis; Antonovsky, 1987), concept of integration (interpersonal neurobiology; Siegel, 2012), and balanced time perspective

(Zimbardo & Boyd, 1999), IHM (2014) accentuates the importance of coherence. All these presuppositions have the same objective. That is achieving balance and attaining optimal functioning in cognitive, affective, behavioral, and social aspects.

As illustrated in Figure 4, HRV is quantified by measuring the interval between RR intervals in the ECG. When an individual's breathing is at an optimal frequency, the RSA becomes a dominant component of the change in the RR interval where this is known as "resonant frequency," also referred as "coherence" (Kim et al., 2013). Hence, coherence is measurable through HRV analyses (McCraty & Shaffer, 2015). According to the researchers at IHM, the term coherence implies a correlation, connectedness, consistency in the system, and efficient energy utilization. In this paper, the terms coherence, cardiac coherence, and physiological coherence are used interchangeably to depict this harmonious interaction in the physiological oscillatory systems (McCraty & Zayas, 2014).

Consistent with research in the fields of neuroscience, neurocardiology, and psychophysiology, IHM developed the psychophysiological coherence model to enhance a specific physiological state related to optimal cognitive functioning and emotional stability (McCraty et al., 2009). Based on dynamic systems theory, this model accentuates the "importance of healthy physiological variability, feedback, inhibition, and reciprocal interactions among a hierarchy of nested neural systems that underlie a complex psychophysiological system for maintaining stability and adaptability to complex changing environments and social demands" (McCraty & Zayas, 2014, p.1).

In the context of physiology, coherence describes the degree of coupling, synchronization and harmonious interaction between two or more physiological oscillatory systems, such as respiratory rhythms, heart rhythms, and blood pressure oscillations (McCraty et al., 2009;

McCraty & Childre, 2010). When two or more nonlinear physiological oscillatory systems become entrained and oscillate at the same frequency, a *cross-coherence* has occurred. In other words, cross-coherence is a result of an increased coherence in a single system that is coupled to other systems, which can pull the other systems to the frequency of the dominant system (McCraty & Childre, 2010; McCraty & Shaffer, 2015). In addition, when a coherent activity occurs within a single system, this is known as *autocoherence*. This can be depicted as a sine-wave-like heart rhythm oscillating at a frequency of approximately 0.1 Hz, which is equivalent to a 10-second rhythm, dominating the HRV power spectrum, portrayed by a narrow-band, high amplitude peak near the center of the LF band as shown in Figure 9. When coherence is strengthened in a system that is twinned with other systems, it can pull the other systems into increased synchronization into its rhythms that propel more efficient functioning. Hence, it led to the entrainment of these systems (McCraty, 2015).

Figure 5 gives an illustration of how entrainment of a physiological state can induce increased coherence between multiple oscillating systems such as the heart, respiratory, and blood rhythms as well as between very-low-frequency brain rhythms, craniosacral rhythms, and electrical potentials measured across the skin (Bradley & Pribram, 1998; McCraty, 2015; Tiller et al., 1996). This process of entrainment demonstrates a psychophysiological state encompassing an increased coherence within each system (autocoherence) and among various oscillating systems (cross-coherence). All these can be achieved by an intentional self-induced positive emotional state which can initiate a phase-shift in the physiological activity that thrust the physiological systems into a globally coherent mode of function (McCraty et al., 2009).

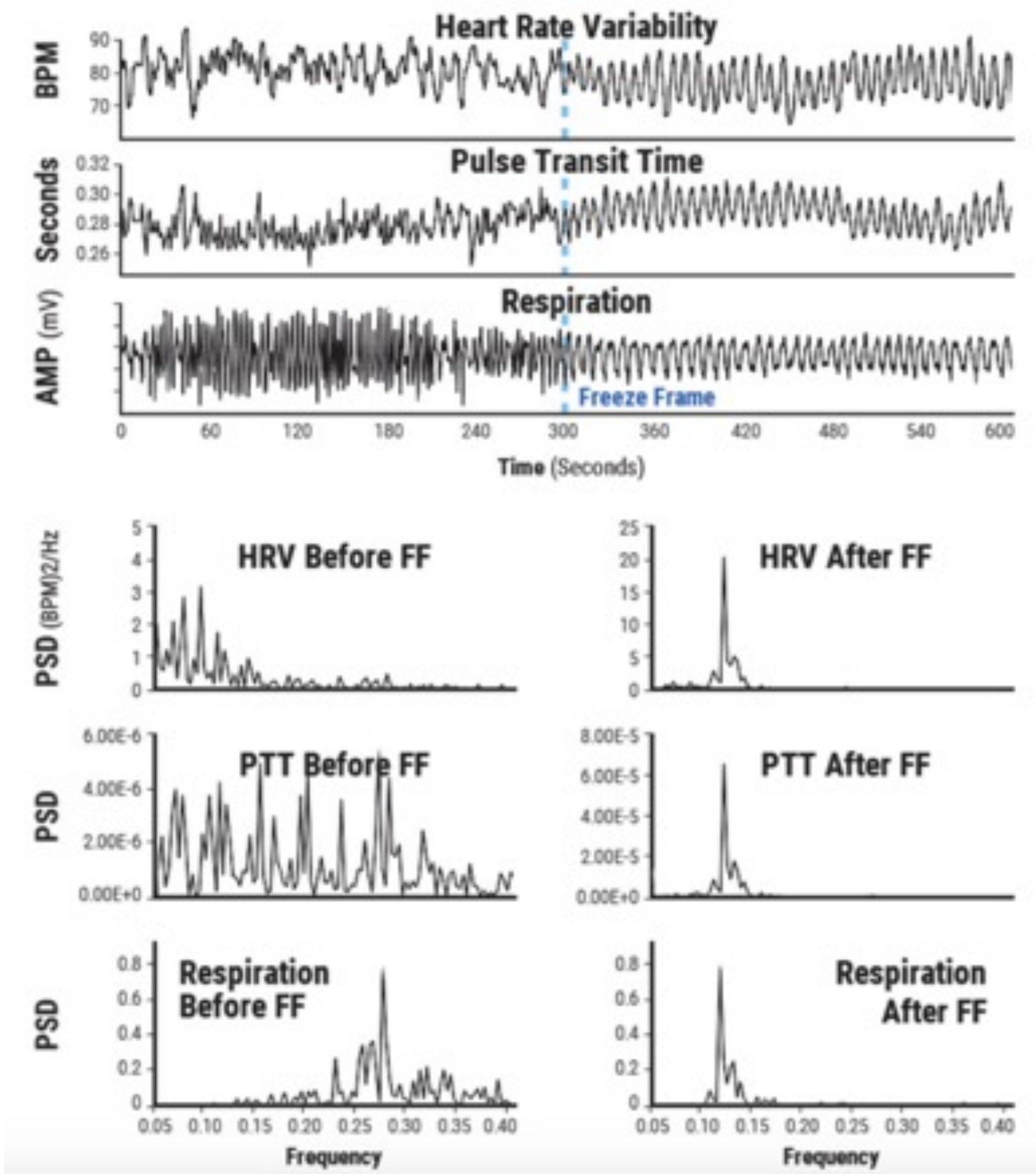

Figure 5. Entrainment between systems. The top graphs show an individual's heart rate variability, pulse transit time, and respiration rhythms over a 10-minute period. At the 300-second mark, the individual used the Freeze-Frame positive emotion refocusing technique, causing these three systems to come into entrainment. The bottom graphs show the frequency spectra of the same data on each side of the dotted line in the center of the top graph. Notice the graphs on the right show that all three systems have entrained to the same frequency. From "Science of the Heart: Exploring the Role of the Heart in Human Performance," by R. McCraty, Institute of HeartMath, p. 25. Copyright 2015 by Institute of HeartMath. Reprint with permission.

Emotions and Coherence

Experiencing stress-related emotions such as anxiety, frustration, anger, and worry can produce highly variable, erratic, and jagged waveform in the heart rhythm patterns. In other words, the reciprocal action of SNS and PNS of the ANS are not synchronized with each other, which indicates a decreased coherence. (McCraty & Childre, 2004; McCraty & Rees, 2009; McCraty et al., 2009; Pontet et al., 2003; Tiller et al., 1996). The reason for an increased disorder in heart rhythm patterns may be resulted from disordered activity in the high-level-brain systems, linking to the disarranged activities between the prefrontal cortex and the parasympathetic branch of the ANS (Lane et al., 2001).

In contrast, intentional shifts to a sustainable positive emotional state such as appreciation, compassion, and love can naturally activate coherence (McCraty, 2004; McCraty & Childre, 2004). With the utilization of HRV analysis that presents distinction of heart rhythm patterns characterizing different emotional states, the above-mentioned positive emotions can generate a smooth, sine-wave-like pattern in the heart's rhythms (McCraty et al., 2009). This particular state reflects increased order in higher-level control systems in the brain, increased synchronization between the SNS and PNS of ANS, a general shift in autonomic balance toward increased parasympathetic activity (vagal tone), and entrainment between diverse physiological systems. Research has shown that a sine-wave-like pattern naturally emerges in heart's rhythms without any conscious changes in breathing when individuals experience positive emotions (Edwards, Edwards, & Highley, 2015; McCraty, Atkinson, Tiller, Rein, & Watkins, 1995; McCraty & Rees, 2009; Scolnick, Mostofsky, & Keane, 2014; Tiller et al., 1996).

According to a recent study which is consistent with the broaden-and-build theory of positive emotions (Fredrickson, 2004) found that positive emotions can build physical health as indexed objectively by cardiac vagal tone. The findings demonstrate that positive emotions, positive social connections, and physical health build an upward-spiral dynamic. Individuals also see themselves as more socially connected when they experience greater positive emotions. With that, increased and accrued moments of positive emotions and positive social connectedness can lead to improved vagal tone, strengthening biological resources that are linked to numerous health benefits and resilience (Kok et al., 2013).

The above suggests that the rhythmic beating patterns of the heart change significantly according to the different emotions people experienced (McCraty et al., 2009; McCraty & Tomasino, 2006b; Tiller et al., 1996). Research has shown that the ANS is correlated with emotions supposedly differ with the valence of emotions that links to implications for the pathophysiological mechanisms of emotion-generated cardiac events (Ekman, Levenson, & Friesen, 1983; Kop et al., 2011; Kreibig, 2010). A recent review has shown that the emotion of fear can generate physiological responses that lead to sympathetic activation, including cardiac acceleration, vasoconstriction, increased myocardial contractility, and increased electrodermal activity. On the other hand, the review also determined that except for joy, all positive emotions are characterized by the decreased sympathetic influence and increased cardiac vagal control (Kreibig, 2010). As illustrated in Figure 6 and also verifiable by quantitative methods, heart rhythms associated with sustained positive emotions are noticeably more coherent (auto-coherence) than those generated during a negative emotional experience. Also, a harmonious heart rhythm occurs when an individual is in the coherent mode, and it typically oscillates at around six cycles per minute (McCraty et al., 2009; Tiller et al., 1996).

Additionally, it is crucial to discern a coherent heart rhythm is distinct from the heart rhythm that arises during the relaxation responses. Although the latter may have demonstrated a reduced heart rate, it not necessarily a more coherent rhythm. In a study, Lehrer et al. (2006) found that improved pulmonary function in both younger and older patients, albeit the latter group has lower HRV. The improvements were associated with HRV biofeedback training but not with relaxed breathing or muscle tension relaxation (Lehrer et al., 1997). As depicted in Figure 7. consists of heart rhythm patterns during relaxation and coherence. It is noticeable that the coherence state produces a highly ordered, smooth, sine-wave like heart rhythm patterns as compared to the state of relaxation on the upper graph. The former is also marked by an unusually large, narrow peak in the LF band, centered around 0.1 Hz (10-seconds rhythm) while the latter results in an HF band, lower amplitude rhythm, signifying reduced autonomic outflow. Hence, it is imperative that coherence and relaxation are two distinct states. While relaxation is a low-energy state in which the individual typically disengages from cognitive and emotional processes, coherence is a state of calm, balanced, yet energized and responsive in navigating through challenging and difficult situations (McCraty & Tomasino, 2006a; McCraty et al., 2009). Coherence can be attained with breathing alone, yet the HeartMath System raises the level of benefits resulting from establishing and sustaining a positive emotional state (Institute of HeartMath, 2017).

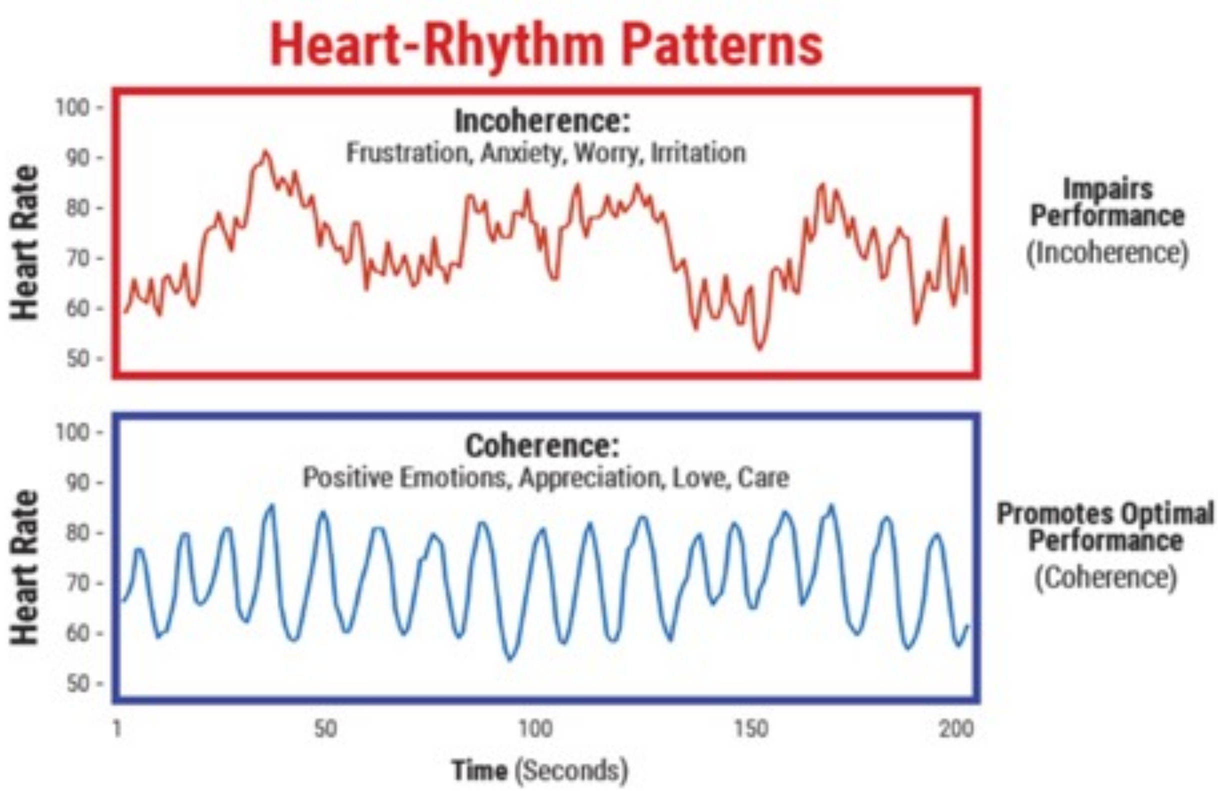

Figure 6. Heart-Rhythm Patterns. The heart-rhythm pattern shown in the top graph, characterized by its erratic, irregular pattern (incoherence), is typical of negative emotions such as anger or frustration. The bottom graph shows an example of the coherent heart-rhythm pattern that is typically observed when an individual is experiencing sustained, modulated positive emotions. From "Science of the Heart: Exploring the Role of the Heart in Human Performance," by R. McCraty, Institute of HeartMath, p. 25. Copyright 2015 by Institute of HeartMath. Reprint with permission.

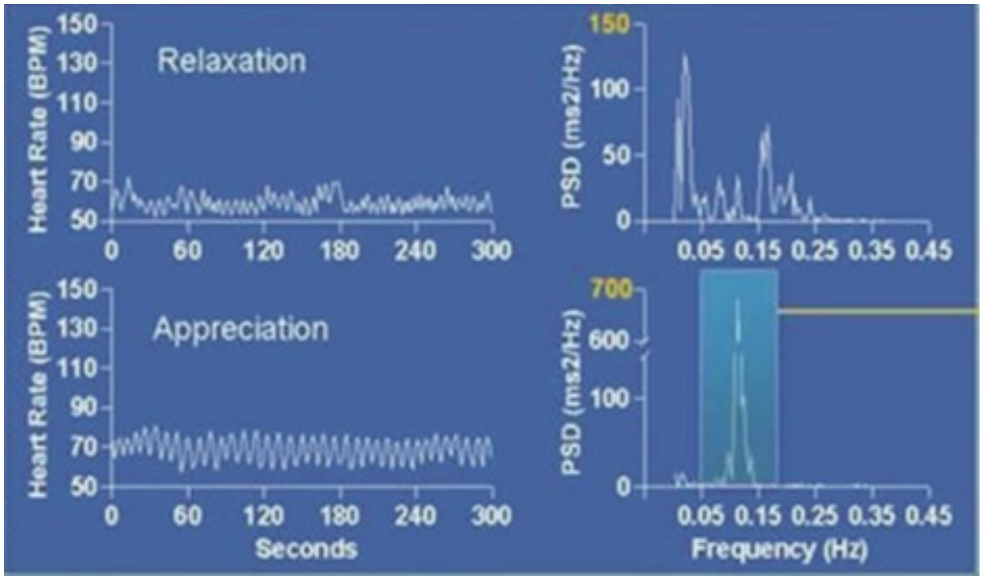

Figure 7. Heart-Rhythm Patterns during Different Psychological Modes. From "The Coherent Heart: Heart-brain Interaction, Psychophysiological Coherence and the Emergence of a System Wide Order," by R. McCraty, p. 13. Copyright 2009 by Institute of HeartMath. Reprint with permission.

Theoretical Framework

As discussed in Chapter 1, this research study is the first to examine the efficacy of HeartMath System, consisting of coherence building tools and technologies, in relation with heart rate variability (HRV), sense of coherence (SOC), and Zimbardo's time perspective theory (ZTP) in Singapore. These are the theoretical models for this research on the understanding of how the HeartMath System can increase personal physiological coherence, and thus leading to a high level of SOC and achieving a balanced time perspective, in which all are correlated to health, well-being, and resilience.

The HeartMath System

The Institute of HeartMath (IHM; 2014) defines resilience as "the capacity to prepare for, recover from and adapt in the face of stress, challenge or adversity" (p. 2). In this context, the term *capacity* is the key to resilience, as it refers to the amount of energy people have stored in an inner battery – energy that is available to use mentally, emotionally, and physical. A high level of resilience denotes a fully charged inner battery which embodies a higher capacity to remain one's composure, and able to take charge of one's reactions and perceive things more clearly. In other words, a person can obtain more exceptional ability to self-regulate and take charge of one's emotions in the heat of the moment when one can intelligently manage of one's energy expenditures and recharge one's inner battery. Hence, when one has more energy, one is more resilient.

The IHM (2014) suggests that the key to building resilience in order to sustain good health and optimal functioning is good management in one's emotions. This is because emotions are closely associated with resilience, where emotions are the primary drivers of numerous vital physiological processes that are engaged in energy regulation. Hence, it is by learning energy-management skills for effective self-regulation, individuals can be mindful of how and where their energy is drained that induces inflammation. With this, they can increase their personal energy reserves and thus increasing one's resilience capacity. Research has shown that the use of the HeartMath system, which employs heart-based emotion refocusing and restructuring techniques, and assistive technologies, are associated with a significant reduction in emotional stress, improved resilience, increased in health status and quality of life in both general and clinical populations (e.g., Field, Edwards, Edwards, & Dean, 2018; Kim et al., 2019; Pyne et al., 2019; Sarabia-Cobo, 2015; Trousselard et al., 2016).

HeartMath Coherence-Building Tools and Techniques

Physiological coherence is deemed as a natural human state which can occur spontaneously, but it is generally difficult to sustain in this state. Although specific rhythmic breathing techniques may engender coherence and entrainment for brief periods, IHM's research has identified that active self-induced positive emotions can help individuals to maintain extended periods of physiological coherence. When a positive emotional state is generated, physiological coherence becomes psychophysiological coherence, indicating the increased synchronization and harmony between the cognitive, emotional, and harmonious functioning of the whole. Such coherent state that is driven by a positive emotion seems to excite the system at its resonant frequency, allows individuals to enjoy a high degree of mental and emotional stability for a longer duration, even during challenging situations (Culbert, Martin, & McCraty, 2014; McCraty & Tomasino, 2004).

The increased complexity and speed of today's world has given rise to alarming stress levels, and people are facing increased personal and social challenges that create incoherence. These forbid them to maintain both psychological and physiological health, thus affecting their well-being and quality of life (McCraty et al., 2009; McCraty & Shaffer, 2015). Based on almost three decades of extensive research, IHM has designed and developed self-regulation tools and assistive technology (e.g., emWave, emWave Pro, and Inner Balance) that provide real-time HRV coherence feedback to help people to systematically increase psychophysiological coherence and emotional stability. Examples of these practical and easy-to-use coherence-building tools and techniques include positive emotion-refocusing tools such as Heart-Focused Breathing, Quick Coherence Technique, Freeze-Frame Technique, and positive emotional restructuring tools such as the Attitude Breathing and Heart Lock-In Technique (Childre & Martin, 1999; McCraty, 2015; McCraty et al., 2009; McCraty & Shaffer, 2015).

A common characteristic among these techniques starts with the shift in attention and focus to the area of the heart while breathing is a little slower and deeper than usual called the Heart-Focused Breathing. Attention will then be placed onto a conscious regulation of one's respiration at a 10-seconds rhythm (0.1 Hz) that facilitates an increased cardiac coherence leading to the process of shifting into a more coherent state, which is a practical, first step in most tools. With this technique that facilitates RSA, it enables people to "helps take the intensity out" or "turn down the volume" of the reaction, and it can be built upon with other techniques by combining a purposeful generation of a heartfelt, positive emotional state. This attentional shift and generation of positive emotions allow for the emergence of the coherence mode, which is an essential marker of one's capacity to adapt effectively to environmental demands. Also, over time, a new inner-baseline reference which is characterized by a type of implicit memory that organizes perception, feelings, and behavior can be established (Childre & Martin, 1999; McCraty, 2015; McCraty et al., 2009; McCraty & Shaffer, 2015; McCraty & Tomasino, 2006b; McCraty & Zayas, 2014).

The abovementioned positive emotion-refocusing tools are designed to empower people to induce rapid emotional shifts so that they can obtain in-the-moment stress reduction. This ability of intentional shifting out of a state of emotional unease helps to facilitate people by reducing their nervous system chaos and achieve a "new" positive state of emotional calm and stability (Childre & Martin, 1999; McCraty & Rees, 2009). With more practice on these techniques, people will learn how to identify and modify persistent self-defeating and energy-depleting thought patterns and feelings such as anxiety, fear, anger, and perfectionism. Further, people can acquire a higher sense of awareness of their habitual mental and emotional processes that trigger their stress. Also, people who practice regularly would be able to use any of the techniques to make an intentional shift to a coherent state before, during, and after challenging or stressful situations. With that, people who have acquired optimized mental clarity, emotional composure, and stability through practicing these techniques obtain the higher capacity to detect the onset of these depleting emotions and modify their physiological stress, response, hence diminishing their influence (McCraty, 2003, 2015).

In addition to the positive emotion-refocusing techniques that are primarily designed for people to use in the moment, IHM has also designed positive emotional restructuring tools that are useful for people to maintain a state of coherence for more extended periods which is typically sustained for five to fifteen minutes. These techniques are useful measures to diffuse accrued stressed and negative feelings as well as establishing a new psychophysiological baseline for sustained behavioral change. It also facilitates resetting maladaptive emotions and promote new physiological baselines or norms at the heart, brain, and hormonal levels (Childre & Martin, 1999; McCraty, 2015; McCraty et al., 2009; McCraty & Shaffer, 2015; McCraty & Tomasino, 2006b).

On top of these practical and easy-to-use coherence-building techniques, the use of assistive technology such as the emWave, emWave Pro, and Inner Balance can help people to bring their heart, mind, and emotions into greater alignment. These devices use a noninvasive earlobe or finger pulse sensor and display the individual's heart rhythm to provide real-time feedback on one's level of coherence. These HRV coherence feedback training devices along with the coherence-building techniques have been used to reinforce self-regulation skill acquisition in diverse contexts by physicians, mental health professionals, educators, law enforcement officers, cooperate professionals, and the military (Institute of HeartMath, 2017; McCraty & Rees, 2009). For instance, a recent study aiming at improving police officers' physiological and psychological stress has shown that the application of HeartMath coherence-building techniques (e.g., Heart Lock-In technique) and HRV feedback technology increase parasympathetic activity (HF power) and demonstrate 23% reductions in cortisol and a 100% average increase in DHEA over a 30-day period (McCraty & Atkinson, 2012).

Researchers from IHM recently examined the influence of heart coherence and a state of appreciation on crystallization patterns in 20 participants' saliva (Deyhle & Waterman, 2013). The participants were instructed to donate a small amount of saliva into glass tubes before and after practicing a 15-minute Heart Lock-In technique (HLI). The results of the post-coherence practice demonstrated that 18 out of 20 participants showed increased order, crystallization patterns, and crystal size. While ANS activity has been associated with the level of coherence (McCraty et al., 2009; McCraty & Childre, 2004), it has also been found to affect saliva secretion and hormone and immune factors in saliva secretion (McCraty, Atkinson, Rein, & Watkins, 1996; McCraty et al., 1998). This study has demonstrated that practicing self-regulation techniques such as the HLI that is induced by positive emotions may have positive effects on people's physiology.

A recent study was conducted among a group of returning veterans with chronic pain who received instruction in the Quick Coherence technique (QCT). It encompasses controlled breathing and activation of self-induced positive or neutral emotion, along with the use of the HRV coherence feedback device (emWave Desktop) for a total of four weeks. Findings in this study demonstrated marked and statistically significant improvements in coherence (191%; $p = .04$). This group of veterans also showed a marked significant reduction in pain ratings (36%; $p < .001$), stress (16%; $p = .02$), negative emotion (49%; $p < .001$) and limitation of physical activity (42%; $p < .001$). The researchers suggest that the use of the HRV coherence feedback device combined with simple self-regulation techniques such as the QCT can help to reduce cognitive avoidance of physiological processes and promotes tolerance of pain perception (Berry et al., 2014). These findings are consistent with a small pilot study of returning soldiers with PTSD who received training in resonance frequency breathing, and positive emotions induction showed improved cardiac coherence, characterized as increases in HRV power in the LF band, and improved capacity in attention and short-term memory. The researchers also concluded that increased cardiac coherence and HRV might predict cognitive improvement (Ginsberg, Berry, & Powell, 2010).

The Personal and Organization Quality Assessment – Revised 4 Scale (POQA-R4; Barrios-Choplin & Atkinson, 1996; Barrios-Choplin, McCraty, & Cryer, 1997) survey, a subjectively self-reported stress questionnaire designed by IHM which is also a empirically validated and normed assessment, has been used to measure psychological health, physical stress symptoms, emotional competencies, resilience, and organization quality. In a study conducted with police officers at the San Diego Police Department, the POQA-R4 was used as one of the outcome measures to examine the effectiveness of the Stress Resilience Training System (SRTS) that included HRV coherence biofeedback, a series of HeartMath self-regulation techniques and HRV-controlled games. The POQA-R4 results were significantly positive where all four scales demonstrated improvement, including Emotional Vitality (positive factors that enhance performance) improved by 25% ($p = .05$) and Physical Stress (negative factors that impede performance) improved by 24% ($p = .01$). Additionally, improvement has been observed in eight of the nine subscales at approximately 40% ($p = .06$). The responses from the officers were unanimously positive and the researchers concluded that this program for building resilience and improving psychological wellness could be as effective for law enforcement as it is for military personnel (Weltman, Lamon, Freedy, & Chartrand, 2014).

Several studies conducted on the application of the HeartMath system have reported not only on its effectiveness in reducing stress and increasing resilience, but they also have reported significant differences in the outcome variables with large effect size. For instance, a study (Field, Edwards, Edwards, & Dean, 2018) that employed a pre- and post-test design to determine the influence of the HeartMath System showed significant differences and large effect size in almost all outcome variables. The findings in this study demonstrated statistically significant improvements in several variables, such as mood, $t(12)= 3.80$, $p < .05$, with an effect size of 0.83, which according to Cohen (1988) is large; relaxation, $t(12) = 4.85$, $p < .01$, with a very large effect size of 1.07; sense of coherence (SOC), $t(12) = 4.40$, $p < .05$, with a very large effect of 1.57; and HRV intervention, $t(12) = 2.47$, $p < .05$, with a very large effect size of 1.97. Another study conducted by Thurber, Bodenhamer-Davis, Johnson, Chesky, and Chandler (2010) has also shown the effectiveness of using the HeartMath system to decrease music performance anxiety (MPA; 71%) and improve performance (62%) with large effect size. For instance, results revealed that the biofeedback training and emotional techniques had established a significant difference in combined MPA and performance scores, $F(1, 7) = 5.17$, $p < .05$, with $\eta p2 = .32$, denoting a large effect size. Findings have also demonstrated the statistical difference between the scores on HRV between the treatment and the control groups, $F(1, 7) = 25.48$, $p < .001$, and a large effect of .698. Additionally, a large effect size ($\eta_p^2 > .13$) was also found for the components of Performance Anxiety Inventory (PAI), state anxiety, and average heart rate (Thurber et al., 2010).

In sum, studies have examined the HeartMath system, consisting of its self-regulation techniques and technology for people of all ages to use in the moment to manage stress and promote well-being, health, creativity, intuitive insight and zoned performance (Childre &

Martin, 1999; McCraty, 2015, 2017; McCraty et al., 2009; McCraty & Zayas, 2014). The self-regulation techniques developed by the IHM (2014) are designed for individuals to improve psychophysiological coherence by observing their HRV via IHM's biofeedback technologies, an objective measurement of regulatory processes involved in cognitive function and affective stability (Bradley, McCraty, Atkinson, & Tomasino, 2010; McCraty et al., 2009; Porges, 1991; Thayer, Hansen, Saus-Rose, & Johnsen, 2009). Literature consists of both qualitative and quantitative components of research has provided strong evidence that by enhancing the heart-brain communication that is transmitted neurologically, biophysiologically, biochemically, and energetically; synchronicity or integration between them can increase coherence, HRV, autonomic stability, efficiency, improve a sense of well-being, cognitive function, and performance, and promote health (e.g., Edwards et al., 2015; Keller, Ruthruff, & Keller, 2017; Kermani & Birjandi, 2019; Low & McCraty, 2018; McCraty & Tomasino, 2006a; McCraty & Zayas, 2014; Primbram, 1986; Thurber et al., 2010). Hence, individuals who commit to regular practice of the HeartMath system not only can gain internal increased awareness of energy depletion, renewal and resilience, but also acquire the "capacity to prepare for, recover from and adapt in the face of stress, challenge or adversity" (Institute of HeartMath, 2014, p. 2).

Salutogenesis: Salutogenic Model of Health

The term *salutogenesis* is derived from "the origins [*genesis* (Greek)] of health [*salus* (Latin)]" (Antonovsky, 1979, preface vii). It is coined by Antonovsky (1987) during his course of researching the origins of health based on the question 'what makes people healthy?' 'how do people manage the lack of control of their life?' Instead of studying the causes of disease in the pathogenic direction (Lindstrom & Eriksson, 2006; Vinje, Langeland, & Bull, 2017). Antonovsky was amazed by how organisms were able to survive constant exposure to disease and stress even they occur everywhere and all the time (Lindstrom & Eriksson, 2006). In his quests for an answer, he concluded that “The origins of health are to be found in a sense of coherence” (Antonovsky, 1979, preface vii). Health, according to Antonovsky (1987), is deemed as a continuum, not just the absence of disease. Health resides on an axis between two extremes of ‘total absence of health’ (dis-ease) and ‘total health (ease). Instead of being fixated on the healthy/sick dichotomy, Antonovsky posited that individuals could move along the health ease-dis/ease continuum, which depends on the stressors encountered in everyday life. Individuals can maintain their health and make a shift towards ‘health-ease’ if they succeed in dealing with the stressors. Conversely, individuals can experience breakdowns and move towards ‘dis-ease’ followed by unsuccessful coping with the stressors. As health is seen as a process, SOC can facilitate individuals to shift towards, or stay at, in the direction of the ‘health-ease’ end (Antonovsky, 1987, 1993).

Sense of Coherence (SOC)

SOC (Antonovsky, 1987) is a core construct of the salutogenic model which is considered as an internal resistance resource that promotes health when stressful life events challenge individuals. It is a reflection of an individual’s view of life and one’s capacity to respond to stressful situations. SOC is a global orientation to perceive life as structured, manageable, and meaningful or coherent. It suggests a personal way of thinking, being, and acting, entailing an inner trust, which induces individuals to identify, benefits, use, and re-use the resources with high accessibility (Eriksson & Lindstrom, 2006). Rather than constructed around a fixed set of mastering strategies and domain specific, SOC is flexible and it is universal that is based on learning processes in everyday life and develops across time (Antonovsky, 1993; Lindstrom & Eriksson, 2005). It is a resource that allows individuals to manage pressure, to reflect about their availability of resources, to ascertain and utilize them, to foster useful coping strategies, and to resolve adversity healthily. SOC may function as "a 'sixth sense' for survival and generates health prompting abilities" (Eriksson & Lindstrom, 2006, p. 241). According to Antonovsky (1987, p.19):

> "The sense of coherence is a global orientation that expresses the extent to which one has a pervasive, enduring though dynamic feeling of confidence that (1) the stimuli deriving from one's internal and external environments in the course of living are structured, predictable, and explicable; (2) the resources are available to one to meet the demands posed by these stimuli; and (3) these demands are challenges, worthy of investment and engagement."

This definition indicates that SOC has three major components. The first component is comprehensibility, the cognitive dimension which refers to a conviction that the stimuli arising from one's internal and external environments in the course of living are structured, predictable, and understandable. As the requirement to possess the ability to cope with stressful situation is one can to some extend understand it. With that, one could better manage on conditions based on what one comprehends. Hence, comprehensibility cultivates as a result of predictable demands. The second component is manageability, the instrumental/behavioral component which represents the confidence that resources are available at disposal for one to meet environmental demands. This is a result of experiencing between demands and available resources. Individuals with low sense of manageability may experience a feeling of victimization and unfair treatment. The third component is meaningfulness, the emotional/motivational component which signifies the confidence that these demands are deemed as challenges, worthy of investment, and engagement. This is an outcome of experienced commitment and engagement (Antonovsky, 1987; Lindstrom & Eriksson, 2005, 2006).

Antonovsky (1987) emphasized meaningfulness as the most important among the three components as it enables understanding and the obtainment of resources. He added that manageability is secondary to comprehensibility as it is dependent on the latter. With combinations of either high sense of comprehensibility and a low sense of manageability or low sense of comprehensibility and high sense of manageability, some form of change would most likely occur; however, they are dependent on the status of meaningfulness. Hence, a high sense of meaningfulness can most probably raise the SOC to a high level despite a low sense of comprehensibility and manageability. However, Antonovsky saw each component on its own is insufficient to attain a full-strength SOC. Hence, it is crucial to encompass all three components to strengthen SOC (Antonovsky, 1987, 1993). The assessment of whether an individual has a low or high sense of SOC can be measured by the means of the Orientation of Life Questionnaire, which is also known as the SOC scale (Antonovsky, 1987). The two most widely used versions of this scale are the SOC-29 and an abridged version, the SOC-13 (Lindstrom & Eriksson, 2005). A recent review (Eriksson & Mittelmark, 2017) shows that as of 2015, the SOC-29 and SOC-13 have been used in at least 49 different languages in at least 48 different countries around the world. SOC has been considered as a measurable construct and decades of international research demonstrates that the SOC scales are observed to be valid and reliable (Mittelmark et al., 2017). Antonovsky (1987) has provided a mapping sentence comprising of facets and elements that were formally incorporated in a concise fashion of the entire questionnaire items, as shown in figure 8.

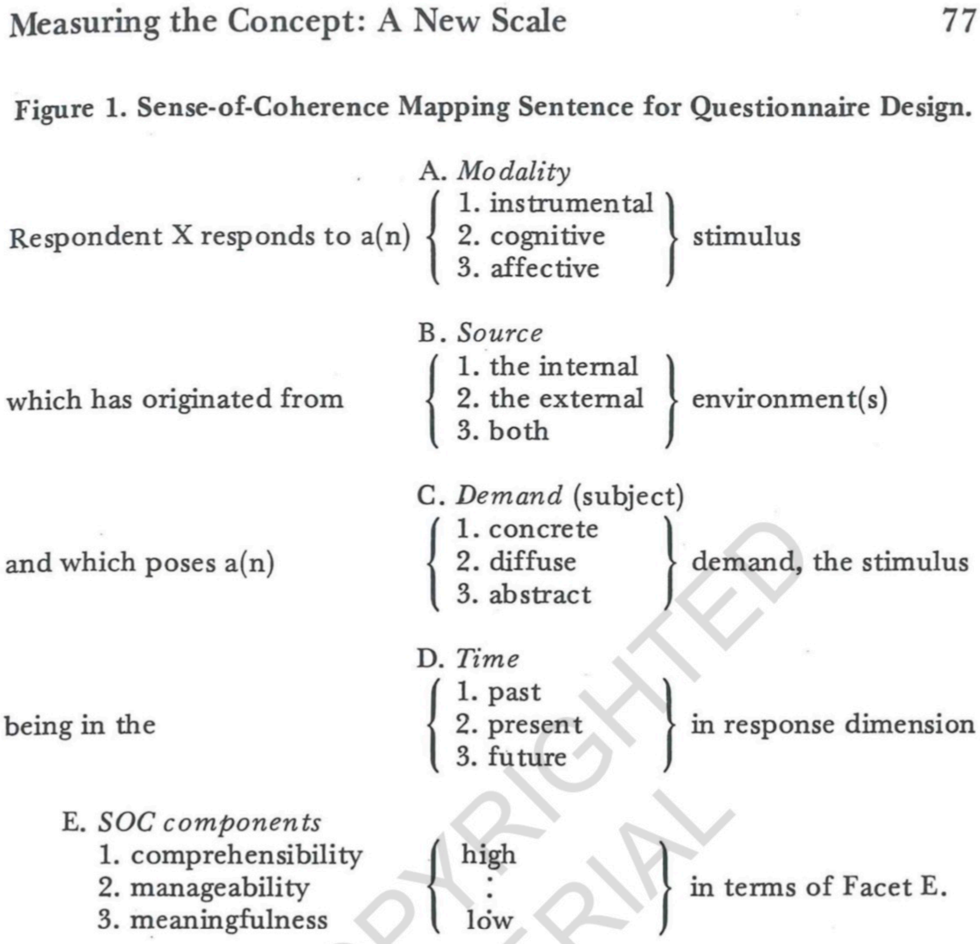
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Figure 1. Sense-of-Coherence Mapping Sentence for Questionnaire Design.

Respondent X responds to a(n) {A. *Modality*: 1. instrumental / 2. cognitive / 3. affective} stimulus

which has originated from {B. *Source*: 1. the internal / 2. the external / 3. both} environment(s)

and which poses a(n) {C. *Demand* (subject): 1. concrete / 2. diffuse / 3. abstract} demand, the stimulus

being in the {D. *Time*: 1. past / 2. present / 3. future} in response dimension

E. *SOC components*: 1. comprehensibility / 2. manageability / 3. meaningfulness {high ⋮ low} in terms of Facet E.

Figure 8. Mapping-Sentence of the SOC questionnaire. From “Unravelling the mystery of health. How people manage stress and stay well,” by A. Antonovsky, p. 77. Copyright 1987 by Jossey-Bass Publishers, San Francisco, CA. Reprint with permission of the copyright holder.

Recent research has explored the association between genetic factors and SOC. For instance, a Twin Mother’s Study (Hansson et al., 2008) recruited 326 Swedish twin pairs (150 monozygotic and 176 dizygotic) to examine how genes and the environment influence resiliency/salutogenic factors. Findings showed that 35% of SOC was the result of genetic effects, and 57% was the outcome of nonshared environment effects. The study demonstrated that while nonshared environment components showed significant importance in individual resiliency/salutogenesis factors, genetic influences were also important. A later study with 3193 Finnish twins conducted by Silventoinen et al. (2014) confirmed the results of the Swedish Twin

Mother's Study. The researchers found that genetic influences illustrated 49% of the variation of SOC in females and 39% in males. The environment factors represented the rest of the variation that was unique to each twin individually. Findings on the highest genetic correlation within the SOC dimensions was found between comprehensibility and manageability (.97 in females and .90 in males). Idan, Eriksson, and Al-Yagon (2017) suggest that these studies highlight the potential role of genetic factors as well as environmental factors in understanding people's SOC.

According to literature, the SOC has been considered as a resilient factor (Braun-Lewensohn, Idan, Lindstrom, & Margalit, 2017). Individuals with high SOC scores have been found to be positively associated with high health-promoting scores, and it is less probable for them to perceive stressful situations as anxiety aggravating and threatening than individuals with low SOC scores (Suraj & Singh, 2011). This has been established by researchers who have examined stress-related syndrome such as anger, anxiety, depression, psychological distress, and other emotional and internalizing or externalizing problems in a range of contexts such as political violence (Braun-Lewensohn & Sagy, 2010, 2011a, 2011b) and racial discrimination (Baron-Epel, Berardi, Bellettiere, & Shalata, 2016; Han & Lee, 2011; Lam, 2007). These studies generally represent the broad literature suggesting that individuals with strong SOC appear to have better capacity in dealing in with not only stressors of everyday life stressors (Bauer, 2017; Surtees, Wainwright, & Khaw, 2006), but also with extreme life stressors (Fossion, Leys, Kempenaers, Braun, Verbanck, & Linkowski., 2014; Fossion et al., 2015). These group of individuals is also better at mobilize the resources at their disposal to cope with these stressors and manage tension successfully (Antonovsky, 1987; Lindmark, Hakeberg, & Hugoson, 2011).

Research have demonstrated that SOC levels can be determined by interventions (Field et al., 2018; Forsberg, Bjorkman, Sandman, & Sandlund, 2010; Kahonen, Naatanen, Tolvanen, &

Salmela-Aro, 2012; Malm et al., 2018; Sarid, Berger, & Segal-Engelchin, 2010; Skodova & Lajcialova, 2013; Vastamaki, Moser, & Paul, 2009). For example, a 12-month lifestyle intervention program with individuals with psychiatric disabilities aged 22-71 demonstrated that structured activities with a sufficient level of challenge might contribute to a significant increase in SOC (Forsberg et al., 2010). A study was conducted with healthy subjects aged 26-62 on the effectiveness of the HeartMath training program showed positive effects on participants' SOC. According to the findings, the mean estimate of the SOC was 34.23 (SD = 6.18) before the intervention and 43.92 (SD = 8.76) at post-intervention. This difference was statistically significant, $t(12) = 4.40$, $p < .05$, with a very larger effect size of 1.57 signifying that participants reported enhanced SOC ensuing the interventions (Field et al., 2018). This result was consistent with an earlier study investigating the effectiveness of the HeartMath coherence feedback training indicating significant increases in SOC scores, $Z = 2.668$, $p = .008$ (Edwards, 2014). According to a review, interventions that aimed to increase SOC suggest that changes are possible, and they can be served as health promotion activities to strengthen SOC (Super, Wagemakers, Picavet, Verkooijen, & Koelen, 2016).

Generalized Resistance Resources (GRRs)

Antonovsky (1979) proposed that in order for individuals to attain a strong SOC, the presence of GRRs is required at least during the developmental process. A strong SOC signifies the association with high levels of all of its three components, and GRRs are essentials that facilitate individuals to experience these three components through sets of consistent, balanced, and participated life experiences (Antonovsky, 1987). Hence, GRRs underpin the development of a strong SOC (Lindstrom & Eriksson, 2005).

According to Antonovsky (1979), GRRs, a term coined by him, is defined as "any characteristic of the person, the group, or the environment that can facilitate effective tension management" (p. 99). These characteristics contribute to one with sets of life experience distinguished by consistency, participation in shaping outcomes, and an under-load-overload balance, in which these factors are deemed as crucial for developing a strong SOC (Antonovsky, 1993). Antonovsky (1979, 1987) proposed that GRRs include biological, emotional, material and psychological factors that make help people cope successfully by making it more straightforward for them to conceptualize their lives as consistent, structured and understandable. Furthermore, GRRs are resources within an individual (e.g., attitudes, self-efficacy beliefs, knowledge) or in their environment (e.g., cultural stability, social support) that are maybe already available for them to counter the stressors of everyday life (Lindstrom & Eriksson, 2010). A formal definition of GRRs by Antonovsky (1979) is shown in Figure 9.

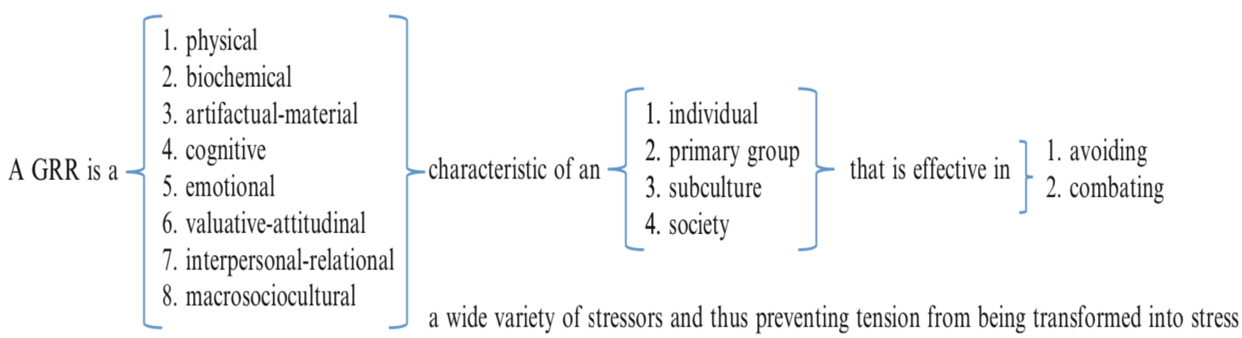

Figure 9. Mapping-Sentence Definition of a GRR. From "Health, Stress and Coping," by A. Antonovsky, p. 103. Copyright 1979 by Jossey-Bass Publishers, San Francisco, CA. Reprint under the terms of the Creative Commons Attribution-Noncommercial 2.5 License (http://creativecommons.org/licenses/by-nc/2.5/) which permits any non-commercial use, distribution, and reproduction in any medium, provided the original authors(s) and source are credited.

When an individual succeeds in mobilizing one's resources, typically are money, knowledge, intelligence, commitment, self-esteem, experience, social support, tradition, cultural capital, and view of life (Lindstrom & Eriksson, 2006), one can cope with the stressors successfully and, as a result, one can maintain in or move towards 'health-ease'. However, the individual who failed to mobilize one's resources may experience increased tension leading to breakdown and move towards 'dis-ease.' Hence, it is crucial to focus on developing a comprehensive understanding of GRRs because they can provide individuals with sets of meaningful and coherent life experiences to meets all demands, and they are the prerequisites for the development of SOC (Antonovsky, 1972; Eriksson, 2007; Lindstrom & Eriksson, 2010; Super et al., 2016).

Specific Resistance Resources (SRRs)

While GRRs are those resources that are potentially accessible for wide-ranging utility (e.g., one's social network for support), specific resources are particular resources that are situation-specific (e.g., an emergency phone number to reach the fire department) (Antonovsky, 1979, 1987). Although Antonovsky (1987) proposed that strong SOC is developed through the development of GRRs and SRRs at the individual's disposal, he did not make a distinction between the two constructs nor wrote much about SRRs. Some later researchers (e.g., Nene, 2006; Poppius, 2007) concurred that the GRR/SRR distinction is not particularly important. Other researchers have attempted to generate the distinction between GRRs and SRRs. For instance, in a study of stress that explored the casual role of GRRs and SRRs in the stress process after physical assault on psychiatric nurses, findings revealed that self-esteem, self-confidence, and coping met the definition of GRRs; and received clinical supervision and staff support services were identified as SRRs (Reininghaus, Craig, Gournay, Hopkinson, & Carson, 2007).

In their attempt to revive the attention on SRRs, Mittelmark, Bull, Daniel, and Urke (2017) provide a formal definition of SSRs, as shown in Figure 10. They conceptualize SRRs are available in the river, to be picked up and mobilize as needed in specific stressor situations. In other words, in the developmental process of SOC, GRRs are already available, which can be recognized, engaged, and then muster SRRs as means to keep tension from evolving into debilitating stress — taking a simple example of a middle school wanting to promote emotional health and well-being of students. This intention is a powerful GRRs for their students and will contribute to strong SOC in the school's psychosocial environment. When school counselors teach distressed students self-regulation skills, such as HeartMath's Quick Coherence breathing (Institute Of HeartMath, 2014), the intervention that is designed to induce psychophysiological balance will be deemed as an SRR for the students. Mittelmark (2011) presents the interactions between the abovementioned components leading to successful coping and eventually toward health, as presented in Figure 11.

In a normal circumstance, SRRs are not invoked unless tension is perceived as a threat to convert to encumbering stress (Mittelmark et al., 2017), specific intervention to a specific situation available at disposal is imperative to health. For instance, a student can immediately use the breathing technique taught by one's counselor a day earlier comes in handy when one is feeling highly anxious ten minutes before a presentation to the class. The student would have the specific skill to prepare oneself prior to the presentation and may even able to do self-regulation during presenting. This demonstrate that the student has successfully cope with the stressful event which provide platform for one to better attain resilience and health. Hence, it is important to ensure the accessibility to the right SRRs when it is needed (Mittelmark et al., 2017).

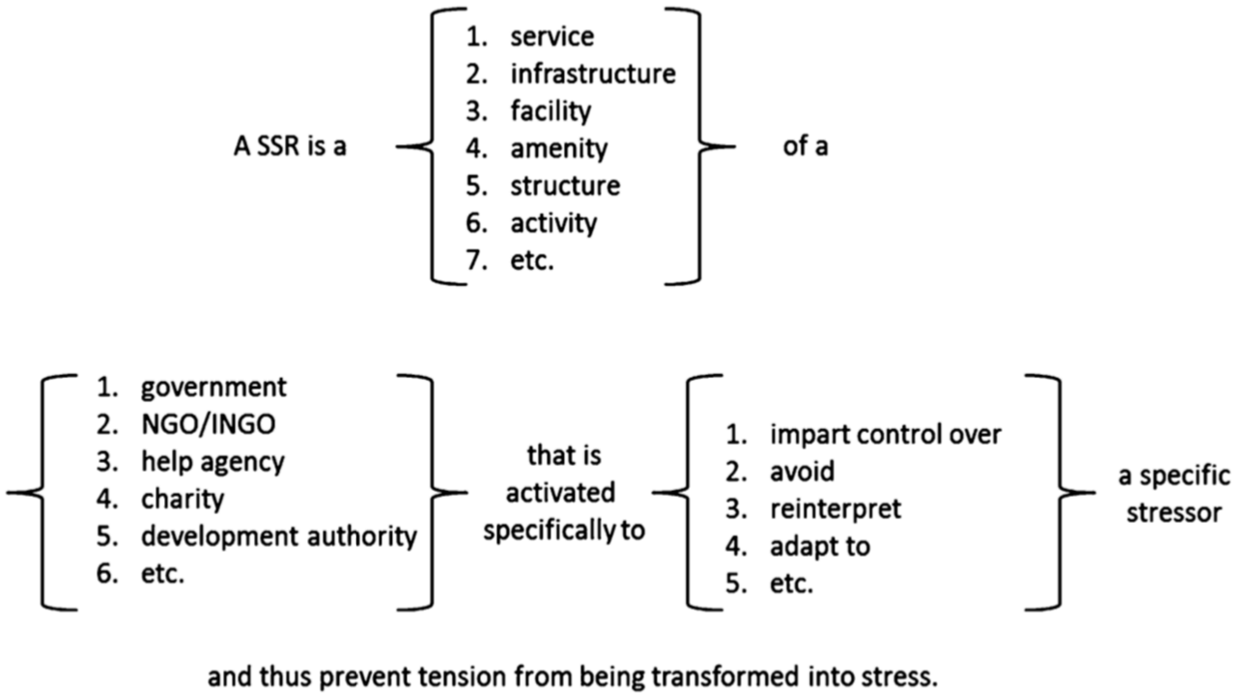

Figure 10. Mapping-Sentence Definition of a SRR. From “Specific Resistance Resources in the Salutogenic Model of Health,” by M. B. Mittelmark, T. Bull, M. Daniel, and H. Urke, p. 74. Copyright 2017 by Spring Nature, Switzerland. Reprint under the terms of the Creative Commons Attribution-Noncommercial 2.5 License (http://creativecommons.org/licenses/by-nc/2.5/) which permits any non-commercial use, distribution, and reproduction in any medium, provided the original authors(s) and source are credited.

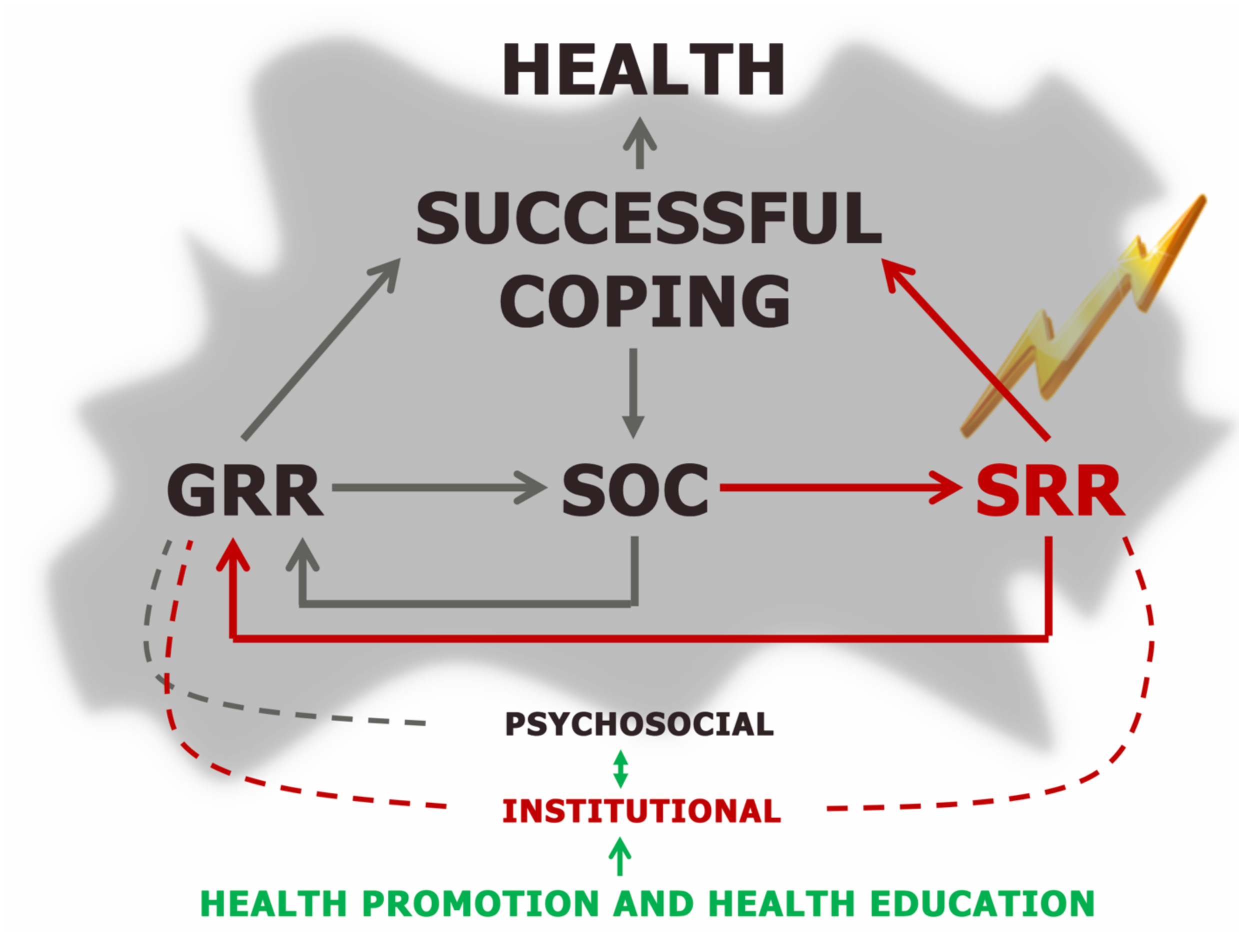

Figure 11. Interactions between SOC, GRR, and SRR towards Health. From "Resistance Resources in the Context of Health Promotion Practice and Research," by M. B. Mittelmark, slide number 18. Copyright 2011 by M. B. Mittelmark.. Reprint with permission.

Antonovsky (1987) illustrated that the accessibility to GRRs and SRRs where both originate from the social, cultural, and historical context in which people live, they can provide people with meaningful life experiences that are also comprehensible and manageable that further foster their SOC, which is an important mechanism underpinning the development of stress-related resilience and health (Mc Gee, Holtge, Maercker, & Thoma, 2018). In his thesis, Antonovsky (1996) proposed the salutogenic orientation to serve as a direction and focus that allow the field to be dedicated to concern with the entire continuum of health ease/dis-ease.

There should be a focus on salutary rather than merely risk factors, and a dedication to see the entire person (or collective) rather than the disease (or disease rate).

Psychological Time

Since the last few decades, researchers have hypothesized theories and conducted studies to explain human behavior, such as psychoanalysis (Freud, 1900; Seligman, 2019), stimulus-response theory of learning (Hull, 1943; Jessup & O'Doherty, 2011; Watson, 1928), psychosocial (Erikson, 1950; Kuther & Burnell, 2019), cognitive-developmental (Kohlberg, 1975; Piaget, 1936; Pascual-Leone & Johnson, 2011), self-determination (Deci & Ryan, 1985; Ryan, Soenens, & Vansteenkiste, 2019), social learning (Bandura & Schunk, 1981; Pratt et al., 2010), sociocultural (Vygotsky, 1978; Helou & Newsome, 2018), and ecological systems (Bronfenbrenner, 1977; Zhang, 2018). Another construct that has been an interest to explain human behavior can be dated back to as early as the dawn of philosophical thinking – time. For instance, Aristotle (n.d./1983), poses the question in *Physics IV* on whether time depends on the mind for its existence. He acknowledges that the discussion of time as being difficult. Hence, he continues to examine the real existence of time, and also investigates the notion of whether there is a single "Now" or several "Now."

During the late nineteenth century, James (1890/1950) began to reflect on the notion of time by stating the outbound of the past subsequently drops away, and the inbound of the future making up the loss. He added that human beings are unique in comparison to other species because humans have the capacity to travel backward and forward in time. His introduction of the “specious present” doctrine engendered a wide range of philosophical and scientific discussions on the nature of temporal experience (Power, 2012). Lewin (1943) who also established on the relationship of the present to the past and the future by formulating the concept of “life-space.” As one of the first scholars to discuss the theory on time perspective, he defines time as “the totality of the individual’s views of his psychological future and psychological past existing at a given time (Lewin, 1951, p. 75). Nuttin and Lens (1985) were one of the several scientists that extended Lewin’s (1951) concept of a time-filled space. In their research, they postulate that both past events and the future underlie an impact on the individual’s present behavior, which to the extent that they occur on the cognitive level of behavioral functioning. In other words, how people perceive the past, present, and future may influence their present behavior and thoughts as well as decisions and judgments (Wiberg, Sircova, Wiberg, & Carelli, 2017). The abovementioned suggests that the study of time is not a new concept (Hawking, 1988).

Autonoetic Consciousness

Although animal studies have demonstrated their ability to engage this temporal ability (Corballis, 2013), humans appear to possess a more advanced ability to “internalize” the world through the formation of spatial and temporal patterns. It is through temporal binding, in particular, that permits people to comprehend the relation between cause and effect, which is crucial for experiencing “the arrow of time” (Liljenstrom, 2011). Tulving (1983, 1985) maintains that episodic memory, a memory system that been traditionally considered to support the recollection of personal experiences, has the distinctive mission of enabling individuals to travel backward and forward in time mentally. In an essay, Tulving (2005) reasserts that “only human beings possess ‘autonoetic’ episodic memory and the ability to mentally travel into the past and the future, and that in a sense they are unique” (p. 4). His position not only in concurrence with James (1890/1950), but also received supports from many findings from memory research in humans (e.g., Botzung, Denkova, & Manning, 2008).

In addition to the three systems, which include procedural memory, semantic memory, and episodic memory, Tulving (1985) proposed three kinds of consciousness. He referred them as anoetic (non-knowing), noetic (knowing), and autonoetic (self-knowing). First, the anoetic consciousness is temporally and spatially bound to the situation, and it is a characteristic of procedural memory. Second, the noetic consciousness enables organisms to possess the awareness and can flexibly act upon symbolic knowledge of the world, and it is related to the semantic memory. Last, the autonoetic consciousness is what Tulving implies as "the special phenomenal flavor to the remembering of past events, the flavor that distinguishes remembering from other kinds of awareness, such as those characterizing perceiving, thinking, imaging, or dreaming (1985, p. 3).

One of the first evidence for autonoetic consciousness was drawn from a clinical observation where Tulving (1985) worked with an amnesic patient. Tulving found that the patient's language skills and general knowledge, as well as the concept of the chronological time, were relatively intact. However, the patient's difficulty with the conscious awareness of personal time that entails both the past and the future seems to be severely impaired. The patient's condition demonstrated that the patient possessed both anoetic and noetic consciousness but not autonoetic consciousness. It was suggested that the patient's procedural and semantic memory systems were relatively undamaged, but his episodic memory was severely impaired. Later research has shown that similar deficits with autonoetic consciousness and personal selfhood in patients with severe mental retardation, dementia, or patients with other disorders (Markowitsch & Staniloiu, 2011), such as individuals with Asperger syndrome or autism (Tanweer, Rathbone, & Souchay, 2010).

Tulving (1985) proposed an essential distinction between knowing (noetic) and remembering (autonoetic), which both are related to the difference between semantic and episodic memory, A vast storehouse of facts about the world, the semantic memory is the combined dictionary and encyclopedia of the mind. Episodic memory, on the other hand, is the memory for events, the mind's personal memoir (Tulving, 1972), which has been postulated as a past-oriented context-embedded neurocognitive memory system defined by both its content (personally experienced events spatially and temporally) and the particular state of consciousness that accompanies retrieval (autonoetic consciousness) (Tulving, 1999, 2002, 2005). Research has shown that episodic memory, because of its complexity, it is more susceptible to neuronal dysfunction due to psychogenic stress or accidental damage than other memory systems (Dickerson & Eichenbaum, 2010; Erk et al., 2011; Markowitsch, Vandekerckhove, Lanfermann, & Russ, 2003; Tulving, 2002, 2005). In sum, Tulving (1985) posits that a healthy individual who has autonoetic consciousness would have the capacity to be aware of one's past and future. This individual is capable of mental time travel.

Mental Time Travel

In the literature, episodic memory has been widely related to the ability to mentally reliving past events which have been extensively investigated (e.g., Tulving, 1985, 2002, 2005). In recent years, emerging evidence has shown that episodic memory is also involved in mental travel into the future. This concept of mental time travel (MTT) was extensively developed by Suddendorf and Corballis (1997, 2007), where they refer it as the faculty that allows humans to mentally project themselves backward in time to re-live or forward to pre-live possible events that may occur in the future. In relation to these constructs of remembering one's past or imagine one's personal future, researchers have variably referred the past MTT as episodic or autobiographical memory (e.g., Conway & Pleydell-Pearce, 2000; Rubin, 2006; Tulving, 1983), whereas the future MTT is regularly indicated as episodic future (Atance & O'Neill, 2001; Szpunar, 2010), constructive simulation (Schacter & Addis, 2007; Taylor & Schneider, 1989), and prospection (Buckner & Carroll, 2007; Gilbert & Wilson, 2007; Okuda, 2007). The latter construct signifies that the individual imaging oneself in the future has been considered to play a vital role in planning, allowing one to select strategic behaviors in order to engage in successful goal pursuit (Kohler et al., 2015).

Although there is a distinct temporal orientation existing between the two MTT components, Suddendorf and Corballis (1997, 2007) propose that the ability to travel into the past and the future share phenomenological features and activate common neural substrates in the brain. Recent research has concurred with this notion where the two MTTs may rely on common cognitive capacities (Botzung et al., 2008). For instance, fMRI and behavioral studies demonstrated the common neural network that mediates the elaboration of past and future events, including the prefrontal cortex, the parietal cortex (e.g., posterior cingulate cortex), and the medial temporal lobe (e.g., hippocampus) (e.g., Addis, Wong, & Schacter, 2007; Botzung et al., 2008; Viard et al., 2011). However, researchers have also highlighted the distinction between the two MTTs. That is, the projected future events are more emotionally positive and idyllic than the remembered past events (e.g., Bernsten & Bohn, 2010; Bernsten & Jacobsen, 2008; D'Argembeau & van der Linden, 2004). Bernsten and Bohn (2010) postulate that this distinct positivity bias for future events may be linked to crucial functional differentiation between the two temporal directions.

Recently, MTT has become a key component of cognitive neuroscience (Viard et al., 2011). Studies have focused on identifying malfunctions in future MTT with individuals who are suffering from mental disorders such as episodic amnesia (Kwan et al., 2012), schizophrenia (D'Argembeau, Raffard, & van der Linden, 2008), depression (Kohler et al., 2015; Williams et al., 1996), and PTSD (Brown et al., 2014; Kleim et al., 2014). For instance, a recent study using a VR-based approach to examine episodic memory formation and MTT in patients with PTSD demonstrated that these individuals exhibited deficits in recollecting item and temporal information. Consequently, there were signs of impairments in the patients' capability to engage information from episodic memory to solve current and future problems (Zlomuzica et al., 2018). The results are consistent with earlier studies showing that PTSD patients with impaired MTT function display difficulties in planning and structuring everyday activities, and encounter problems in their social and professional functioning (Brown et al., 2014; Mehnert, Lehmann, Graefen, Huland, & Koch, 2010; Reich, Blackwell, Simmons, & Beck, 2015; Scrignaro, Barni, & Magrin, 2011).

Recent research proposes that future MTT also plays a crucial role in attaining wellbeing and happiness in daily life (MacLeod & Conway, 2005; Quoidbach, Wood, & Hansenne, 2009). It has been found that 12% of daily thoughts are about the future (Klinger & Cox, 1987) and yet another study estimated that young adults spent 38% of their time deliberating the future (Jason, Schade, Furo, Reichler, & Brickman, 1989). These findings suggest that individuals spend a significant amount of time thinking about the future and they are inclined to imagine themselves achieving and succeeding rather than seeing themselves failing (Gilbert, 2006; Jason et al., 1989). Studies have also shown that projection of positive future, such as the mental images of future success and the process to achieve it may increase achievement motivation, effort, and performance (Faude-Koivisto, Wuerz, & Gollwitzer, 2009; Greitemeyer & Wurz, 2006; Quoidbach et al., 2009; Ten Eyck, Labansat, Lord, & Dansereau, 2006).

Zimbardo Time Perspective Theory

As discussed above, MTT to the past and the future is uniquely human (James, 1890/1950; Suddendorf & Corballis, 1997, 2007; Tulving, 1983, 2005). Also, according to his life-space theory, Lewin (1951) remarked that the behavior exhibited by an individual is not entirely dependent on the occurrence of the present situation, but instead, also influenced by the views on the past as well as the hopes in the future. Emerging evidence has shown that the recollections of the past, feelings about the present, and the future people envision can exert an impact on a variety of behaviors and psychological processes, in which they endorsed Lewin's proposition (Zimbardo & Boyd, 1999). Based on Lewin's (1951) work in time and future thinking, he defined time perspective (TP) as "the totality of the individual's views of his psychological future and psychological past existing at a given time" (p. 75). This integrative view of all temporal frames within the present moment has later become the foundation and the advancement of the time perspective theory in both individual and societal functioning (Zimbardo & Boyd, 1999).

Research on the construct of time has grown since Lewin where subsequent researchers such as Nuttin and Lens (1985), Seijts (1998), Lennings, Burns, and Cooney (1998), and the abovementioned, Tulving (1985) and Suddendorf and Corballis (1997), who have all contributed substantially to the existing literature. Among them, one of the most popular concepts of TP was created by Zimbardo and his colleagues (Boniwell & Zimbardo, 2004; Zimbardo & Boyd, 1999, 2008; Zimbardo & Sword, 2017). Drawing from Lewin's (1951) work which is considered the first research to emphasize the importance of TP in social science where it asserted that TP influences emotion, behavior, and motivation. Zimbardo and Boyd (1999, 2008) extended this notion and claim that the individual's self-image, world view, and interpersonal relations are shaped by cognitive processes that divide experience into past, present, and future.

Zimbardo and Boyd (1999, 2008) also maintain that people's individual attitude is primarily learned (e.g., cultural, educational, religious, social class, and family modeling) and the relation to time is usually operated in an unconscious, subjective manner. In other words, TP, as a dimension of psychological time, is significantly prevalent in people's lives and multiple dimensional that people are rarely aware of its subtle operation, influence, or biasing power. With these unconscious and subjective processes, people learn to divide the continual flow of their experience, such as categorizing their personal and social experiences into time frames (past, present, and future) that help to give order, coherence, and meaning to these events. These time frames may represent cyclical patterns, such as changing seasons, one's parent's or children's birthdays, or they can signify unique and singular linear events, such as the day of a tragic accident, the death of a loved one, a terrorist attack. Hence, these time frames serve as a fundamental process in "encoding, storing, and recalling your experiences; in feeling and being; in shaping expectations, goals, contingency plans; and in imaging scenarios (Zimbardo & Boyd, 2008, p. 18). These suggest that TP is a "basic aspect of individual subjective experience" (Boniwell & Zimbardo, 2004, p. 165), and a "fundamental psychological process" (Luyckx, Lens, Smits, & Goossens, 2010, p. 243).

Although everyone engages in MTT (Suddendorf & Corballis, 1997, 2007), Zimbardo and Boyd (1999, 2008) maintain that TP is individually varying. In other words, an individual's particular judgments, decisions, and actions are influenced by the dimension of TP that one prefers. Research has shown that people develop a habitual focus on, or orientation towards, a particular time frame over another. For instance, the individual may favor in reminiscing the past, living in the present moment, or looking towards the future. This individual who tends to overuse or underuses a specific time frame has been found to serve a cognitive bias or a TP bias that can influence one's cognition, emotion, and behavior (Zimbardo & Boyd, 1999, 2008). Individuals who are persistently focusing on their future where they had achieved impressive successes in either academic or professional career may experience difficulty in achieving happiness due to developed incapacity of living in their present (Stolarski, Wiberg, & Osin, 2015). With that, these individuals who have a predominant time frame tend to ignore the remaining ones and so, as a consequence, they may have difficulty switching between them when necessary (Stolarski, Fieulaine, & Van Beek, 2015; Zimbardo & Boyd, 1999, 2008). It is also theorized that how these individuals utilize a particular TP is closely associated with their personality (Fortunato & Furey, 2009).

Zimbardo and Boyd (1999) developed a multi-dimensional model of TP, and it was operationalized in the Zimbardo Time Perspective Inventory (ZTPI) that accentuates the subjective experience of time. The ZPTI is a theory-based instrument including the cognitive, emotional, social, and motivational processes determining the TP. The explanatory principal-components factor analysis used in Zimbardo and Boyd's (1999) research revealed five dimensions of TP. In the ZPTI, TP is measured through these five TPs (subscales) that are identified as past-negative (PN), past-positive (PP), present-fatalistic (PF), present-hedonistic (PH), and future (F). Each of these subscales is independent, and when combined, they constitute the individual's profile. The individual who scores high in one of the TP subscales and low in others reflects that one has a TP bias (Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999, 2008). ZPTI has been the subject of numerous studies, such as the United States and in other countries. Their findings, based on ZPTI, have demonstrated that it is a crucial psychological variable associated with plenteous areas of human functioning, such as subjective well-being, health behaviors, risky behaviors, propensity to become addicted, et cetera (e.g., Carelli, Wiberg, & Wiberg, 2011; Zimbardo & Boyd, 1999, 2008; Zhang & Howell, 2011).

Past-Negative (PN). PN reflects a negative, pessimistic, and aversive view of the past, which may be based on actual adverse life experience, or negative reconstruction of past events (Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999). Research has shown that PN was positively associated with shyness, aggressiveness, less consideration of future consideration, less emotional stability, loneliness, and self-reported symptoms of anxiety and depression. On the other hand, PN was negatively related to self-reported subjective happiness and self-esteem (Zhang, Howell, & Stolarski, 2013; Zimbardo & Boyd, 1999). Additionally, research has shown that PN is associated with low energy and high tension which poses as a stronger predictor of negative moods as compared to other TP biases (Stolarski, Matthews, Postek, Zimbardo, & Bitner, 2014).

Past-Positive (PP). PP reflects a warm and sentimental aspect of the past (Boyd & Zimbardo, 2005). According to Zimbardo and Boyd (2008), such positive attitudes toward the past may reflect positive events that individuals actually experienced or a positive mindset that individuals hold where they made the best of challenging situations. Findings showed that PP was positively associated with high self-esteem, well-being, resilience, a sense of security and happiness, agreeableness and energy, and having social support. It is negatively related to aggression and self-reported symptoms of anxiety and depression (Bryant, Smart, & King, 2005; Lyubomirsky & Nolens-Hoeksema, 1995; Zimbardo & Boyd, 1999).

Present-Fatalistic (PF). PF indicates a sense of hopelessness toward the future and an inability to connect current behavior to future consequences (Boyd & Zimbardo, 2005). An individual with a bias toward PF holds a pessimistic attitude toward the present and future for one perceives the future as predetermined, cannot be influenced by anyone's actions. Hence the present must be accepted and left unchanged (Zimbardo & Boyd, 1999, 2008). Also, such hopelessness is commonly related with depressed, suicidal patients where they are usually preoccupied with the PF and PN, and less PH as well as a lack of positive future (Laghi, Baiocco, D'Alessio, & Gurrieri, 2009; Yufit, 1977).

PF has been found to associated positively with lying, stealing, and sensation seeking, as well as self-reported symptoms of anxiety and depression. On the other hand, PF was negatively related to less consideration of future consequences, proactive coping, dispositional optimism, self-esteem, and lower grade point average (Zimbardo & Boyd, 1999, 2008). According to a recent research, along with a high PN, $t(71) = 4.35$, $p < .001$, a high PF, $t(71) = 4.82$, $p < .008$, have been found to predict a high perceived stress level (Papastamatelo, Unger, Giotakos, & Athanasiadou, 2015).

Present-Hedonistic (PH). PH embraces living in the moment with enjoyment, immediate gratification, and pleasure-seeking (Boyd & Zimbardo, 2005). PH was positively associated with creativity, sensation seeking, novelty-seeking, lack of concern about future consequences of actions, as well as the increased occurrence in lying and stealing. It is negatively related to preference for consistency (Keough, Zimbardo, & Boyd, 1999; Zimbardo & Boyd, 1999, 2008). Research has found that both PF and PH have been positively associated with risky behaviors, such as alcohol consumption, practiced unsafe sex, and drug abuse (Daugherty & Brase, 2010; Keough et al., 1999; Rothspan & Read, 1996), and excessively fast driving (Zimbardo, Keough, & Boyd, 1997).

Future (F). F represents the active engagement in delaying gratification, avoidance of wasting time and putting effort and planning for future goals and rewards (Boyd & Zimbardo, 2005). F has been found to be positively related to conscientiousness, optimism, increased likelihood of thinking about future consequences, higher grade point average, higher level of well-being, less risk-taking, and increased health-oriented behaviors such as having preventive screenings (Barber, Munz, Bagsby, & Grawitch, 2009; Boniwell, Osin, Linley, & Ivanchenko, 2010; Boyd & Zimbardo, 2005; Zimbardo & Boyd, 1999). Conversely, F is negatively associated with sensation-seeking and self-reported symptoms of anxiety and depression (Zimbardo & Boyd, 1999). Additionally, the individual who is persistently focused on the future may experience reduced spontaneity and may lose the ability to enjoy the 'here and now' (Boniwell & Zimbardo, 2004; Sobol-Kwapinsk, 2009, 2013; Zimbardo & Boyd, 2008). Research has also shown that F has an inverse relationship with drug abuse (Henson, Carey, & Carey, 2006; Beenstock, Adams, & White, 2011).

The discussion above briefly noted the characteristics of individual TP. Collectively, in the literature, extensive research reveals that PN, PP, and PF are associated with problems in mental health, such as anxiety (Anagnostopoulos & Griva, 2011; Papastamatelo et al., 2015; Zimbardo & Boyd, 1999) and depression (Naeger, 2001; van Beek, Berghuis, Kerkhof, & Beekman, 2011; Zimbardo & Boyd, 1999). Also, individuals who are depressed are more inclined to score significantly higher on PN, PH, and PF, whereas scoring lower on PP and F (Zimbardo & Boyd, 1999). On the other hand, PP and F are found to be associated with well-being (Boniwell et al., 2010; Drake, Duncan, Sutherland, Abernethy, & Colette, 2008; Naeger, 2001; Zimbardo & Boyd, 1999), and protective factors against psychopathological issues (van Beek et al., 2011; Zimbardo & Boyd, 1999).

Balanced Time Perspective (BTP). Zimbardo and Boyd (1999) maintain that present decisions and behaviors are affected by previous events and expected future experiences. This means that a person's TP bias is a predictor of how one makes life choices which may lead to a dysfunctional lifestyle. However, if the individual has a more balanced time perspective (BTP), one could possess the ability to flexibly adapt between the temporal frames (past, present, and future) according to contextual demands, resource availability, one's needs, and values. Hence, BTP, according to Zimbardo and Boyd (1999) is defined as "mental ability to switch effectively among the TPs depending on task features, situational considerations, and personal resources, rather than biased towards a specific TP that is not adaptive across situations" (p. 1285). Zimbardo and Boyd (2008) strongly encourage individuals to examine their TP and start working toward an optimally BTP. Research has demonstrated that individuals scoring high in BTP achieve higher levels of well-being as well as more positive mood (Boniwell et al., 2010; Drake et al., 2008; Zhang et al., 2013).

According to Zimbardo and Boyd (2008), a BTP that combines the elements of PP, PH, and F time perspectives will enable individuals to learn from their past, enjoy the present, and plan for the future. They added that biased TPs would shut potential doors to happiness, whereas BTP offers mental flexibility and be adaptive to situations that are often uncontrollable. Hence, for an individual to achieve an optimal BTP, one would have to receive a high score in PH (4.33), moderately high in PP (3.67), moderately high in F (3.69), low in PN (2.1), and low in PF (1.67) (Figure. 12).

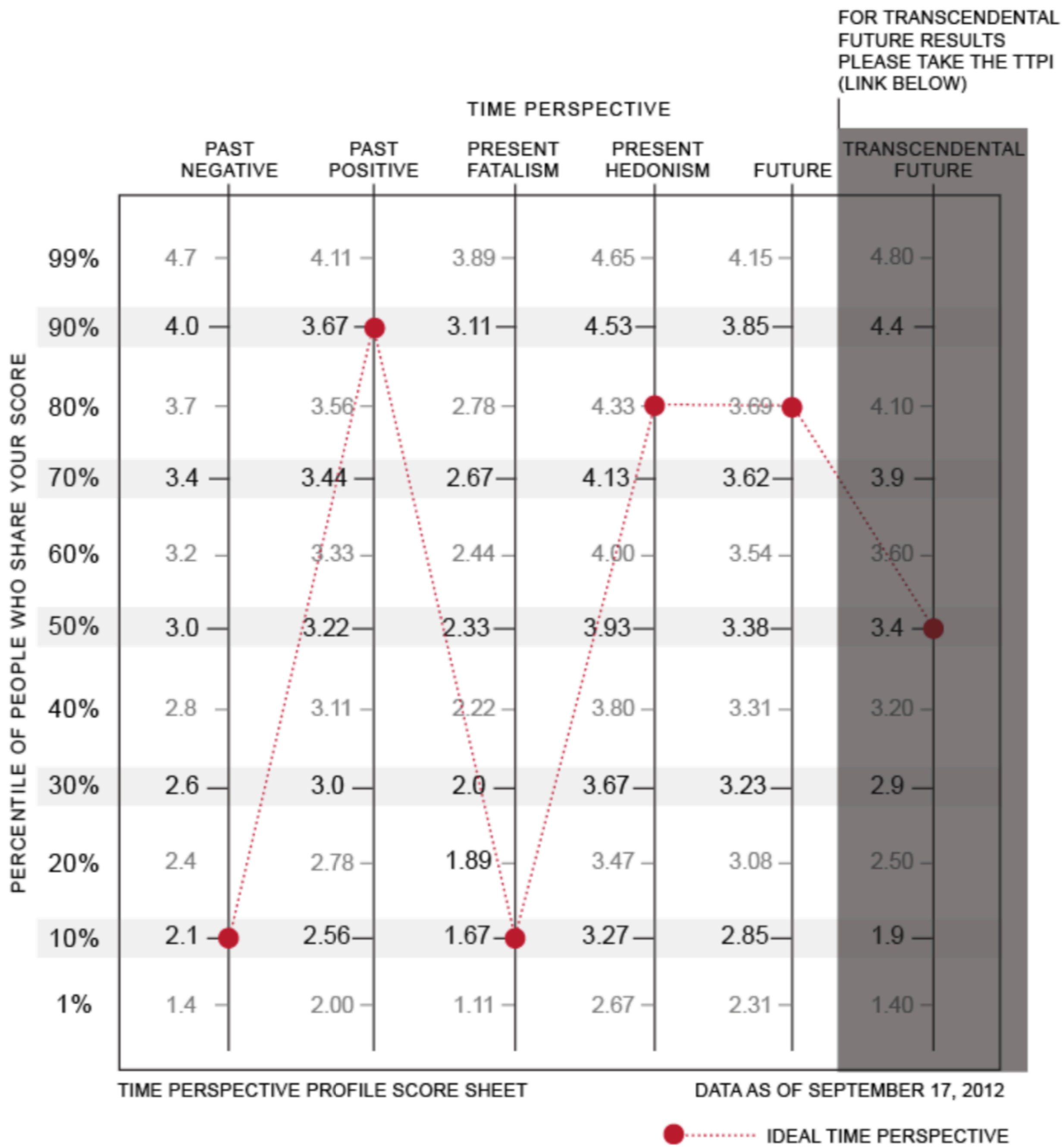

Figure 12. The Ideal Time Perspective. From “Zimbardo Time Perspective Inventory, “From “Living and Loving Better with Time Perspective Therapy: Healing from the Past, Embracing the Present, Creating an Ideal Future,” by P. G. Zimbardo and R. K.M. Sword. Copyright 2017 by McFarland & Company. Reprint with permission.

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Zimbardo and Boyd (2008) state that the ideal TP is low on PN and PF as research shows that they are adversaries to well-being. Hence, scores that are moderately high and high on PP, PH, F, and low on PN and PF are preferred. This blend is considered as beneficial for both psychological and physical health, and it has been supported by numerous studies (Zimbardo & Boyd, 1999, 2008). For instance, a study which investigated the relationships between BTP and well-being found that individuals with BTP profile reported higher life satisfaction, less negative affection, frequent positive affection, and stronger self-update (Boniwell & Zimbardo, 2004). In another study, Drake et al. (2008) examined the connection between BTP and a subjective sense of happiness and mindfulness. Findings showed that individuals who achieved a BTP profile were happier and more mindful than those with “unbalanced” profiles. Recent studies have also found that BTP is associated with a strong sense of coherence, suggesting that a coherent individual appears to be able to contemplate all TPs simultaneously and appraise them in a balanced way (Ruzhytska, 2015; Wiesmann et al., 2018).

Another recent study used a new method to determine BTP where they calculated a deviation coefficient of a given participants’ profiles. Their findings demonstrated that higher emotional intelligence is a predictor of smaller deviations from BTP and they also found that the strongest predictor of the propensity to delay gratification was the BTP coefficient, calculated according to the formula known as the Deviation from balanced Time Perspective (DBTP; Stolarski, Bitner, & Zimbardo, 2011). The DBTP measures the difference between an individual’s TP and the optimal BTP profile, as stated by Zimbardo and Boyd (2008).

A study conducted by Zhang et al. (2013) found that DBTP (Stolarski et al., 2011) is most strongly correlated with subjective well-being in comparison with the cut-off point approach (Drake et al., 2008) and the cluster analysis (Boniwell et al., 2010). Recently Stolarski et al. (2014) reported the relationship between DBTP and mood, where they found that participants with low DBTP experienced more positive states and lower tension. Conversely, high DBTP was observed in individuals with higher levels of perceived stress and anxiety (Papastamatelo et al., 2015), suggesting that DBTP is relevant for an array of severe mental illnesses (Oyanadel & Buela-Casal, 2014). In DBTP calculation, a score of zero indicates the perfect BTP, while a higher DBTP score refers to biased TP (Stolarski et al., 2011).

In sum, research has shown the humans have the unique ability to mentally travel in time (Suddendorf & Corballis, 1997, 2007; Tulving, 1985, 2005). However, individuals get stuck in one of the biased TPs at the expense of other people and their overall well-being (Zimbardo & Boyd, 2008). With that, individuals must strive to achieve a BTP so that they could freely go on mentally travel in time and yet have the ability to anchor to the present reality. The active concentration on the present not only allows individuals to experience the enjoyment of satisfaction and pleasure, but it is also critical in responding to crises (Boniwell & Zimbardo, 2004; Sobol-Kwapinsk, 2009; Zimbardo & Boyd, 1999). For instance, a study demonstrated that homeless people who possessed the ability to actively focus on the present were more effective in dealing with the acute crisis. Also, this study found that concentration on the future was related to a greater sense of self-efficacy and optimism whereas focusing on the present enables openness towards solutions seeking and problem-solving (Epel, Bandura, & Zimbardo, 1999). Hence, the individual who possesses a BTP has a more favorable alternative to living life rather be a slave to any particular TP bias (Boniwell & Zimbardo, 2004). In their book, Zimbardo and Sword (2017) assert that “being stuck in one or two negative time perspectives of the six possible time perspectives seems to be a critical factor in emotional distress; a balanced time perspective is the cornerstone of emotional well-being” (p. 184).

Summary

Resilience is a construct that has varied definitions. Research has shown that most of the definitions emphasize positive adaptation and the ability to "bouncing back" from the stressful experience. In this chapter, the researcher attempts to examine how people can obtain resilience via achieving a high level of sense of coherence (SOC; Antonovsky, 1987), a balanced time perspective (BTP; Zimbardo & Boyd, 1999), a good mindsight (Siegel, 2012), and acquiring a good HRV and psychophysiological coherence (Institute Of HeartMath, 2014, 2017). Consistent with Bischof (2008), the researcher of this paper also posits that all systems in the organism must be coherent, balanced, ordered, harmonious, and integrated to a certain degree to be functional. Hence, the researcher chose these theoretical frameworks because, as mentioned, they have the same objective, which is achieving health, balance and attaining optimal functioning in cognitive, affective, behavioral, and social aspects.

The stress response can cause disordered activities in the neural regulation of the ANS and related endocrine and immune systems, such as excitation of the HPA and SAM axes which inhibits the PNS and neurovegetative function, including eating and sleep, resulting in a state of high arousal. Such conditions allow the instinctual fight-or-flight responses to dominate, causing the PFC to be inhibited, which in turn, switching off the more complex cognition of the forebrain. This state of emotional distress can be observed in the heart-rhythm patterns as discordant, erratic, and jagged waveform as well as a surge in the low LF band as shown in the HRV power spectrum, suggesting a high sympathetic activity. This is also a demonstration of disordered activity in the high-level-brain systems, linking to the disarranged activities between the prefrontal cortex and the parasympathetic branch of the ANS. An individual who is in an incoherent state will have low HRV, signifying a monotonously regular heart rate, and it is associated with impaired ANS functions leading to lower ability to cope with internal and external stressors. Hence, one will have lower psychological flexibility and higher allostatic load.

With that, the researcher maintains that these individuals may be overwhelmed by their disordered physiological state, which causes them to have a lower capacity to perceive the world objectively. There is a high chance that they may not possess enough insights to understand the situation (comprehensibility), do not know what resources or where to get them to solve the problem (manageability), and see the value or learning opportunity in the current situation (meaningfulness). Thus, these individuals have a low sense of SOC.

This group of individuals may also get stuck in one of the biased TPs at the expense of other people and their overall well-being. This is not uncommon for individuals to get stuck in the familiar even though they knew about their unhealthy emotional and behavioral patterns. The reason may attribute to the challenging or adverse conditions they experienced have been normalized into a new baseline. In other words, these individuals may have felt "at home" or "comfortable" with internal incoherence. With that, the PN and PF may become "good friends" with these individuals. It is worth to note the practice of HeartMath positive emotion-refocusing technique such as the QCT where individuals are encouraged to make a sincere attempt to experience a regenerative feeling such as appreciation or care for someone or something in their life (Institute Of HeartMath, 2014). This re-experiencing of a particular positive feeling requires the individual to recollect a PP memory in-the-moment. The process of re-experiencing has a profound effect. Research has shown that a purely mental activity such as cognitively recollecting a past event that provoked an emotion (e.g., anger) does not generate an effect on physiological processes as profound as actually engaging the emotion related to that memory (McCraty et al., 1995; Rein, Atkinson, & McCraty, 1995). With regular practice, re-experiencing of positive feelings can help individuals to evade out of their biased TPs, and they can work to enrich the narratives of their PP and create a new baseline.

In addition, the Freeze-Frame technique, another positive emotion refocusing technique that is built on top of the QCT by first acknowledging the problem, re-experiencing the positive feeling, and then objectively ask oneself what would be a more efficient or effective attitude, action, or solution. The individual would quietly observe whether is any subtle changes in perceptions, feelings, or attitudes, which one could tap on it and acting on these new insights (Institute Of HeartMath, 2014). This technique appears to help individuals to freeze that perceptual frame which may link to their PN or PF. By asking the heart intelligence for wisdom can activate future TP, which can translate into positive and adaptive behaviors. As shown in Figure 5, at the 300th seconds of using the Freeze-Frame technique can facilitate the heart, respiratory, and blood-pressure systems to come into entrainment. This process of entrainment that demonstrates an increased coherence within each system (autocoherence) and among various oscillating systems (cross-coherence) is akin to Siegel's (2012) example of hearing the choir singing in harmony. Not only every member contributed to the differentiation and linkage of their voices, but also the workings of their embodied brains where all their bodily senses including sensing each other's body cues to start or end a phrase, listening to each other with reference to produce the intended pitch, and moving their body according to the rhythm and the flow of the song. All these require an integration of the whole functional embodied brain.

These shifts allow individuals to flexibly adapt between the temporal frames (past, present, and future). Such mental flexibility enables them to have the ability to reject negative TPs and embrace positive TPs. Coupled with a high SOC, individuals can see their future as predictable, manageable, and meaningful. Also, individuals with high SOC and a BTP are associated with high HRV (e.g., Edwards, Edwards, Buscomebe, Beale, & Wilson, 2015; Field et al., 2018; Watson, 2015; Wiesmann, Ballas, & Hannich, 2018). With these interlinked relationships between HRV, SOC, and BTP, the researcher hypothesizes that through the use of the HeartMath System, its self-regulation techniques and assistive technology as a specific resistance resource (SRR) can effectively facilitate people to increase their psychophysiological coherence. McCraty (2015) accentuates that, "failures of self-regulation are central to the vast majority of health and social problems that plague modern societies. The most important strength that the majority of people need to build is the capacity to self-regulate their emotions, attitudes and behaviors" (p. 33). Hence, the goal is to increase the synchronization between the heart and brain that is aligned with IPNB where it aims to nurture and cultivate linkage on the differentiation areas of the system and emancipate its impediments to integration. With that, individuals can move towards a flexible, adaptive, coherent, energized, and stable (FACES) flow of healthy life through the movement of an integration system. Individuals can gain a high level of cognitive, emotional, and behavioral flexibility towards the path of achieving resilience. According to Siegel (2012), integration is a lifelong process and a journey, not the destination. This research echoes this notion, and it is through interventions such as the HeartMath system that focuses on the linkage areas of differentiated areas (e.g., heart-brain communication) promotes integration and coherence opens the first door to individuals' journey to health, well-being, and resilience.

CHAPTER THREE

METHODOLOGY

In recent years, numerous agencies in Singapore have taken active steps to promote knowledge of and skills in acquiring resilience and emotion regulation. Despite the extensive effort of implementing such programs to the diverse community, there is a paucity of published intervention programs on resilience and emotion regulation. Thus, there is a need for more evidence-based interventions on emotion regulation that could be introduced as a nationwide movement to achieve resilience and well-being.

The purpose of this quantitative experimental study was to determine the effectiveness of the HeartMath System (Institute of HeartMath, 2014) on both physiological and psychological measures, which are related to improved emotion regulation flexibility and personal resilience for Singaporeans. The quantitative method that is typically based on the positivist approach is designed to explore scientific inquiry of the relationship between the delivery of the coherence-building program and psychophysiological coherence that are crucial to achieving resilience, as well as to examine the interplay between these factors in relation to the sense of coherence (SOC; Antonovsky, 1993) and the balanced time perspective (BTP; Zimbardo & Boyd, 1999, 2008) as all these factors have been associated with emotion regulation and resilience.

The applicability of the quantitative method for this study was discussed in-depth in this chapter, which described the methodology used to test the hypotheses presented below. These included research design, research questions, hypotheses, and sample population. In addition, the conceptual framework, instrumentation, and data collection were presented. Finally, the chapter has discussed the data analysis and ethical concerns of this study. Specifically, the study has attempted to answer the following research questions:

1. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase psychophysiological resilience, as measured by HRV and POQA-R4?

   H1. The practice of HeartMath coherence-building techniques significantly increases psychophysiological resilience.

2. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase the sense of coherence?

   H2. The practice of HeartMath coherence-building techniques significantly increases sense of coherence.

3. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days facilitate a balanced time perspective?

   H3. The practice of HeartMath coherence-building techniques significantly increases balanced time perspective.

4. What are the factors that may improve emotion regulation flexibility?
5. How does the HeartMath coherence-building program compare with other strategies for building resilience?

Research Method

As defined by Leedy and Ormrod (2001), research methodology is "the general approach the researcher takes in carrying out the research project" (p.14). In quantitative research, the collection of data is an essential process as it allows the information to be quantified and subjected to statistical treatment which could then be used to support or refute "alternate knowledge claims" (Creswell, 2014). In addition, Creswell (2014) maintains that a quantitative method is considered suitable when a researcher pursues to learn relationships between variables.

As the goal of this study was to examine the effectiveness of the HeartMath System on individual's resilience, time perspectives, HRV, and SOC, a quantitative approach is deemed to be an appropriate choice for an interventional study.

This study employed a true experimental design, the core method of a quantitative approach. It consisted of a pretest/posttest experimental-control group design to examine the research questions that were presented. According to Christensen (1988), "to be true experimental design, a research design must enable the researcher to maintain control over the situation in terms of assignment of subjects to groups, in terms of who gets the treatment condition, and in terms of the amount of treatment condition that subjects receive" (p. 231). A true experimental design involves the random assignment of the study subjects to the experimental group or the control group. The targeted intervention to studied (independent variable) takes place in the experimental group whereas the control group receives either no treatment or some other form of interventions. The evaluation of both groups on their behavior/response of the dependent variable is measured before the application of the intervention (pre-test and baseline data) and after the administration of the desired intervention (post-test). The difference examined between the groups ascertain the relationship between the independent and dependent variables (Harkiolakis, 2017; Levy & Ellis, 2011).

This study employed a 2x2 mixed factorial design. There were two independent variables and four dependent variables. Time (within-Ss) is one of the independent variables, which included two levels consisting of simultaneous pre-and post-testing of the HeartMath System intervention group and the wait-list control group. The other (between Ss) independent variable was presence (treatment group) or absence (control group) of the HeartMath System. The four dependent variables were the measures of heart rate variability (HRV, including both time and frequency domains), personal organization and quality assessment (POQA-R4), sense of coherence (SOC), and time perspectives (ZTPI).

Participants

Participants for this study comprised a random sample of healthy adults between the ages of 18-65 who are currently residing in Singapore. The inclusion criteria for the study consisted of adults between the ages of 18-65, with no declared major physical or mental health concerns, and were required to have the ability to read and write in English. The primary exclusion criteria were the presence of an existing heart condition, which may affect the baseline HRV measurements.

Study Sample

In the literature, several studies have demonstrated large effect sizes which supported the effectiveness of the use of HeartMath System, including its patented self-regulation techniques and technology that facilitates biofeedback training to improve HRV, reduction of stress and anxiety, and improvement of subjective well-being (e.g., Field et al., 2018; Thurber et al., 2010). These findings are in line with a recent meta-analysis by Goessl, Curtiss, and Hofmann (2017). With that, an estimated large effect size ($\omega^2 = .15$; Keppel, 1991) was considered for this study.

According to Clark-Carter (2019), “statistical power is defined as the probability of avoiding a Type II error” (p.161), denoting rejecting the research hypothesis even though it is true. A prospective power analysis was performed to determine the required sample size to reduce Type II errors. According to Keppel (1991, p.72), to achieve a power of between .70 to .80, with a large effect size of .15, and a significance level or alpha (a) of .05, the target sample size requires around 14 to 17 participants for each group. This study attempted to recruit a total of 40 participants (20/group) to account for attrition.

Sampling Procedures

An on-line invitation to participate in the study (Appendix A) and a demographic information form containing questions regarding age, gender, marital/relationship/family status, level of education, and current health status (Appendix B) were sent to potential participants. The method of recruitment is described in the Data Collection section. Interested participants registered via an online link and complete the demographic form. The researcher has screened through the given information and informed the participants based on the inclusion/exclusion criteria. Upon consenting to participate in the study, the participants who meet the criteria were asked to read and sign the Informed Consent Form (Appendix C). They were randomly assigned to the intervention group and the wait-list control group. Simple random assignment was used to allocate participants to the HeartMath System (HMS) intervention group and the wait-list control group.

The random assignment represents a distribution of potential error or bias among people that might influence the outcome (e.g., motivation, attention span) (Creswell, 2012). A number was assigned to each participant to obtain fair randomization. Based on the appearance of the numbers in the first column, which was generated by a computer program, the Random Sequence Generator (Random.org, 2019) determined the allocation of the HMS intervention group.

Study Setting

The study was conducted at the principal researcher's (PR) office, where data was collected during the morning session. It was a mid-size office which was divided by a partition that allowed participants to have a private space during the data collection phase. Also, the office can accommodate about 20 participants and provided them a safe and quiet environment during the HMS training workshop.

Instrumentation

In this study, several instruments were used to assess the effectiveness of the HeartMath System in the non-clinical population. They were categorized into physiological assessment and psychological and behavioral assessments. HRV is the physiological assessment to quantify physiological coherence variables. The three questionnaires are the psychological and behavioral assessments that were used to quantify resilience, sense of coherence, and time perspective.

Physiological Assessment

Heart Rate Variability (HRV). HRV was measured with the biofeedback pulse sensor tool, the emWave Pro Plus® (Institute of HeartMath, Boulder Creek, CA; see Appendix D). It is a HeartMath patented computer-based heart rhythm technology that is based on decades of research on stress, emotions, and performance that objectively monitors heart rhythms and displays the physiological coherence, an optimal physiological state. With either a finger or earlobe pulse sensor that is plugged to a computer, the emWave software program measures the interval between each heartbeat and then computes and displays the coherence level on the computer monitor. This interbeat interval (IBI) data that includes a number of standard indices of HRV is presented with advanced graphic information that provides both the researcher and the participant a real-time "mirror" of the participant's heart rhythm patterns which is the results of one's attitudes and emotional response to stress (Institute of HeartMath, 2017). (see Appendix D for the example of the computer monitor HRV reading).

The emWave Pro Plus uses the HeartMath Photoplethysmographic Monitor (PPG, see Appendix E). It is a non-invasive, inexpensive, and simple optical measurement technique that is capable of obtaining HRV indices via the detection of phasic volumetric changes in the peripheral blood circulation at the skin surface (Allen, 2007; Challoner, 1979; HeartMath Inc, 2018). The finger and earlobe pulse sensors that are used with the emWave Pro Plus utilize infrared emitter and a detector to detect the blood volumes variations in the microvascular bed. In comparison to traditional HRV recording methods such as the electrocardiography (ECG) that capture the electrical activity of the heart, the PPG operates as a mechanical signal that measures the propagation of the peripheral pulse wave. PPG has been directly associated with the cardiac function that follows a measure of the pulse transit time (PTT), the time of propagation of the pulse pressure (PP) wave from the heart to the distal arterioles. It is a quantitative measure of the time that elapsed between the R-wave of QRS complex in the ECG and the corresponding PPG wave. Research has shown that PTT appears to be a surrogate marker of ANS comparable to HRV (Foo & Lim, 2006; Georgiou et al., 2018).

Research has supported that PPG technology is comparable to standard ECG measurement, considering it a valid and reliable method when recorded during in a steady and stationary condition as well as from deep breathing tests (Georgiou et al., 2018; Russoniello, Zhirnov, Pougatchev, & Gribkov, 2013). HRV measures that are included in emWave Pro Plus are the time domain parameters consist of Mean Heart Rate, Mean Inter Beat Interval (IBI), Mean Heart Rate Range (MHRR), SDNN, RMSSD, and the frequency domain parameters comprise of Total Power, VLF, LF, HF, LF/HF ratio, and Normalized Coherence (HeartMath Inc, 2018).

In this study, both time domain and frequency domain parameters were used. Within the time domain parameters, SDNN is the sinus-initiated IBIs measured in milliseconds that reflects the ebb and flow of all the factors contributing to HRV as well the heart’s ability to respond to hormonal changes (Task Force, 1996; Umetani, Singer, McCraty, & Atkinson, 1998). The RMSSD is the root mean square of successive differences between normal heartbeats, reflecting the beat-to-beat variance in heart rate. The RMSSD is the primary time domain measure used to evaluate the vagally mediated changes reflected in HRV (McCraty & Shaffer, 2015; Shaffer et al., 2014).

Within the frequency domain parameters, the Total Power is the sum of the energy in the VLF, LF, and HF bands for short-term recordings (Shaffer, McCraty, & Zerr, 2014). The VLF band ranges from 0.0033 to 0.04 Hz (Task Force, 1996), and it is a significant factor of physical activity and has been regarded as a marker of sympathetic activity (Sztajzel, 2004). The LF band ranges from 0.04 to 0.15 Hz, which is modulated by both the SNS and PNS (Ernst, 2017; Malliani et al., 1991; Sztajzel, 2004; Task Force, 1996). The HR band ranges from 0.15 Hz to 0.4 Hz, which represents an index of vagal tone or PNS (Eckberg, 1983; Task Force, 1996). The LF/HF ratio reflects the global sympathetic/vagal balance (Sztajzel, 2004). The normalized coherence is a frequency domain measure of coherence in the heart rhythm pattern. It is determined by quantifying the power spectral density (PSD) across the greatest peak in the coherence range and dividing it by the PSD total power, which yields a normalized coherence score ranging from 0-100 (HeartMath Inc, 2018).

Psychological and Behavioral Assessment

Personal and Organizational Quality Assessment (POQA). The Personal and Organizational Quality Assessment – Revised 4 Scale (POQA-R4) is a tested, valid, and reliable instrument developed by the Institute of HeartMath (IHM; 2011; Appendix F). Out of the current 52 questions POQA-R4, a subset of 49 items is based on the original 81 questions POQA-R survey questionnaire (Barrios-Choplin & Atkinson, 1996) which was designed to provide an assessment in two domains of workplace quality and function. The assessment has been revised and updated by HeartMath Research Center scientists with a new, empirically validated conceptual framework, known as the current POQA-R4. The POQA-R4 is a subjectively self-reported stress questionnaire designed to reflect the key psychological and workplace elements that contribute to the overall quality and effectiveness of an organization. The onset of the questionnaire includes eight items of basic socio-demographic information describing the respondents' characteristics were measured. They are 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 (Institute of HeartMath, 2011).

Based on the new conceptual framework, items have been reclassified into four primary scales and nine multi-item subscales of workplace quality, which have a direct impact on health and job performance. These four factors are Emotional Vitality, Emotional Stress, Organization Stress, and Physical Stress. Two of the four factors are designed to measure emotions, which is in line with HeartMath's focus on the vital role emotions play in the workplace. While the Emotional Vitality scale reflects a positive or enhancing effect on health, well-being, and performance; the Organizational Stress, Emotional Stress, and Physical Stress indicate adverse or deleterious effects on health, well-being, and performance. The responses for each question will be gathered through two formats of a 7-point ordinal Likert-type scale, ranging from "Not at all" to Always" for items 1 to 40, and "Strongly Disagree" to "Strongly Agree" for items 41 to 52 (Institute of HeartMath, 2011).

The psychometric analysis of the reorganization of the 49 items into the new framework has been verified by validity and reliability of measurement study conducted on the existing POQA-R database of 5,971 working adults (Institute of HeartMath, 2011). Statistical analyses were performed to substantiate measurement validity and reliability. Cronbach's alpha test is designed to check the reliability and internal consistency of the questionnaire items. The

Cronbach's alpha of .60 indicates an acceptable coefficient, a .72 signifies a satisfactory level, a .80 suggests a good level, and a .93 specifies a high coefficient (Creswell, 2012; Nunnully & Bernstein, 1994). The seven scales and their associated subscales were subjected to an analysis of internal consistency of measurement using Cronbach's coefficient alpha a. The findings for the four primary scales revealed that all constructs surpassed the criterion for technical adequacy (a > .75); the alpha coefficients ranged from .76 (Organizational Stress) to .92 (Emotional Vitality and Emotional Stress). Except for Relational Tension (a = .69), results for the other eight multi-item subscales showed that they have either achieved or exceeded the criterion for adequate measurement reliability. Across these subscales, the alpha coefficient ranged from .76 (Health Symptoms) to .90 (Emotional Buoyancy, Intention to Quit, and Anxiety/Depression). Overall, all the available statistical evidence consisting of the validity of the item assignment to both the primary scales and subscales as well as its measurement reliability suggests that the new POQA-R4 framework appears to be psychometrically sound (Institute of HeartMath, 2011).

Orientation to Life Questionnaire (SOC-13).

The Sense of Coherence (SOC) measure was assessed on the abbreviated 13-item version of Antonovsky's (1987) Orientation to Life Questionnaire (OLQ) to obtain quantitative data (Appendix G). The SOC-13 scale has three components: Comprehensibility (items 2, 6, 8, 9, 11); Manageability (items 3, 5, 10, 13); and Meaningfulness (items 1, 4, 7, 12) as shown in Table 1. The questionnaire includes a 7-point Likert-type scale for each item with two fixed contradictory responses at opposing ends of the scale, for instance, "very often or never" to "very seldom" as response to questions such as "Do you have the feeling that you don't really care about what goes on around you?" The sum of the scores for SOC-13 is 13 (low SOC) to 91 (highest possible SOC). The higher the score, the stronger the SOC (Antonovsky, 1987).

Eriksson and Lindström (2005) conducted a systematic review and determined the validity of Antonovsky's SOC scale. Findings showed that the SOC questionnaire had been used in at least 33 languages in 32 countries with at least 15 different versions of the questionnaire. The mean scores of the SOC-13 ranged from 35.39 (standard deviation [SD] 0.10) to 77.60 (SD 13.80) points across the studies reviewed.

While the Cronbach's alpha based on 16 studies, according to Antonovsky (1993) maintained that the internal consistency of SOC-13 range from .74 to .91, Eriksson and Lindstrom (2005) found the Cronbach's alpha in 127 studies using SOC-13 range from .70 to .92. They added that "SOC scale seems to be a reliable, valid, and cross-culturally applicable instrument measuring how people manage stressful situations and stay well" (p. 1). Hence, the SOC-13 has demonstrated a coefficient of satisfactory to a good level. Further, a recent study considers the 13- item SOC measure seems to provide a psychometrically sound survey instrument for testing Antonovsky's theory of life orientation and health (Feldt, Metsapelto, Kinnunen, & Pulkkinen, 2007). The choice of a shortened 13-item version is based on the recommendation from the Society for Theory and Research on Salutogenesis (STARS; n.d.) stating that the SOC-13 is especially useful for measuring SOC when used in studies that include other measures.

Table 1

SOC-13 Scale

Factors	**Items**	**Min – Max Scores**
Comprehensibility	2*, 6, 8, 9, 11	5 - 35
Manageability	3*, 5, 10, 13	4 - 28
Meaningfulness	1*, 4, 7*, 12	4 - 28
SOC-13 Total	1 to 13	13 - 91

Note. Distribution of the items by factors with minimum and maximum values for each factor, and aggregate scores for SOC-13. (* denotes items to be reverse-coded).

Zimbardo Time Perspective Inventory (ZPTI). In this study, time perspective (TP) was measured using the ZTPI developed by Zimbardo and Boyd (1999; Appendix H). The ZTPI is a 56-item scale comprises of five subdimensions with each is assessed using a 5-point scale (1 = very untrue, 5 = very true). Nine items measure the past positive (PP) perspective which reflects pleasant and sentimental views of one's past (e.g., "Happy memories of good times spring readily to mind"). Ten items measure the past negative (PN) which represents negative attitudes toward a past full of anxiety, regret, and traumatic events (e.g., "Painful past experiences keep being replayed in my mind"). Fifteen items measure the present hedonistic (PH) which signifies risky attitudes to life and a focus on pleasure ("here and now") (e.g., "I take risks to put excitement in my life"). Nine items measure the present fatalistic (PF) which denotes the perception of life as something uncontrollable and possesses a passive expectation of what life brings (e.g., "It doesn't make sense to worry about the future, since there is nothing that I can do about it anyway"). Thirteen items measure the future (F) perspective which reflects goal directed behavior (e.g., "When I want to achieve something, I set goals and consider specific means for reaching those goals"). Researchers have proposed that the scores for an individual to achieve a balanced time perspective (BTP), when assessed with ZTPI, one should score low on PN and PF (scoring 1 or 2 on most items), moderate on PH (scoring 3 on most items), moderately high on F and FP (scoring 3 or 4 on most items), and high on PP (scoring 4 or 5 on most items (Boniwell & Zimbardo, 2004; Wiberg, Sircova, Wiberg, & Carelli, 2012; Zimbardo & Boyd, 2008). The ZTPI has shown to be a reliable and valid measure over the years. Cronbach's alpha for ZTPI scales are found in Table 2.

Deviation from the Balanced Time Perspective (DBTP: Stolarski, Bitner, & Zimbardo, 2011) based on the ZPTI scores will be employed as a continuous indicator of BTP. The DBTP (Stolarski et al., 2011) measures the difference between an individual's TP and the optimal BTP profile. A study conducted by Zhang et al. (2013) found that DBTP is the most optimal among available methods such as the cut-off point approach (Drake et al., 2008) and the cluster analysis (Boniwell et al., 2010), and is most strongly correlated with subjective well-being. Lower DBTP scores reflects a higher level of balance (Stolarski et al., 2011). The following formula will be applied to calculate DBTP, where oPN – ePN denotes optimal PN minus empirical PN. This formula is repeated for each time dimension:

$$DBTP = \sqrt{\begin{array}{l}(oPN - ePN)^2 + (oPP - ePP)^2 + (oPF - ePF)^2 \\ \quad +(oPH - ePH)^2 + (oF - eF)^2\end{array}}$$

Table 2

Distribution of the Items by Subdimensions of Time Perspective.

ZTPI		
Time Perspective	**Items**	**Cronbach's Alpha Values**
Past Positive	2, 7, 11, 15, 20, 25, 29, 41, 49	.80 / .79*
Past Negative	4, 5, 16, 22, 27, 33, 34, 36, 50, 54	.82 / .77*
Present Hedonism	1, 8, 12, 17, 19, 23, 26, 28, 31, 32, 42, 44, 46, 48, 55	.79 / .75*
Present Fatalistic	3, 14, 35, 37, 38, 39, 47, 52, 53	.74 / .68*
Future	6, 9, 10, 13, 18, 21, 24, 30, 40, 43, 45, 51, 56	.77 / .76*

Note. Cronbach's alpha values for each TP is based on ZTPI original English version conducted in USA (Zimbardo & Boyd, 1999). Cronbach's alpha represented in * denotes ZTPI English version conducted in UK (Boniwell, Osin, Linley, & Ivanchenko, 2010).

Data Collection

This study was approved by the California Southern University Institutional Review Board (IRB).

Recruitment

Once IRB approval was obtained, the online invitation (Appendix E) and demographic information form (Appendix F) were sent to invite participants to join the study. This study aimed to invite a total of forty healthy men and women (twenty participants for each group), ages of 18-65 from all walks of life, who are currently residing in Singapore. An invitation email was broadcasted through social media such as Facebook and email blasts to various groups such as counseling/psychology schools and associations, and music groups and societies. The PR had also acquired help from the friends to disseminate the invite letter to their friends and colleagues.

The content of these documents consists of descriptions of the study, including the inclusion/exclusion criteria, purpose, and requirements of the study, compensation, as well as the confidentiality effort to protect their privacy. After the interested participants who had signed up via an online registration form, the PR reviewed the given demographic information and selected participants who met the study criteria. After they had read and signed the Informed Consent Form (Appendix H) they were randomly assigned to either the HMS intervention group or the wait-list control group as illustrated above. The PR had then informed participants in each group about the appointment schedule and requirements of the study. The PR had reiterated that the study is voluntary, and they will receive compensation upon the completion of the study.

Informed Consent

At the first session, each participant was guided through the informed consent process before the commencement of the study. Each participant was asked to read the content of the informed consent form (Appendix H), and they were encouraged to ask any question or concerns. The PR accentuated the importance of ensuring the confidentiality of their identities and the effort to safeguard the collected data. Upon the signing and dating the informed consent form, the process was completed. Participants have each receive a personal copy of their informed consent form. In order to ensure confidentiality, these will be stored separately from all other forms, which will be coded with a group and subject number only.

Planned Pre- and Post- Intervention

Following the completion of the informed consent process, all participants regardless of the HMS intervention group or the wait-list control group were administered with pre-study and post-study surveys and assessments at the first session and the conclusion of the study (see Figure 13). All sessions were conducted in PR's office, a controlled, quiet environment conducive to relaxation.

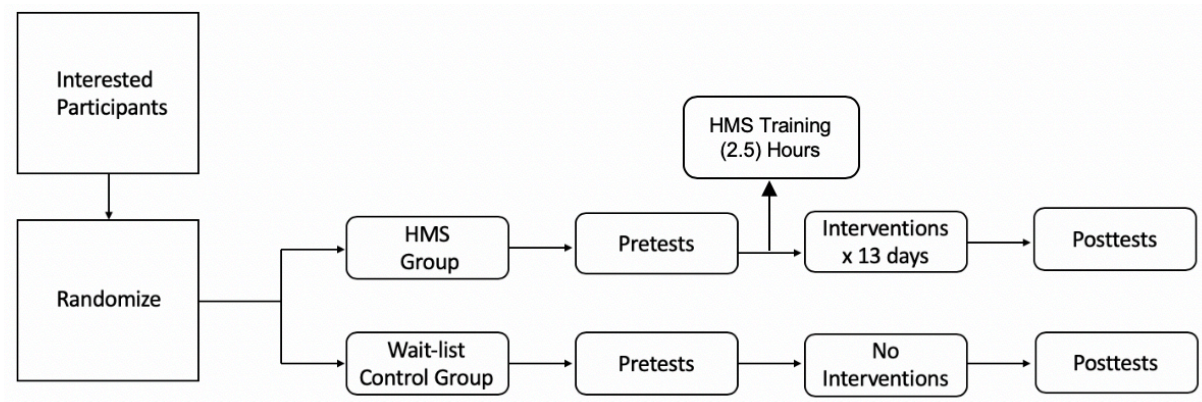

Figure 13. Flow chart illustrating plan of study.

Procedures

During the HRV assessments, participants were recorded individually. HRV was measured with the emWave ear sensor. The sensor was placed on one of their earlobes which is powered by the emWave USB sensor module that interprets the data transmitting to the software program, the emWave Pro Plus. The HRV assessments comprise the two steps protocol (McCraty, personal e-mail, March 1, 2019), which took an average of ten minutes for each participant. The assessments will be performed as follows:

1. Five-minute resting HRV assessment: Participants are required to be seated and imagine they are waiting for the bus with absence of any activities (e.g., chewing of gum, or reading magazines).

   Printed instructions to participants: Please sit quietly and relax for 5 minutes without talking, try to remain as still as possible without sacrificing comfort. Do not engage in intense mental or emotional activity. Also, do not engage with any physical activity such as eating a sweet or reading a magazine, as well as making any significant or rapid body movements. Keep your eyes open to avoid falling asleep. Do not meditate or use other similar practices. Just sit quietly as if you were waiting at the bus stop for the bus.

2. Stress preparations (3 minutes):

   Printed instructions: During the next 3 minutes, please do the following. As if you were preparing yourself mentally and emotionally for an important upcoming event or activity. Focus your attention in the center of your chest. Try and activate and experience a positive feeling such as care or appreciation for someone or something or some special place.

   Upon the completion of the HRV assessments, each participant was requested to complete three sets of questionnaires. The SOC-13 and ZTPI were paper-and-pencil administered questionnaires while participants were provided with an iPad to complete the POQA-R4 web-based survey. Due to the limited availability of laptops with installed emWave Pro Plus software that were used to collect HRV data, the pretests of the HMS intervention group and the wait-list control group were performed one day apart.

HMS Training Session. Participants who were randomly assigned to the HMS intervention group received a 2.5-hour training workshop one day after the pretest session. The workshop was conducted at the PR’s office, where he led the training. Beverages and snacks were provided for the participants. The 2.5-hour training workshop was based on HeartMath’s Resilience Advantage training program (2014) where the PR has strategically selected relevant modules to help participants to learn and apply practical resilience and emotion regulation skills. The PR is a HeartMath Certified Practitioner and a HeartMath Certified Trainer, where he is qualified to administer and interpret the HRV assessments and conduct a workshop teaching the HMS techniques to a class (see Appendices I and J).

The workshop was divided into two parts: 1) Basic concepts of resilience, depleting and renewing emotions, balanced care and overcare, and the physiology of coherence and optimal functioning; 2) Explanation and practice HeartMath (HM) coherence-building techniques: Heart-focused Breathing, Quick Coherence Technique, Freeze-Frame Technique, and Heart Lock-In Technique. The group had learned how to use the HeartMath Inner Balance Monitor (See Appendix K), a portable device that monitors and provides psychophysiological coherence biofeedback which was loaned to each participant. Each HMS intervention group participant received Resilience Advantage worksheets and cue cards on how to practice the HM self-regulation techniques. As the Inner Balance is a Bluetooth device that connects to phones that run either on Android or iOS, the operation of the Inner Balance was taught during the workshop. An example of the HM coherence-building techniques, Heart Lock-In, can be found in Appendix L.

Daily Practice. As part of the study, each participant was required to practice HM coherence-building techniques with the aid of the Inner Balance device. They were required to practice the Heart Lock-In, an emotion restructuring technique for 8 minutes, twice a day, for 13 days. Participants were instructed to take a screenshot of their completed practices which will serve as a practice log, which the participants will have to send to the PR via e-mail at the conclusion of the study. In order to ensure consistency, all participants were guided to customize to the same settings in the Inner Balance app, as shown below:

i) Switch off all volume (music and sound effects);

ii) Set challenge level to level 2;

iii) Set breath pacer to 10 seconds per breath;

iv) Set session timer to 8 minutes

Participants were encouraged to practice and use the emotion refocusing techniques such as Quick Coherence and Freeze Frame when they are feeling stressed or overwhelmed by difficult situations to achieve a state of "active calm" and make sound decisions.

Posttests. At the conclusion of the study, all participants returned to PR's office to have their post-study HRV assessments measured and filled out the three questionnaires. The HMS intervention group were requested to return the Inner Balance to the PR, and the wait-list control group were provided with information on the workshop. The PR has offered compensation to all participants who completed all required sessions. All participants in both groups received a $20 supermarket voucher as well as being entitled to a lucky draw chance to win a HeartMath Inner Device worth $220.

Data Analysis

The web-based POQA-R4 surveys were sent directly to the Institute of HeartMath (IHM) for data analysis when participants have completed the questionnaire. The IHM has then provided an aggregate analysis and group report to the PR. All other statistical data analyses were performed using the Statistical Package for the Social Sciences (SPSS, version 26.0; IBM Corp, 2019). The significance or alpha level for all analyses were set at .05.

A 2 (Condition: HMS Intervention Group versus Wait-list Control Group) x 2 (Time: Pre-test versus Post-test) mixed factorial MANOVA, univariate tests, paired sample t-test, and Pearson's correlation coefficient analysis were performed on HRV measurements, POQA-R4, SOC-13, and DBTP to analyze the data for significant results.

Research Bias

A design bias can occur when the choice of research question and methodology were motivated by the researcher's personal beliefs to support the usefulness of the selected topic being investigated. In this case, the PR for this study, a professional psychotherapist who has been using the HMS techniques and tools with his clients considers its effectiveness in helping individuals to obtain higher resilience. There was an expectation that the outcomes of the HMS training will demonstrate considerable improvements in HRV measurements, sense of coherence, time perspective, and stress resilience. With such motivated personal beliefs, an analysis bias may occur as the PR may overlook data varying with these beliefs and examining only at data that confirms one's hypotheses or personal experience (Smith & Noble, 2014).

Summary

This study was performed employing a quantitative experimental approach to examine the effectiveness of the HMS coherence-building program has been quantified by psychometric measures of POQA-R4, sense of coherence, time perspectives (psychological aspect), and HRV measurements (physiological aspect). The outcomes of these findings were expected to be considered as a practical and effective therapeutic system for Singapore agencies who work with either or both clinical and non-clinical populations.

CHAPTER FOUR

RESULTS

This chapter presents the results of this research study. The purpose of this study is to use a quantitative experimental design to determine the effectiveness of the HeartMath System (Institute of HeartMath, 2014) on participants' heart rate variability (HRV), stress and resilience (POQA; Institute of HeartMath, 2009), sense of coherence (SOC-13; Antonovsky, 1987), and time perspective (ZTPI; Zimbardo & Boyd, 1999, 2008). These are physiological and psychological measures related to emotion regulation flexibility and personal resilience.

The goal of this study was to examine the following research questions:

1. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase psychophysiological resilience, as measured by HRV and POQA?

   H1. The practice of HeartMath coherence-building techniques significantly increases psychophysiological resilience.

2. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase the sense of coherence?

   H2. The practice of HeartMath coherence-building techniques significantly increases sense of coherence.

3. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days facilitate a balanced time perspective?

   H3. The practice of HeartMath coherence-building techniques significantly increases balanced time perspective.

4. What are the factors that may improve emotion regulation flexibility?

5. How does the HeartMath coherence-building program compare with other strategies for building resilience?

The findings of these research questions were examined with mixed factorial MANOVA and univariate analyses, and a Pearson correlational coefficient analysis of HRV measurements, POQA-R4, SOC-13, and ZTPI with the use of SPSS version 26.0 (IBM Corp, 2019).

Participants

The participants studied in this research study currently reside in Singapore. A total of 43 individuals signed up for the study, of which one individual was excluded due to existing heart conditions. Due to the lack of response from six individuals and the urgent need to attend to a family crisis from one individual, only thirty-five individuals signed the consent form and agreed to participate. A randomized assignment was performed on the sample size of 35 in this study, where17 participants were assigned to the HeartMath System (HMS) intervention group, and 18 participants were assigned to the wait-list control group (WLG). During the data collection, one participant in the HMS group was hospitalized and was not able to complete the post-test assessments. Hence, the final sample size for this study was reduced to 34 participants. (see figure 14).

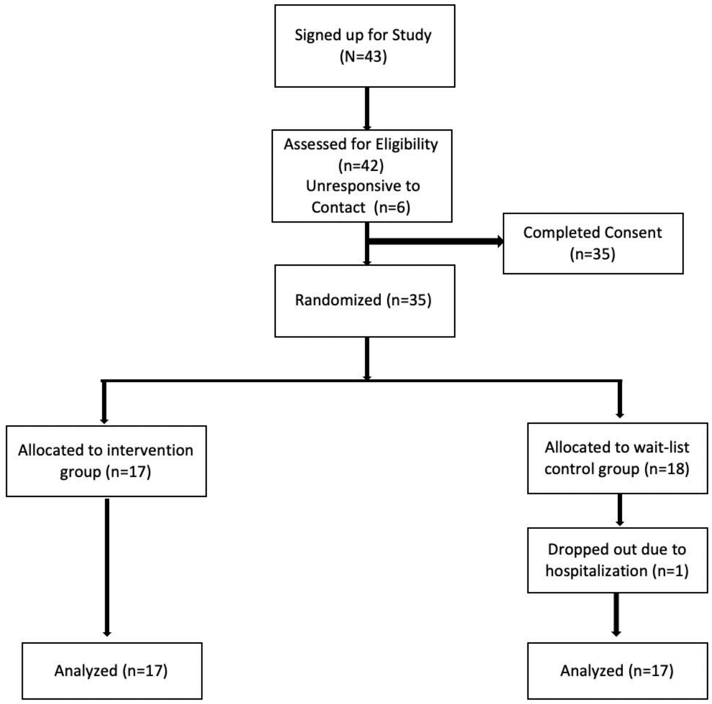

Figure 14. Recruitment flow chart

The frequency table for the demographic characteristic of the total sample and tested groups is presented in Table 3. Fifty-eight percent of the total sample were female, and 41.2% were male. The study consisted of a majority of Chinese (94.1%), an Indian (2.9%), and a Javanese (2.9%). Most participants were within the age range of 21-30 (32.4%) and 41-50 (32.4%), 23.5% were within the range of age 31-40, and 8.8% were within the range of age 51-60. Only one participant (2.9%) was above 61 years old. Females' mean age was 39.9 (*SD* = 10.47, age range: 24-63 years), and males' mean age was 38.21 (*SD* = 9.17, age range: 22-52 years).

A majority of the participants were married *(n* = 20; 58.8%), 38.2% (*n* = 13) were single, and 2.9% (*n* = 1) were divorced. Most participants reported having earned a Bachelor's degree (38.2%; *n* = 13), followed by qualifications obtained in some college (14.7%; *n* = 5), high school (11.8%; *n* = 4), and technical school (8.8%; *n* = 3). A minority have also earned some graduate qualifications (8.8%; $n = 3$), a master's degree (8.8%; $n = 3$), and a doctorate (2.9%; $n = 1$). A majority were employed as professionals (29.4%; $n = 10$), where other participants identified to work in the area of management (20.6%; $n = 7$), executive (20.6%; $n = 7$), other (11.8%; $n = 4$), student (5.9%; $n = 2$), and engineer/technical (5.9%; $n = 2$). One participant (2.9%) reported as unemployed. Descriptive statistics of the HMS intervention group and the wait-list control group, consisting of results from the pre- and post-test assessments can be found in Table 4.

The following presents an essential note in response to research questions one to three. The significance of the differences in the changes from pre-test to post-test between the HeartMath intervention (HMS) and the wait-list control (WLG) groups are reflected in the CONDITIONS (HMS and WLG) x TIME (pre-test and post-test) interactions, so these are being presented graphically wherever the interactions were significant.

Table 3.

Demographic Information of Total Sample and Tested Groups

Total Sample (n = 34)				HMS Group (n = 17)		Control Group (n = 17)	
		n =	%	n =	%	n =	%
Gender							
	Male	14	41.2	8	46.1	6	35.3
	Female	20	58.9	9	52.9	11	64.7
Race							
	Chinese	32	94.1	16	94.1	16	94.1
	Indian	1	2.9	0	0	1	5.9
	Javanese	1	2.9	1	5.9	0	0
Age							
	21-30	11	32.4	5	29.4	6	35.3
	31-40	8	23.5	4	23.5	4	23.5
	41-50	11	32.4	6	35.3	5	29.4
	51-60	3	8.8	2	11.8	1	5.9
	61-70	1	2.9	0	0	1	5.9
Marital Status							
	Single	13	38.2	6	34.3	7	41.2
	Married	20	58.8	10	58.8	10	58.8
	Divorced	1	2.9	1	5.9	0	0
Education							
	High School	4	11.8	3	17.6	1	5.8
	Technical School	3	8.8	2	11.8	1	5.8
	Some College	5	14.7	3	17.6	2	11.8
	Bachelor's	13	38.2	5	29.4	8	47.1
	Some Graduate	3	8.8	2	11.8	1	5.8
	Master's	3	8.8	2	11.8	1	5.8
	Doctorate	1	2.9	0	0	1	5.8
Employment Status							
	Student	2	5.9	2	11.8	0	0
	Skilled/Clerical	1	2.9	2	11.8	1	5.9
	Management	7	20.6	5	29.4	5	29.4
	Professional	10	29.4	5	29.4	5	29.4
	Executive	7	20.6	1	5.9	2	11.8
	Engineer/Technical	2	5.9	1	5.9	1	5.9
	Unemployed	1	2.9	1	5.9	0	0
	Other	4	11.8	0	0	3	17.6

Table 4.

Pre- and Post-Tests Mean Comparison for all Outcome Variables by Group

	HeartMath System Group						Wait-list Control Group					
	Pre		Post				Pre		Post			
Measures	*M*	*SD*	*M*	*SD*	*t*	*p*	*M*	*SD*	*M*	*SD*	*t*	*p*
5-Minute Resting HRV												
Mean Heart Rate (BPM)	81.32	9.69	83.79	9.50	1.47	.161	79.36	8.70	75.02	10.73	-1.73	.102
Mean Inter-beat Interval (ms)	749.7	90.07	728.6	90.61	-1.43	.172	767.5	85.63	818.3	122.5	1.97	.067
SDNN (ms)	34.28	13.59	44.20	19.30	2.97	.009**	39.34	19.94	41.79	12.34	0.59	.563
Ln RMSSD (ms)	3.27	0.27	3.41	0.21	2.65	.018*	3.36	0.34	3.45	0.34	1.28	.219
Ln Total Power (ms2/Hz)	5.55	0.84	6.11	1.04	2.78	.013*	5.84	1.06	5.95	0.75	0.65	.526
LnVLF (ms2/Hz)	4.51	0.83	4.56	0.88	0.27	.788	4.65	1.10	4.74	0.74	0.45	.660
LnLF (ms2/Hz)	4.34	1.02	5.33	1.48	2.62	.018*	4.58	1.16	4.55	1.24	-0.13	.902
LnHF (ms2/Hz)	3.95	1.03	3.86	0.88	-0.49	.626	4.21	1.11	4.41	1.03	1.09	.290
Ln LF/HF Ratio (ms2/Hz)	0.38	0.71	1.48	1.57	2.59	.019*	0.35	0.81	0.16	0.98	-0.89	.387
Normalized Coherence (%)	40.26	7.96	57.89	18.26	4.05	.000***	40.00	13.38	38.15	9.50	-0.66	.517
3-Minute Stress-Prep HRV												
Mean Heart Rate (BPM)	82.71	10.07	82.58	9.51	-0.07	.949	79.72	9.02	75.58	11.04	-1.64	.121
Mean Inter-beat Interval (ms)	737.5	89.55	739.7	89.79	0.12	.903	764.0	89.34	813.04	120.2	1.91	.075
SDNN (ms)	35.51	12.97	48.69	19.61	3.22	.005**	37.31	17.17	41.47	14.49	0.93	.366
Ln RMSSD (ms)	3.32	0.28	3.35	0.20	0.42	.68	3.36	0.36	3.42	0.33	0.79	.438
Ln Total Power (ms2/Hz)	5.61	0.80	6.38	1.14	3.24	.005**	5.72	1.09	5.82	0.72	0.39	.698
LnVLF (ms2/Hz)	4.49	0.73	4.29	0.91	-1.16	.263	4.73	1.29	5.01	0.79	0.85	.407
LnLF (ms2/Hz)	4.61	1.06	5.78	1.64	3.31	.004**	4.36	1.36	4.16	0.93	-0.23	.822
LnHF (ms2/Hz)	3.92	1.09	3.69	0.97	-1.03	.32	4.16	1.18	4.36	0.88	0.75	.462
Ln LF/HF Ratio (ms2/Hz)	0.70	0.61	2.10	1.82	3.67	.002**	0.19	0.85	0.06	0.89	-0.43	.672
Normalized Coherence (%)	39.27	7.25	71.65	17.17	7.62	.000***	40.48	11.47	36.47	10.11	-1.41	.178
POQA-R4												
Emotional Vitality	4.21	0.99	4.31	1.07	0.90	.382	4.55	1.08	4.53	1.04	-0.18	.858
Emo Buoyancy	4.19	1.08	4.28	1.09	0.63	.538	4.70	1.13	4.54	1.01	-1.08	.298
Emo Contentment	4.23	0.99	4.36	1.16	0.82	.423	4.35	1.21	4.51	1.23	1.03	.318
Organizational Stress	4.10	0.88	3.90	0.91	-0.97	.348	3.86	0.98	4.00	0.98	1.18	.255
Pressures of Life	3.99	1.27	3.85	1.04	-0.55	.593	3.83	1.35	3.85	1.34	0.13	.900
Relational Tension	4.55	1.33	4.08	1.76	-1.61	.126	4.27	1.53	4.49	1.58	1.27	.226
Stress	7.71	3.04	7.87	3.16	0.15	.884	6.76	3.63	7.44	3.50	0.54	.592
Emotional Stress	2.45	0.64	2.32	0.67	-1.08	.297	2.43	0.78	2.32	0.81	-1.39	.179
Anxiety/Depression	2.57	0.79	2.36	0.64	-1.43	.172	2.37	0.83	2.34	0.88	-0.47	.637
Anger/Resentment	2.34	0.57	2.29	0.79	-0.37	.712	2.49	0.82	2.31	0.84	-1.46	.167
Physical Stress	2.96	1.00	2.77	0.90	-1.33	.201	2.58	0.94	2.61	0.94	0.19	.847
Fatigue	3.59	1.45	3.34	1.18	-1.17	.261	3.19	1.37	3.12	1.32	-0.58	.569
Health Symptoms	2.54	0.78	2.38	0.78	-1.35	.197	2.20	0.77	2.26	0.82	0.62	.537
Intention to Quit	2.74	1.51	2.88	1.36	0.70	.492	3.00	1.80	3.38	1.70	2.34	.033*
SOC-13												
Comprehensibility	20.88	4.50	21.59	4.30	1.01	.329	21.53	5.51	21.71	5.42	0.21	.837
Manageability	17.47	3.84	20.71	3.18	3.86	.001***	17.59	2.35	17.24	3.01	-0.60	.556
Meaningfulness	20.35	4.70	20.41	3.69	0.08	.939	21.12	2.64	20.18	3.26	-1.49	.156
Total SOC	58.71	10.50	62.71	8.63	3.73	.002**	61.15	8.98	59.12	9.18	-0.63	.296
ZPTI												
Past Positive	3.54	0.52	3.64	0.47	1.28	.218	3.68	0.32	3.63	0.34	-0.98	.340
Past Negative	3.02	0.50	2.74	0.49	-3.07	.007***	2.72	0.60	2.66	0.50	-0.92	.373
Present Hedonistic	3.38	0.50	3.35	0.48	-0.41	.687	3.36	0.36	3.30	0.30	-1.51	.151
Present Fatalistic	2.71	0.73	2.50	0.64	-2.56	.021*	2.44	0.40	2.56	0.43	1.82	.087
Future	3.74	0.40	3.77	0.33	0.38	.706	3.67	0.43	3.58	0.40	-1.86	.083
DBTP	2.24	0.70	1.90	0.66	-3.63	.002***	1.85	0.43	1.91	0.49	0.82	.426

Note. N= 34; intervention = 17, control = 17. * $p < .05$, ** $p < .01$, *** $p < .001$. HRV = Heart Rate Variability; POQA-R4 = Personal and Organizational Quality Assessment (Revised 4 Scale); SOC-13 = Sense of Coherence 13-item Scale; ZPTI = Zimbardo Time Perspective Inventory. Physiological assessment was measured with HRV. Psychological and behavioral assessments were measured with POQA-R4, SOC-13, and ZTPI.

Research Question One

The first research question asks, “To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase psychophysiological resilience, as measured by HRV and POQA-R4?” The purpose of this question was to establish whether the HeartMath coherence-building program is effective in demonstrating improvements in personal stress, energy factors which can help people to increase their psychophysiological resilience as reported in the literature (e.g., Beckham, Greene, & Meltzer-Brody, 2013; Berry et al., 2014; Culbert, Martin, & McCraty, 2014; Gao, Borlam, & Zhang, 2015; Lackey & Hector, 2014; McCraty & Shaffer, 2015; McCraty & Zayas, 2014; Thayer et al., 2009).

A 2 (Condition: HMS Intervention Group versus Wait-list Control Group) x 2 (Time: Pre-test versus Post-test) mixed factorial MANOVA was conducted with a physiological and a psychological measures as dependent variables (DVs): HRV measurements to reflect improvement in physiological resilience and POQA-R4 to reflect improvement in psychological resilience. This was followed by univariates analyses on the sub-scales of the two DVs. It is predicted that in comparison to the wait-list control group, the HMS group would demonstrate greater increase in both HRV measures and POQA-R4 scores.

Results Research Question One

HRV Measurements

5-minute Resting HRV Measures. The mixed factorial MANOVA was performed to test the effectiveness of the HMS system on the 5-minute resting HRV measures. There was no multivariate main effect of condition, Wilks' $\Lambda = .592$, $F(1, 34) = 1.59$, $p = .173$, ηp2 = .408. There was no multivariate main effect for time, Wilks' $\Lambda = .579$, $F(1, 34) = 1.66$, $p = .148$, ηp2 =

.421, but a multivariate condition x time interaction, Wilks' $\Lambda = .413$, $F(1, 34) = 3.27$, $p < .01$, $\eta p2 = .587$, was observed.

Significant univariate effects were observed for five of the ten 5-minute resting HRV measures: SDNN, $F(1, 34) = 5.39$, $p < .05$, $\eta p2 = .144$; LnRMSSD, $F(1, 34) = 6.74$, $p < .05$, $\eta p2 = .174$; LnTP (Total Power), $F(1, 34) = 6.41$, $p < .05$, $\eta p2 = .167$; LnLF (Low Frequency), $F(1, 34) = 4.68$, $p < .05$, $\eta p2 = .128$; and Normalized Coherence, $F(1, 34) = 9.30$, $p < .01$, $\eta p2 = .225$. Significant univariate condition x time interaction were observed for five of the ten 5-minute resting HRV measures: Mean Heart Rate, $F(1, 34) = 5.10$, $p < .05$, $\eta p2 = .138$; Mean Inter-Beat Interval (MIBI), $F(1, 34) = 5.85$, $p < .05$, $\eta p2 = .155$; LnLF, $F(1, 34) = 5.27$, $p < .05$, $\eta p2 = .141$; LnLF/HF Ratio, $F(1, 34) = 7.34$, $p < .05$, $\eta p2 = .186$; and Normalized Coherence, $F(1, 34) = 14.19$, $p < .01$, $\eta p2 = .307$. These interaction effects indicate that the differences between the HMS group and the WLG group on the linear combination of the 5-minute resting HRV measures are significantly greater at post-test than pre-test (see Figure 15 to 19).

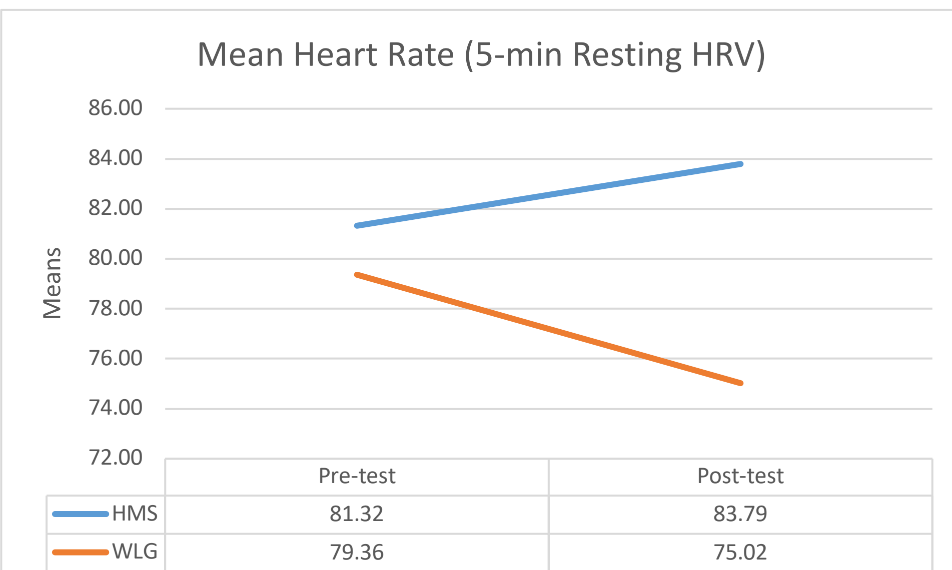

Figure 15. Comparison of mean Mean Heart Rate (5-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

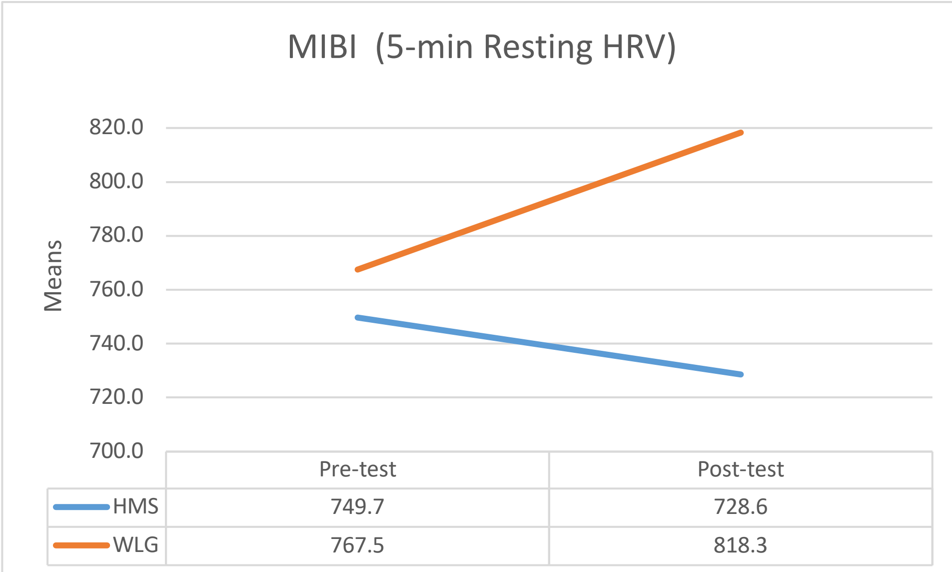

Figure 16. Comparison of mean Mean Inter-Beat Interval (5-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

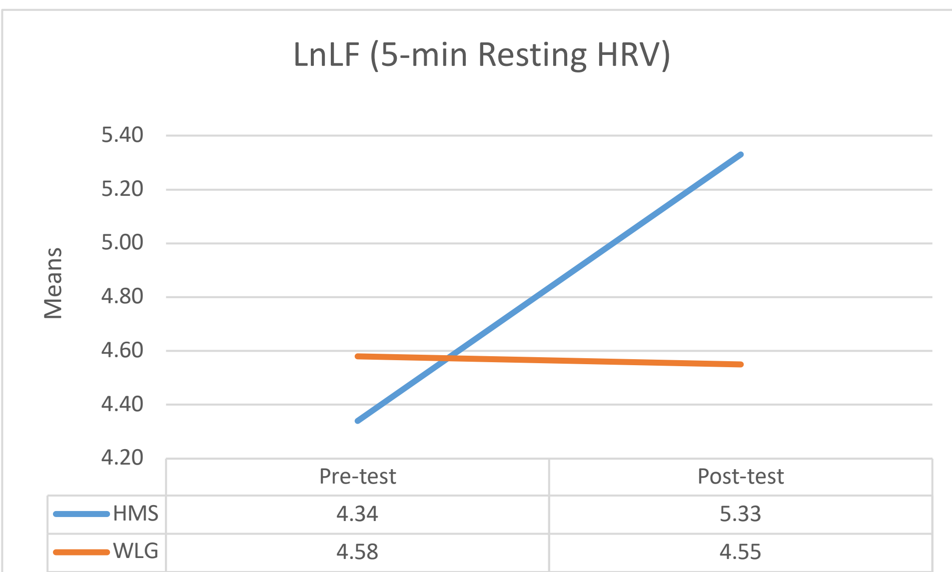

Figure 17. Comparison of mean LnLF (5-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

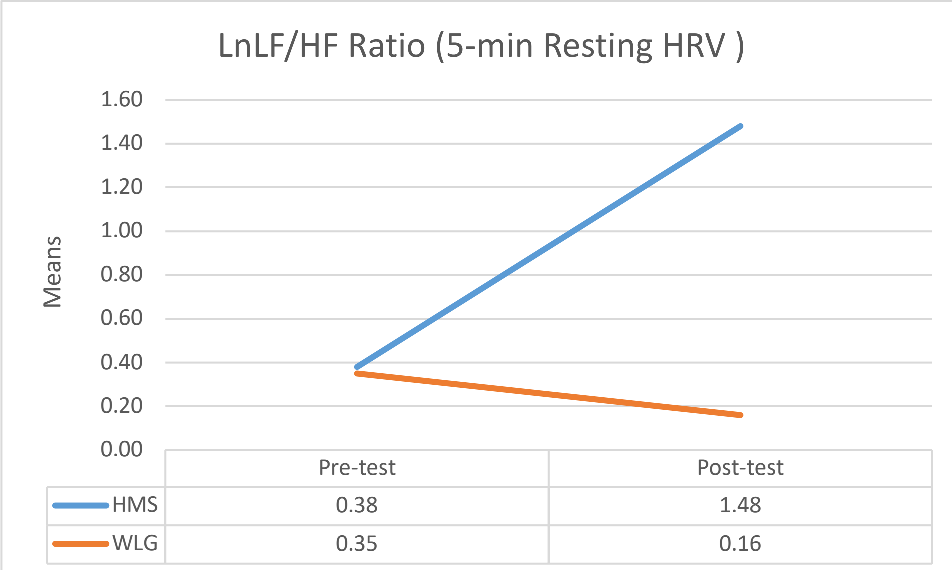

Figure 18. Comparison of mean LnLF/HF Ratio (5-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

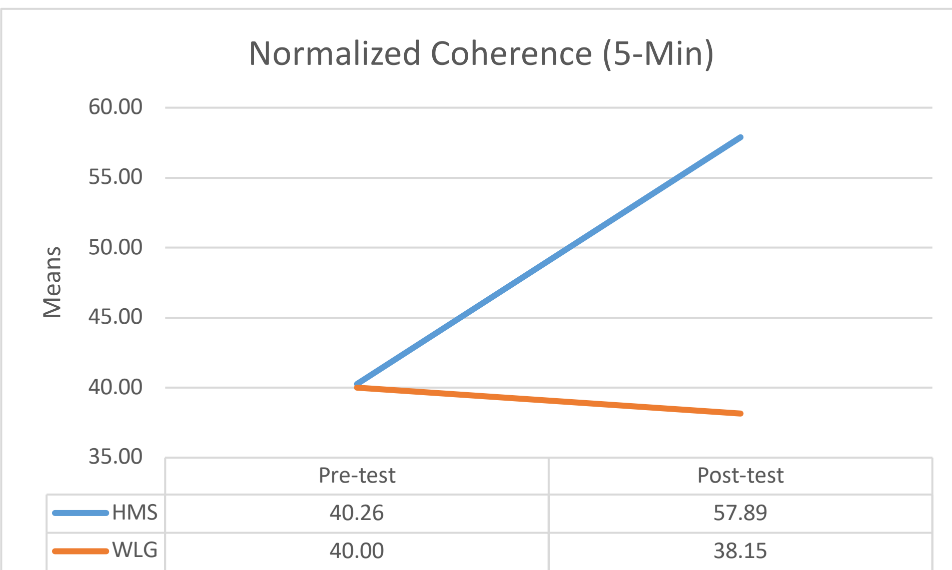

Figure 19. Comparison of mean Normalized Coherence (5-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

3-minute Stress Prep HRV Measures. The mixed factorial MANOVA was performed to test the effectiveness of the HMS system on the 3-minute Stress Prep HRV measures. There was a significant multivariate main effect of condition, Wilks' Λ = .371, $F(1, 34) = 3.90$, $p < .01$, ηp2 = .629. Significant multivariate effects were also observed for the main effects of time, Wilks' Λ = .447, $F(1, 34) = 2.85$, $p < .05$, ηp2 = .553, as well as a multivariate condition x time interaction, Wilks' Λ = .225, $F(1, 34) = 7.90$, $p < .001$, ηp2 = .775. This interaction effect indicates that the differences between the HMS group and the WLG group on the linear combination of the 3-minute Stress Prep HRV measures are significantly greater at post-test than pre-test.

Significant main effects were observed for five of the ten 3-minute resting HRV measures: SDNN, $F(1, 34) = 8.20$, $p < .01$, ηp2 = .204; LnTP, $F(1, 34) = 6.30$, $p < .05$, ηp2 = .164; LnLF, $F(1, 34) = 7.41$, $p < .05$, ηp2 = .188; LnLF/HF Ratio, $F(1, 34) = 7.15$, $p < .05$, ηp2 = .183; and Normalized Coherence, $F(1, 34) = 30.75$, $p < .001$, ηp2 = .490.

Significant univariate condition x time interaction were observed for three of the ten 3-minute resting HRV measures: LnLF, $F(1, 34) = 5.93$, $p < .05$, ηp2 = .156; LnLF/HF Ratio, $F(1, 34) = 10.19$, $p < .01$, ηp2 = .241; and Normalized Coherence, $F(1, 34) = 50.61$, $p < .001$, ηp2 = .613. These interaction effects indicate that the differences between the HMS group and the WLG group on the linear combination of the 3-minute resting HRV measures are significantly greater at post-test than pre-test (see Figure 20 to 22).

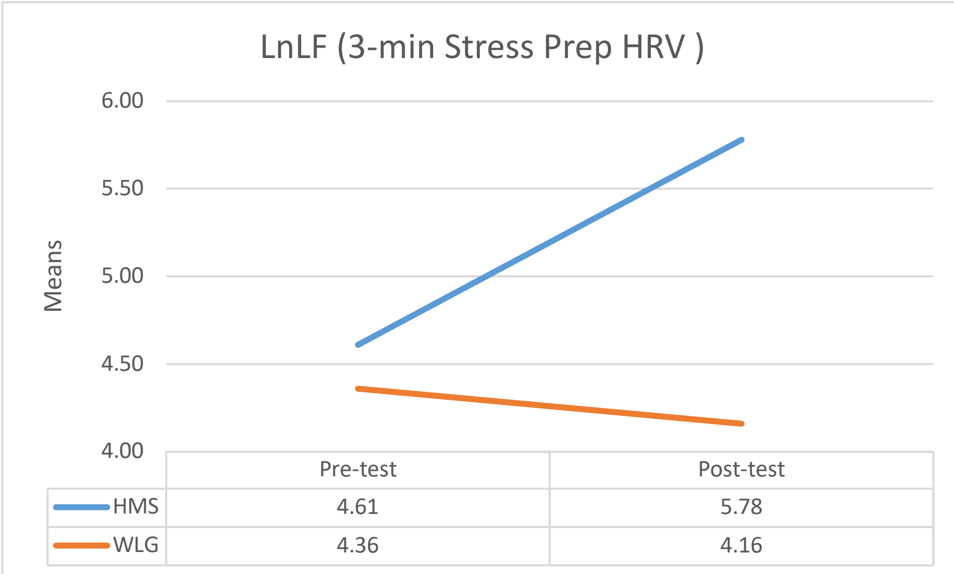

Figure 20. Comparison of mean LnLF (3-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

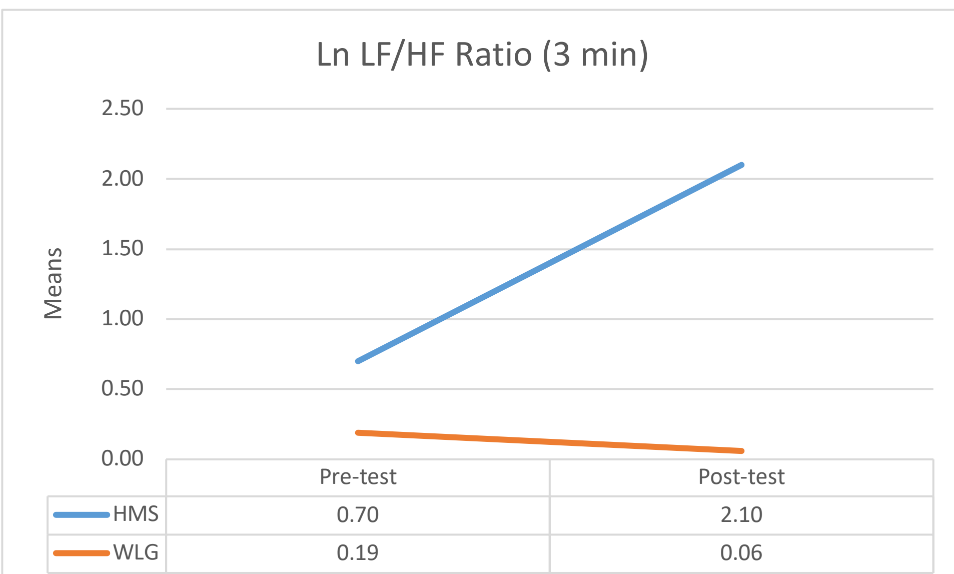

Figure 21. Comparison of mean LnLF/HF Ratio (3-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

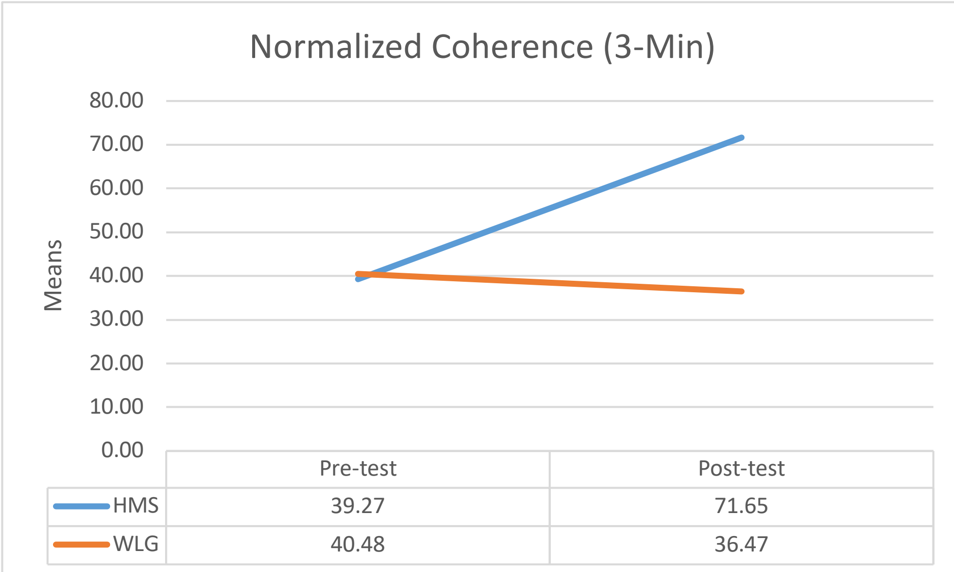

Figure 22. Comparison of mean Normalized Coherence (3-min Resting HRV) between HMS group and wait-list control group from pre- to post-tests.

POQA-R4 Results

The mixed factorial MANOVA was performed to test the effect of HMS system on POQA-R4. There was no multivariate main effect of condition, Wilks' Λ = .808, $F(1, 34) = .37$, $p = .967$, ηp2 = .192. A multivariate main effect on time, Wilks' Λ = .303, $F(1, 34) = 3.53$, $p <$ .01, ηp2 = .697, was observed but there was no multivariate condition x time interaction for POQA-R4, Wilks' Λ = .667, $F(1, 34) = .77$, p = ..682, ηp2 = .333. Univariate tests were performed to assess the effects on the four primary scales and the nine subscales. Relational Tension, $F(1, 34) = 4.13$, $p = .050$, ηp2 = .114, is the only significant effect of group x pre-post interaction established (see Figure 23). This interaction effect indicates that the differences between the HMS group and the WLG group on the linear combination of the POQA-R4 measures are significantly greater at post-test than pre-test.

Although the majority outcomes of the intervention that the HMS group received did not reach statistical significance, the raw score means (see Table 5) showed increased positive change in almost all factors as compared to the control group. The primary and subscales, as reported by the POQA-R4, in comparison to a large sample of 5791 employees, demonstrated consistently, desired directional changes in contrast to the control group (see Figures 24 and 25). While the "Intention to Quit" factor has shown an increase for both groups, the WLG group had more participants (13%; $t(17) = 2.34$, $p < .05$) thinking of quitting their job as compared to the HMS group (5%; $t(17) = .70$, $p = .492$).

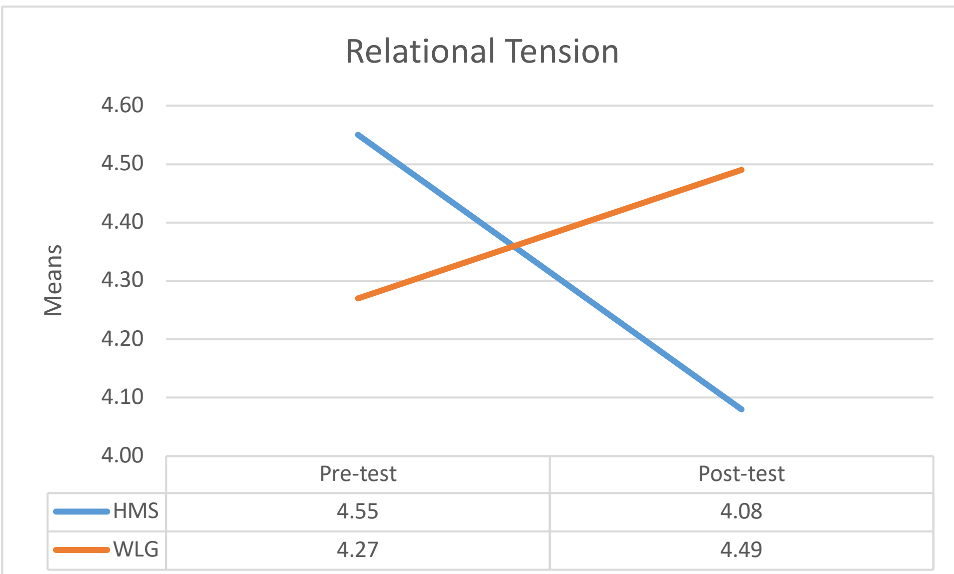

Figure 23. Comparison of mean Relational Tension between HMS group and wait-list control group from pre- to post-tests.

Table 5.

Raw Score Means for POQA-R4 Survey

	HeartMath System Group				Wait-list Control Group			
	Pre	Post	*% Change*	*Significance*	Pre	Post	*% Change*	*Significance*
Emotional Vitality	4.21	4.31	2%	ns	4.55	4.53	0%	ns
Emo Buoyancy	4.19	4.28	2%	ns	4.70	4.54	-3%	ns
Emo Contentment	4.23	4.36	3%	ns	4.35	4.51	4%	ns
Organizational Stress	4.10	3.90	-5%	ns	3.86	4.00	4%	ns
Pressures of Life	3.99	3.85	-4%	ns	3.83	3.85	1%	ns
Relational Tension	4.55	4.08	-10%	ns	4.27	4.49	5%	ns
Stress	7.71	7.87	2%	ns	6.76	7.44	10%	ns
Emotional Stress	2.44	2.32	-5%	ns	2.43	2.32	-5%	ns
Anxiety/Depression	2.57	2.36	-8%	ns	2.37	2.34	-1%	ns
Anger/Resentment	2.34	2.29	-2%	ns	2.49	2.31	-7%	ns
Physical Stress	2.96	2.77	-6%	ns	2.58	2.61	1%	ns
Fatigue	3.59	3.34	-7%	ns	3.19	3.12	-2%	ns
Health Symptoms	2.54	2.38	-6%	ns	2.20	2.26	3%	ns
Intention to Quit	2.74	2.88	5%	ns	3.00	3.38	13%	.033*

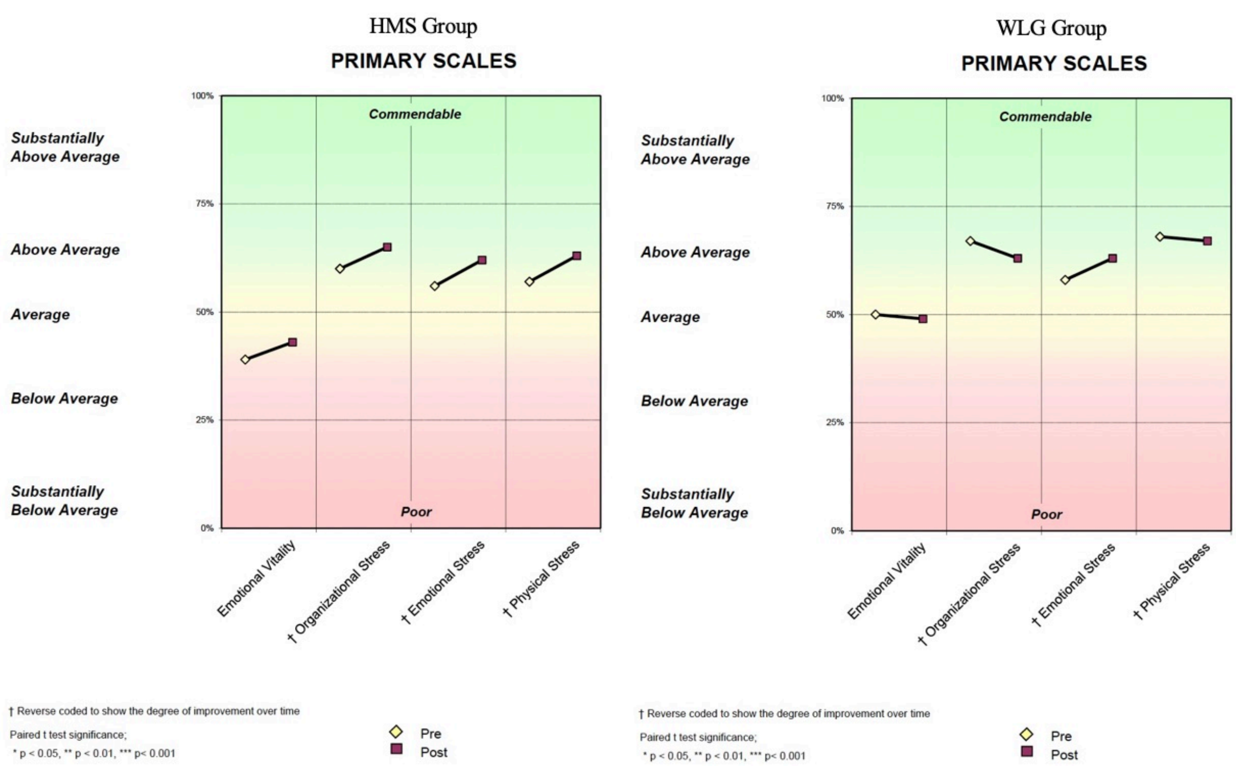

Figure 24. Primary scales scores for both groups in comparisons to a large sample of 5791 employees as reported in POQA-R4.

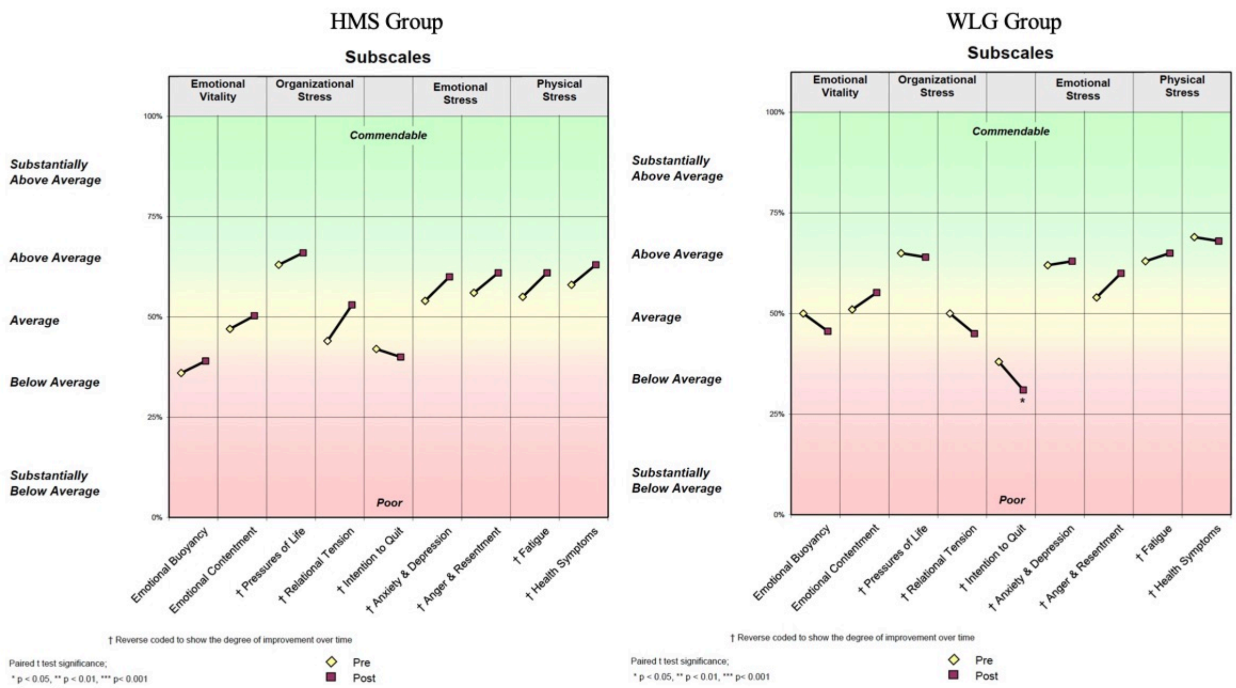

Figure 25. Subscales scores for both groups in comparisons to a large sample of 5791 employees as reported in POQA-R4.

Research Question Two

The second research question determines, "To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase the sense of coherence?" The purpose of this question was to ascertain whether the HeartMath coherence-building program is effective in strengthening a high sense of SOC, consisting of its three components – comprehensibility (C), manageability (MA), and meaningfulness (ME) that are essential mechanisms underpinning the development of stress-related resilience and health crises (Antonovsky, 1987).

A 2 (Condition: HMS Intervention Group versus Wait-list Control Group) x 2 (Time: Pre-test versus Post-test)) mixed factorial MANOVA was conducted on the Orientation of Life Questionnaire (SOC-13) as the DV. It is predicted that in comparison to the wait-list control group, the HMS group would demonstrate greater increase in SOC-13 scores.

Results Research Question Two

The mixed factorial MANOVA was performed to test the effect of HMS system on SOC. There was no multivariate main effect of condition, Wilks' $\Lambda = .840$, $F(1, 34) = 1.38$, $p = .265$, $\eta p2 = .160$. No multivariate main effect for time, Wilks' $\Lambda = .760$, $F(1, 34) = 2.29$, $p = .083$, $\eta p2 = .240$, was observed, but there was a multivariate condition x time interaction for SOC scores Wilks' $\Lambda = .674$, $F(1, 34) = 3.51$, $p < .05$, $\eta p2 = .326$. Univariate tests indicated that main effects on SOCMA $F(1, 34) = 7.93$, $p < .01$, $\eta p2 = .199$, and a significant condition x time interaction for SOCMA $F(1, 34) = 12.29$, $p < .01$, $\eta p2 = .278$ were observed. The HMS group showed a dramatic increase in SOCMA, while the WLG group showed a slight decrease. This interaction effect indicates that the differences between the HMS group and the WLG group on the linear combination of the SOCMA are significantly greater at post-test than pre-test (see Figure 26).

Although there was no main effect on Total SOC $F(1, 34) = .82$, $p = .371$, $\eta p2 = .025$, a significant condition x time interaction for Total SOC $F(1, 34) = 7.76$, $p < .01$, $\eta p2 = .195$ was observed. Again, there was a dramatic increase in Total SOC for the HMS group, accompanied by a decrease for the WLG group. This interaction effect indicates that the differences between the HMS group and the WLG group on the linear combination of the Total SOC are significantly greater at post-test than pre-test (see Figure 27).

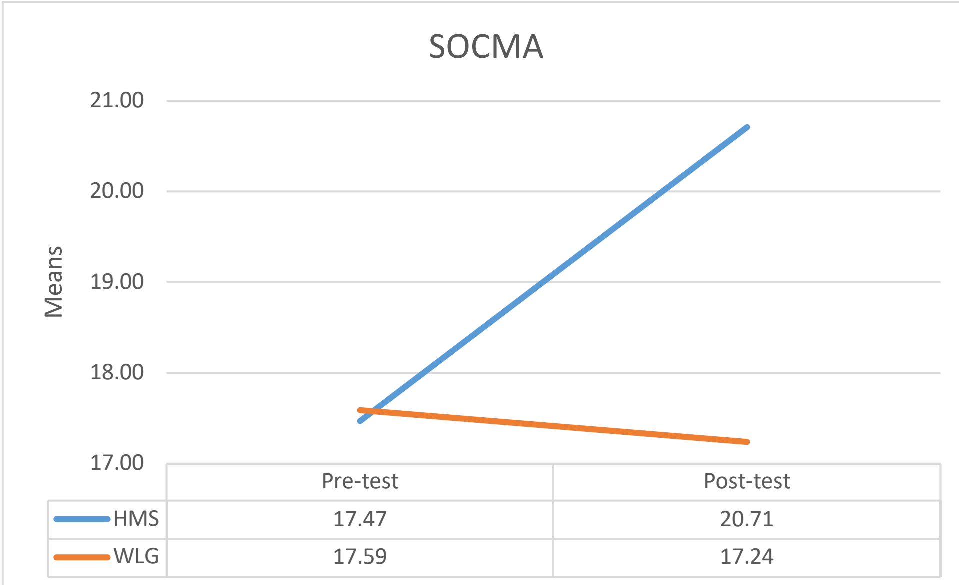

Figure 26. Comparison of mean SOCMA between HMS group and wait-list control group from pre- to post-tests.

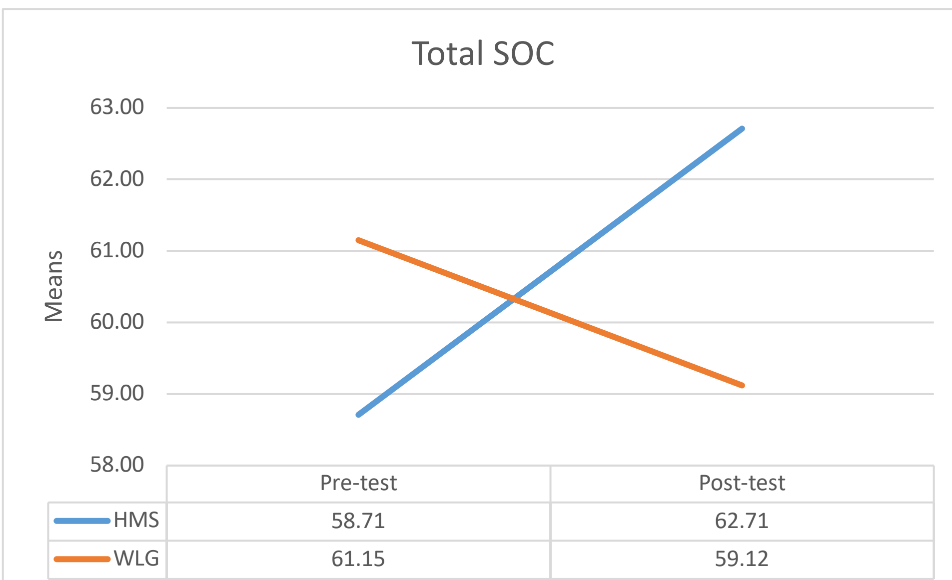

Figure 27. Comparison of mean Total SOC between HMS group and wait-list control group from pre- to post-tests.

Research Question Three

The third research question examines, “To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days facilitate a balanced time perspective?” The purpose of this question was to establish whether the HeartMath coherence-building program is effective in shifting to a more balanced time perspective. It has been considered to be the cornerstone of emotional well-being that enables individuals to possess the ability to adapt between the temporal frames flexibly (past, present, and future), according to contextual demands, resource availability, one’s needs, and values (Boniwell & Zimbardo, 2004; Zimbardo & Boyd, 1999; Zimbardo & Sword, 2017).

A 2 (Condition: HMS Intervention Group versus Wait-list Control Group) v 2 (Time: Pre-test versus Post-test)) mixed factorial MANOVA was conducted on ZTPI, and the balanced time perspective scores derived from the DBTP formula. It is predicted that in comparison to the wait-list control group, the HMS group would show higher ability in achieving an optimal BTP.

Results Research Question Three

The mixed factorial MANOVA was performed to test the effect of HMS system on ZTPI. There was no multivariate main effect of condition, Wilks' $\Lambda = .915$, $F(1, 34) = .42$, $p = .861$, $\eta p2 = .085$. Significant multivariate effects were found for the main effects of time, Wilks' $\Lambda = .647$, $F(1, 34) = 2.46$, $p = .05$, $\eta p2 = .353$, as well as a multivariate condition x time interaction, Wilks' $\Lambda = .607$, $F(1, 34) = 2.91$, $p < .05$, $\eta p2 = .393$. This interaction effect indicates that the difference between the HMS group and the WLG group on the linear combination of the ZTPI scores are significantly greater at post-test than pre-test.

Univariate tests indicated that main effects on the ZTPI Balanced Time Perspective (BTP; DBTP scores), $F(1, 34) = 5.64$, $p < .05$, $\eta p2 = .150$, as well as a condition x time interaction, $F(1, 34) = 11.38$, $p < .01$, ηp2 = .262 were observed. There was a dramatic decrease in DBTP scores for the HMS group, accompanied by an increase for the WLG group (see Figure 28). There were main effects on ZTPI Past Negative (PN), $F(1, 34) = 9.24$, $p < .01$, ηp2 = .224, and a group x pre-post interaction, $F(1, 34) = 3.97$, $p = .028$ (one-tailed), ηp2 = .110 (see Figure 29). There was no main effects for ZTPI Present Fatalistic (PF), $F(1, 34) = .82$, $p = .373$, ηp2 = .025, but there was a condition x time interaction, $F(1, 34) = 9.82$, $p < .01$, ηp2 = .235. Again, the HMS group showed a decrease in FP, while the WLG group showed an increase (see Figure 30). All these interaction effects indicate that the difference between the HMS group and the WLG group on the linear combination of the above ZTPI scores are significantly greater at post-test than pre-test.

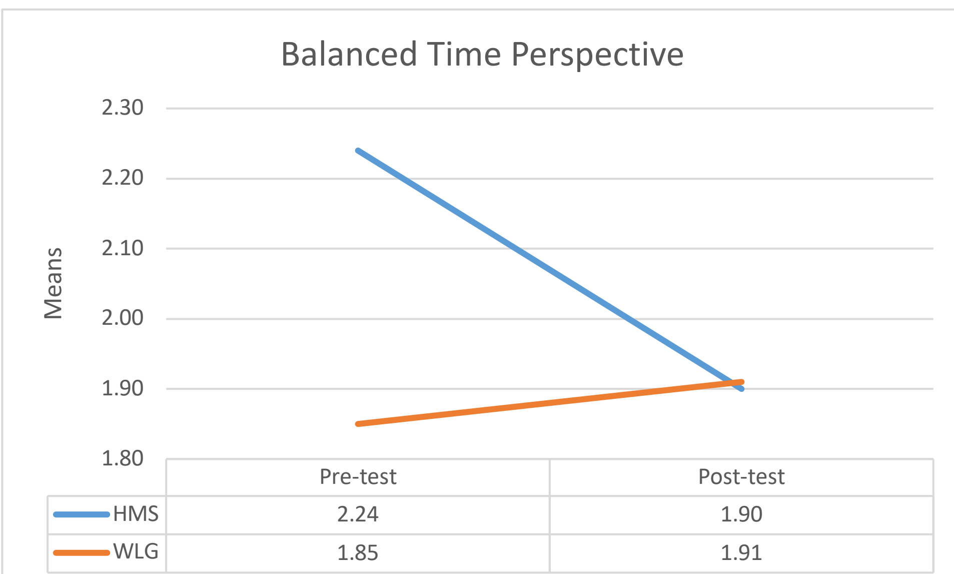

Figure 28. Comparison of mean Balanced Time Perspective between HMS group and wait-list control group from pre- to post-tests.

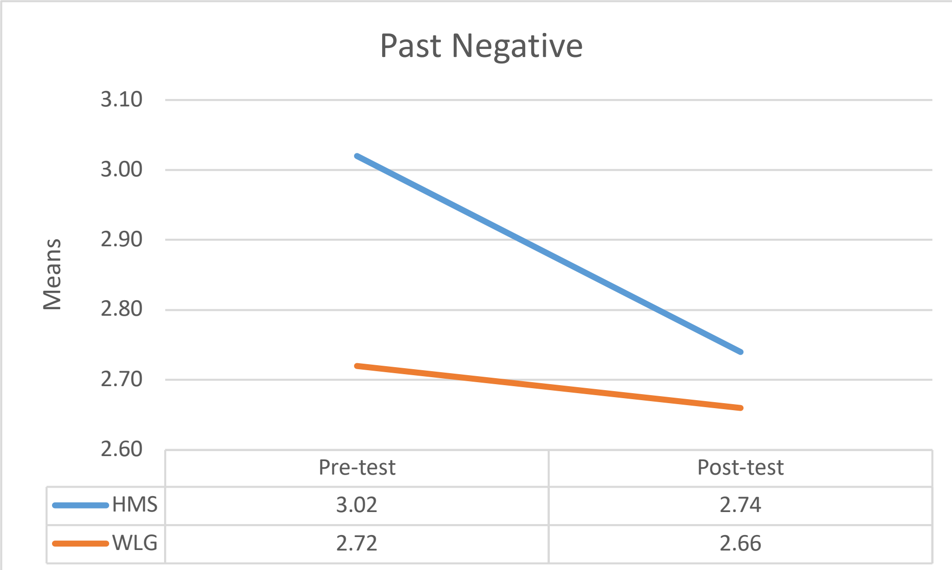

Figure 29. Comparison of mean Past Negative between HMS group and wait-list control group from pre- to post-tests.

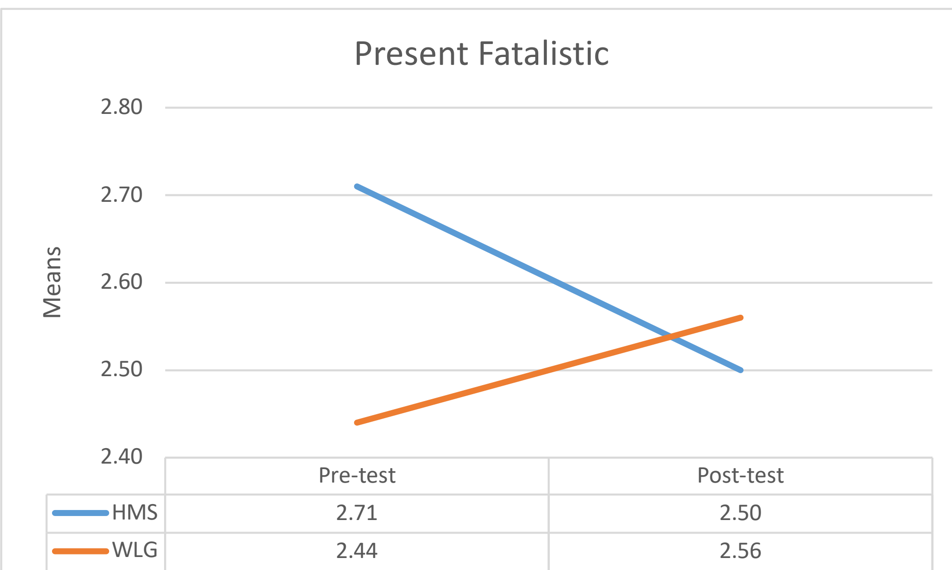

Figure 30. Comparison of mean Present Fatalistic between HMS group and wait-list control group from pre- to post-tests.

Research Question Four

The fourth research question examines, “What are the factors that may improve emotion regulation flexibility?” The purpose of this question was to establish whether the HeartMath coherence-building program predicts improvements in emotion regulation flexibility. As stated in the literature review, with these interlinked relationships between HRV, POQA-R4, SOC, and ZTPI, the researcher hypothesized that through the use of the HeartMath System, its self-regulation techniques and assistive technology as a specific resistance resource can effectively facilitate people to increase their psychophysiological coherence. It is predicted that the attainment of psychophysiological coherence, a sense of coherence, and a balanced time perspective lead to the ability to perform emotion regulation flexibility.

Results Research Question Four

This research question was examined with a Pearson correlational coefficient analysis on all variables obtained from the results for the post-tests of the HMS group with the aim to determine the relationships between the factors that may improve or impede performances. This analysis could generate insights into how to achieve emotion regulation flexibility (see Table 6).

Age

Significant negative correlations were found between several measures: 5-minute SDNN ($r = -.631$, $p < .01$), 5-minute Ln Total Power ($r = -.537$, $p < .05$), 5-minute Normalized Coherence ($r = -.593$, $p < .05$). This result indicates that the older participants have lower SDNN, LnTP, and Normalized Coherence.

Gender

Significant negative correlation was observed between gender and 5-minute Ln RMSSD (r = -.554, p < .05). This indicates that the female participants have lower strength of autonomic nervous system, particularly the parasympathetic branch.

5-minute Resting HRV and SOC

No significant correlation was found between 5-minute HRV and SOC.

5-minute Resting HRV and ZTPI

Significant negative correlations were found between six 5-minute HRV measures and only one (Present Fatalistic; [PF]) of five ZTPI measures. SDNN (r = -.708, p < .01), Ln Total Power (TP; r = -.733, p < .01), Ln Very Low Frequency (VLF; r = -.677, p < .01), Ln Low Frequency (LF; r = -.569, p < .05), Ln High Frequency (HF; r = -.539, p < .05), and Normalized Coherence (NC; r = -.497, p < .05). These results indicate that participants with higher resting HRV (SDNN, LnTP, LnVLF, LnLF, LnHF, and NC) tend to have lower tendency of believing that they have no influence on future outcomes or that the future is predestined.

5-minute Resting HRV and POQA-R4

Significant negative correlations were found between four 5-minute HRV measures and Intention to Quit: SDNN (r = -.629, p < .01), LnTP (r = -.561, p < .05), LnHF (r = -.542, p < .05), and NC (r = -.687, p < .01). These results indicate that participants with higher resting HRV (SDNN, LnTP, LnHF, and NC) tend to lower intention to quit their jobs.

A significant negative relationship was also observed between LnRMSSD and Health Symptoms (r = -.497, p < .05), indicating that the higher the parasympathetic activity, the lower the reported negative health symptoms such as physical tension, headaches, rapid heartbeats, aches, and pain.

3-minute Stress Prep HRV and SOC

A significant positive correlation was found between 3-minute Mean Heart Rate and Meaningfulness (r = .627, p < .01), as well as a negative correlation between 3-minute Mean Inter-Beat Interval and Meaningfulness (r = -.627, p < .01).

3-minute Stress Prep HRV and ZTPI

HRV and Present Hedonistic. Four 3-minute HRV measures were found to have negative relationships with Present Hedonistic: SDNN (r = -.557, p < .05), LnTP (r = -.583, p < .05), LnLF (r = -.546, p < .05), and NC (r = -.647, p < .01). These results indicate that the higher scores in these HRV measures via the use of the HeartMath emotion-focusing techniques, the lesser the participants would either take risks or enjoy the present moments.

HRV and Present Fatalistic. Seven 3-minute HRV measures were found to have negative relationships with Present Fatalistic: SDNN (r = -.767, p < .01), LnRMSSD (r = -.643, p < .01), LnTP (r = -.759, p < .01), LnVLF (r = -.540, p < .05), LnLF (r = -.547, p < .05), LnHF (r = -.593, p < .05), and NC (r = -.621, p < .01). These results indicate that the higher scores in these HRV measures via the use of the HeartMath emotion-focusing techniques, the less likely the participants would experience fatalistic thoughts and feelings.

3-minute Stress Prep HRV and POQA-R4

Significant negative correlations were found between three 3-minute HRV measures and Intention to Quit: SDNN (r = -.598, p < .05), LnTP (r = -.560, p < .05), and LnHF (r = -.518, p < .05). These results indicate that participants with higher scores in these HRV measures via the use of the HeartMath emotion-focusing techniques, have lower intention to quit their jobs.

ZPTI and SOC

Balanced Time Perspective (BTP) and SOC. Significant negative correlations were found between BTP and three SOC measures: Comprehensibility ($r = -.551$, $p < .05$), Manageability ($r = -.689$, $p < .01$), and Total SOC ($r = -.698$, $p < .01$). These results indicate that participants with a balanced time perspective (lower DBTP scores) tend to have better overall sense of coherence, particularly higher capacity to comprehend and higher ability in identifying possible resources to manage stressful situations.

Past Positive (PP) and SOC. Significant positive correlations were found between PP and two SOC measures: Manageability ($r = .488$, $p < .05$), and Total SOC ($r = .591$, $p < .05$). These results indicate that participants with an ability to retrieve positive past memories tend to have a higher sense of coherence, in particular a higher ability in identifying possible resources to manage stressful situations.

Past Negative (PN) and SOC. Significant negative correlations were found between PN and two SOC measures: Manageability ($r = -.677$, $p < .01$), and Total SOC ($r = -.633$, $p < .05$). These results indicate that participants with less negative past memories tend to have a higher sense of coherence, in particular a higher ability in identifying possible resources to manage stressful situations.

Present Hedonistic (PH) and SOC. No relationship was found between these variables.

Present Fatalistic (PF) and SOC. A significant negative correlation was found between PF and Manageability ($r = -.507$, $p < .05$), indicating that participants with a lower level of believing that the future is predestined or have no influence over future outcomes tend to be better at identifying possible resources to manage stressful situations.

Future and SOC. A significant positive correlation was found between Future and Meaningfulness ($r = .516$, $p < .05$), indicating that participants with higher concern for future consequences tend to have higher capacity to perceive that life makes sense, and stressful situations are worthy of commitment.

ZPTI and POQA-R4

Balanced Time Perspective (BTP) and POQA-R4. Significant negative correlations were found between BTP and two POQA-R4 measures: Emotional Vitality ($r = -.505$, $p < .05$) and Emotional Contentment ($r = -.563$, $p < .05$), indicating that participants with a balanced time perspective (lower DBTP scores) tend to experience increased level of positive emotional energy, including feelings of contentment, and inner peace.

On the other hand, significant positive correlations were found between BTP and three POQA-R4 measures: Emotional Stress ($r = .559$, $p < .05$), Anxiety/Depression ($r = .524$, $p < .05$), and Anger/Resentment ($r = .527$, $p < .05$). These results indicate that participants with a balanced time perspective (lower DBTP scores) tend to experience decreased level of negative emotions, including the feelings of anxiety, sadness, anger, and/or resentment.

Past Positive (PP) and POQA-R4. Significant negative correlations were found between PP and two POQA-R4 measures: Emotional Stress ($r = -.555$, $p < .05$), and Anger/Resentment ($r = -.587$, $p < .05$). These results indicate that participants with higher level of PP tend to experience decreased level of negative emotions, including the feelings of anger, and resentment, and difficulty in emotional control.

Past Negative (PN) and POQA-R4. Significant positive correlations were found between PN and four POQA-R4 measures: Emotional Stress ($r = .605$, $p < .05$), Anxiety/Depression ($r = .610$, $p < .05$), Anger/Resentment ($r = .541$, $p < .05$), and Intention to

Quit ($r = -.516$, $p < .05$). These results indicate that participants with higher level of PN tend to experience elevated level of negative emotions, including the feelings of anxiety, sadness, anger, and resentment, and the intention to quit their jobs.

Present Hedonistic (PH) and POQA-R4. There was no relationship found in these two variables.

Present Fatalistic (PF) and POQA-R4. A significant positive correlation was found between PF and Intention to Quit ($r = .547$, $p < .05$), indicating that participants with higher level of believing that the future is predestined or have no influence on future outcomes tend to have the intention to quit their jobs.

Future and POQA-R4. There was no relationship found in these two variables.

SOC and POQA-R4

Total SOC and POQA-R4. Significant positive correlations were found between Total SOC and three POQA-R4 measures: Emotional Vitality ($r = .698$, $p < .01$), Emotional Buoyancy ($r = .636$, $p < .01$), and Emotional Contentment ($r = .712$, $p < .01$). These results indicate that participants with higher level of SOC tend to experience increased level of positive emotional energy, including feelings of optimism, contentment, and inner peace.

Significant negative correlations were found between Total SOC and three POQA-R4 measures: Emotional Stress ($r = -.618$, $p < .01$), Anxiety/Depression ($r = -.602$, $p < .05$), Anger/Resentment ($r = -.566$, $p < .05$). These results indicate that participants with higher level of SOC tend to experience decreased level of negative emotions, including the feelings of anxiety, sadness, anger, and/or resentment.

Comprehensibility and POQA-R4. Significant positive correlations were found between Comprehensibility and two POQA-R4 measures: Emotional Vitality ($r = .512$, $p < .05$), and Emotional Contentment ($r = .597$, $p < .05$), indicating that participants with an enhanced level of understanding the stressful situation tend to experience increased level of positive emotional energy, including feelings of contentment and inner peace.

Significant negative correlations were found between Comprehensibility and two POQA-R4 measures: Emotional Stress ($r = -.532$, $p < .05$), and Anxiety/Depression ($r = -.579$, $p < .05$), indicating that participants with an enhanced level of understanding the stressful situation tend to experience decreased level of negative emotions, including the feelings of anxiety and sadness.

Manageability and POQA-R4. A significant positive relationship was found between Manageability and Emotional Contentment ($r = .484$, $p < .05$), indicating that participants with a higher capacity to identify possible resources to manage stressful situations tend to experience feelings of contentment and inner peace. A significant negative relationship was found between Manageability and Intention to Quit ($r = -.542$, $p < .05$), indicating that participants with a higher capacity to identify possible resources to manage stressful situations tend to have lower intention to quit their jobs.

Meaningfulness and POQA-R4. Significant positive correlations were found between Meaningfulness and three POQA-R4 measures: Emotional Vitality ($r = .640$, $p < .01$), Emotional Buoyancy ($r = .663$, $p < .01$), and Emotional Contentment ($r = .552$, $p < .05$), indicating that participants with an enhanced level of understanding the stressful situation tend to experience increased level of positive emotional energy, including feelings of optimism, contentment and inner peace.

Table 6.

Correlational Table

Pearson Correlations

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	Age	1																																												
2	Gender	0.041	1																																											
5-Minute Resting HRV																																														
3	Mean Heart Rate (BPM)	0.152	0.228	1																																										
4	Mean Inter-Beat Interval	-0.123	-0.243	-.991**	1																																									
5	SDNN (ms)	-.631**	-0.001	-.519*	.495*	1																																								
6	LnRMSSD (ms)	-0.466	-.554*	-0.334	0.343	0.419	1																																							
7	Ln Total Power (ms2/Hz)	-.537*	0.012	-.622**	.584*	.945**	0.423	1																																						
8	Ln Very Low Frequency (ms2/Hz)	-0.273	0.177	-0.458	0.39	.738**	0.121	.772**	1																																					
9	Ln Low Frequency (ms2/Hz)	-0.464	0.022	-0.465	0.438	.857**	0.356	.922**	.623**	1																																				
10	Ln High Frequency (ms2/Hz)	-0.401	-0.182	-.485*	0.457	0.378	.654**	0.459	0.258	0.191	1																																			
11	Ln Low Frequency/High Frequency Ratio (ms2/Hz)	-0.21	0.123	-0.181	0.172	.604*	-0.017	.623**	0.449	.844**	-0.364	1																																		
12	Normalized Coherence (%)	-.593*	-0.129	-0.473	0.48	.775**	0.398	.744**	0.284	.732**	0.31	.518*	1																																	
3-Minute Stress Prep HRV																																														
13	Mean Heart Rate (BPM)	0.148	-0.003	.924**	-.908**	-.522*	-0.217	-.619**	-0.462	-0.478	-0.435	-0.228	-0.387	1																																
14	Mean Inter-Beat Interval	-0.108	0.01	-.925**	.921**	.498*	0.196	.588*	0.426	0.459	0.399	0.229	0.376	-.994**	1																															
15	SDNN (ms)	-0.311	0.308	-0.288	0.273	.719**	0.155	.684**	.622**	.564*	0.338	0.355	.489*	-0.386	0.379	1																														
16	LnRMSSD (ms)	-0.301	0.046	-.630**	.630**	.527*	0.421	.606**	0.329	.483*	.618**	0.129	.513*	-.714**	.716**	.671**	1																													
17	Ln Total Power (ms2/Hz)	-0.374	0.318	-0.413	0.387	.732**	0.193	.769**	.653**	.672**	0.389	0.431	.533*	-.500*	.487*	.935**	.727**	1																												
18	Ln Very Low Frequency (ms2/Hz)	-.679**	0.193	-0.26	0.259	.693**	0.195	.541*	0.478	0.46	0.204	0.306	.513*	-0.227	0.237	0.454	0.268	0.398	1																											
19	Ln Low Frequency (ms2/Hz)	-0.112	0.422	-0.246	0.217	.562*	-0.036	.639**	.603*	.656**	0.068	.595*	0.366	-0.359	0.351	.829**	.510*	.910**	0.167	1																										
20	Ln High Frequency (ms2/Hz)	-0.387	-0.181	-.647**	.644**	0.436	.553*	.502*	0.218	0.313	.802**	-0.144	.499*	-.598*	.593*	0.354	.808**	0.459	0.331	0.13	1																									
21	Ln Low Frequency/High Frequency Ratio (ms2/Hz)	0.108	0.481	0.128	-0.153	0.27	-0.336	0.306	0.428	0.424	-0.372	.617**	0.063	-0.002	-0.004	.567*	0.032	.583*	-0.032	.844**	-0.421	1																								
22	Normalized Cohernce (%)	-0.161	0.331	-0.4	0.359	.551*	-0.029	.638**	.632**	.486*	0.323	0.295	0.375	-.487*	0.458	.829**	.551*	.868**	0.122	.849**	0.237	.652**	1																							
Sense of Coherence (SOC-13)																																														
23	Comprehensibility	0.257	0.065	0.082	-0.055	-0.154	0.01	-0.139	-0.04	-0.251	0.23	-0.366	-0.041	0.146	-0.124	0.027	0.112	0.03	-0.192	-0.039	0.284	-0.184	0.037	1																						
24	Manageability	-0.26	-0.063	0.07	-0.029	0.414	0.439	0.37	0.13	0.328	0.311	0.14	0.457	0.078	-0.075	0.27	0.267	0.227	0.146	0.09	0.33	-0.106	0.073	0.462	1																					
25	Meaningfulness	-0.177	-0.24	0.384	-0.36	-0.084	0.258	-0.172	-0.08	-0.204	-0.005	-0.208	0.068	.627**	-.627**	-0.188	-0.405	-0.276	0.127	-0.337	-0.159	-0.218	-0.258	0.354	0.357	1																				
26	Total SOC	-0.043	-0.094	0.231	-0.192	0.04	0.277	-0.007	-0.006	-0.091	0.227	-0.22	0.177	0.37	-0.358	0.032	-0.019	-0.02	0.012	-0.13	0.195	-0.224	-0.065	.820**	.751**	.736**	1																			
Zimbardo Time Perspective (ZTPI)																																														
27	Past Positive	-0.225	-0.004	0.236	-0.262	0.139	-0.021	0.163	0.141	0.08	0.141	-0.005	0.224	0.286	-0.329	0.095	-0.144	0.152	-0.189	0.147	-0.059	0.168	0.329	0.459	.488*	0.428	.591*	1																		
28	Past Negative	0.157	0.323	-0.088	0.049	-0.304	-0.458	-0.276	-0.069	-0.233	-0.311	-0.049	-0.285	-0.146	0.142	-0.327	-0.181	-0.289	0	-0.178	-0.27	-0.017	-0.207	-0.442	-.677**	-0.381	-.633**	-.486*	1																	
29	Present Hedonistic	0.028	-0.196	0.245	-0.262	-0.239	-0.087	-0.38	-0.258	-0.298	-0.282	-0.129	-0.326	0.201	-0.212	-.557*	-0.473	-.583*	-0.068	-.546*	-0.31	-0.337	-.647**	-0.072	-0.217	-0.096	-0.156	-0.147	0.339	1																
30	Present Fatalistic	0.462	-0.144	0.314	-0.29	-.708**	-0.333	-.733**	-.677**	-.569*	-.539*	-0.237	-.497*	0.324	-0.307	-.767**	-.643**	-.759**	-.540*	-.547*	-.593*	-0.182	-.621**	-0.275	-.507*	-0.119	-0.375	-0.275	.534*	.585*	1															
31	Future	-0.135	0.075	0.217	-0.182	-0.102	0.04	-0.143	-0.269	-0.202	0.183	-0.312	0.195	0.357	-0.338	-0.094	-0.059	-0.225	0.312	-0.384	0.172	-0.443	-0.278	0.132	0.303	.516*	0.398	0.003	-0.044	-0.299	-0.148	1														
32	Balanced Time Perspective	0.332	0.057	-0.038	0.045	-0.389	-0.29	-0.43	-0.317	-0.331	-0.401	-0.087	-0.356	-0.075	0.097	-0.388	-0.268	-0.422	-0.11	-0.291	-0.362	-0.074	-0.395	-.551*	-.689**	-0.397	-.698**	-.732**	.826**	0.427	.752**	-0.113	1													
Personal and Organizational Quality Assessment - Revised 4 (POQA-R4																																														
33	Emotional Vitality	-0.107	-0.243	0.158	-0.172	0.146	0.248	0.091	0.15	0.056	0.144	-0.044	0.161	0.301	-0.322	-0.123	-0.179	-0.226	0.218	-0.323	0.101	-0.345	-0.266	.512*	0.46	.640**	.698**	0.332	-0.406	0.185	-0.323	0.353	-.505*	1												
34	Organization Stress	0.247	0.131	-0.063	0.11	-0.257	-0.356	-0.232	-0.095	-0.247	-0.223	-0.109	-0.197	0.004	0.061	0.086	0.037	0.121	-0.112	0.193	-0.141	0.253	0.177	-0.082	-0.324	-0.12	-0.211	-0.128	0.279	-0.323	0.179	-0.015	0.286	-.646**	1											
35	Emotional Stress	-0.019	0.233	-0.125	0.115	-0.219	-0.202	-0.174	-0.127	-0.231	0.103	-0.277	-0.354	-0.217	0.224	-0.272	-0.053	-0.263	0.16	-0.328	0.012	-0.312	-0.238	-.532*	-0.466	-0.423	-.618**	-.555*	.605*	0.12	0.271	0.199	.559*	-0.42	0.178	1										
36	Physical Stress	0.086	0.295	0.093	-0.097	-0.246	-0.368	-0.184	-0.197	-0.276	0.138	-0.341	-0.139	0.072	-0.067	-0.095	-0.084	-0.182	-0.046	-0.202	-0.146	-0.104	0.06	-0.119	-0.17	-0.075	-0.153	0.063	0.374	-0.132	0.146	0.461	0.184	-0.163	0.294	.559*	1									
37	Emotional Buoyancy	-0.131	-0.278	0.085	-0.089	0.189	0.237	0.106	0.166	0.083	0.039	0.038	0.214	0.249	-0.263	-0.154	-0.228	-0.259	0.303	-0.353	0.061	-0.352	-0.302	0.407	0.407	.663**	.636**	0.24	-0.363	0.182	-0.281	0.348	-0.42	.968**	-.624**	-0.4	-0.247	1								
38	Emotional Contentment	-0.067	-0.178	0.236	-0.262	0.078	0.241	0.061	0.114	0.014	0.263	-0.146	0.08	0.34	-0.367	-0.075	-0.102	-0.166	0.092	-0.257	0.141	-0.307	-0.199	.597*	.484*	.552*	.712**	0.414	-0.421	0.175	-0.344	0.326	-.563*	.949**	-.617**	-0.407	-0.043	.840**	1							
39	Pressures of Life	-0.057	0.402	-0.016	0.042	0.09	-0.368	0.047	-0.016	0.031	-0.138	0.11	0.2	-0.062	0.094	0.363	0.159	0.404	0.077	0.438	-0.042	0.417	0.383	-0.144	-0.064	-0.277	-0.214	0.082	0.236	-0.287	0.058	0.022	0.187	-.684**	.722**	0.072	0.267	-.680**	-.627**	1						
40	Relational Tension	0.437	-0.135	-0.071	0.106	-0.442	-0.213	-0.377	-0.036	-0.367	-0.274	-0.199	-.511*	0.055	0.007	-0.243	-0.123	-0.225	-0.18	-0.136	-0.176	-0.023	-0.16	0.09	-0.417	0.094	-0.068	-0.305	0.226	-0.093	0.177	-0.104	0.24	-0.169	.664**	0.134	0.039	-0.129	-0.204	-0.011	1					
41	Anxiety/Depression	-0.019	0.376	0.062	-0.079	-0.233	-0.274	-0.18	-0.1	-0.205	0.024	-0.208	-0.368	-0.042	0.045	-0.134	-0.102	-0.159	0.118	-0.151	-0.192	-0.038	-0.079	-.579*	-0.475	-0.323	-.602*	-0.43	.610**	-0.022	0.247	0.23	.524*	-.485*	0.309	.915**	.709**	-.497*	-0.424	0.217	0.152	1				
42	Anger/Resentment	-0.017	0.109	-0.245	0.239	-0.187	-0.13	-0.152	-0.133	-0.226	0.148	-0.298	-0.308	-0.318	0.328	-0.342	-0.013	-0.309	0.173	-0.419	0.155	-0.474	-0.326	-0.444	-0.413	-0.451	-.566*	-.587*	.541*	0.208	0.261	0.157	.527*	-0.332	0.067	.959**	0.397	-0.29	-0.354	-0.037	0.109	.762**	1			
43	Fatigue	-0.046	0.211	-0.037	0.039	-0.054	-0.207	-0.037	-0.046	-0.214	0.322	-0.385	-0.02	-0.018	0.025	0.062	0.031	-0.046	0.12	-0.161	0.013	-0.155	0.154	-0.039	-0.043	0.002	-0.034	0.118	0.243	-0.164	-0.022	0.477	0.072	-0.098	0.312	.494*	.949**	-0.179	0.012	0.303	0.022	.622**	0.353	1		
44	Health Symptoms	0.204	0.357	0.201	-0.212	-0.404	-.497*	-0.3	-0.313	-0.297	-0.058	-0.253	-0.233	0.143	-0.142	-0.234	-0.18	-0.286	-0.202	-0.207	-0.284	-0.032	-0.022	-0.182	-0.286	-0.145	-0.258	0.009	0.475	-0.095	0.289	0.392	0.273	-0.209	0.247	.558*	.947**	-0.288	-0.092	0.207	0.053	.716**	0.39	.797**	1	
45	Intention to Quit	0.359	-0.005	0.271	-0.272	-.629**	-0.362	-.561*	-0.285	-0.392	-.542*	-0.073	-.687**	0.225	-0.202	-.598*	-0.404	-.560*	-0.358	-0.352	-.518*	-0.037	-0.468	-0.227	-.542*	-0.114	-0.362	-0.332	.516*	0.376	.547*	-0.261	0.473	-0.187	0.273	0.34	0.117	-0.174	-0.185	-0.221	.669**	0.367	0.287	-0.071	0.291	1

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

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

Research Question Five

The fifth research question asks, "How does the HeartMath coherence-building program compare with other strategies for building resilience?" The purpose of this question was to determine the similarities and differences between HeartMath coherence-building program and other approaches, such as mindfulness meditation, autogenics, and progressive relaxation, that have been considered to be effective in managing stress and building resilience.

This question will be discussed in chapter five utilizing the results obtained from the above research questions, including the Pre- and Post-Tests Mean Comparison (Table 2), the 2x2 mixed factorial MANOVAs, and the Pearson Correlation Coefficient analysis (Table 4). The researcher hypothesizes that the practice of the HeartMath System, with its focus on building coherence, may differ from most approaches that are reported in the literature.

MANCOVA Analysis

A multivariate analysis of covariance (MANCOVA) using the pre-test scores as covariates was performed on several measures that were significantly different between the groups (HMS and WLG) on the post-tests (e.g., SOCMA), as revealed by the interactions from the MANOVAs. These MANCOVAs compared the groups on the post-test differences when the pre-test scores were entered as covariates. The results showed the differences on the post-tests scores were still significant after adjusting for differences on the pre-test scores.

CHAPTER FIVE

DISCUSSION

Regardless of the extensive effort of implementing stress management programs to the diverse community, the published intervention programs on resilience and emotion regulation in Singapore are scarce. Hence, there is a need for further examination of more evidence-based interventions on emotion regulation that could be introduced as a nationwide movement to achieve resilience and well-being. The purpose of this quantitative experimental study was to examine the effectiveness of the HeartMath self-regulation skills and coherence-building program (Institute of HeartMath, 2014) on both physiological and psychological measures, which are related to improved emotion regulation flexibility and personal resilience for Singaporeans.

This chapter comprises a discussion of the significant findings of this research in relation to the literature on heart rate variability (HRV), sense of coherence, and time perspective, and the implications that may be valuable for use by individuals, professionals, and organizations who may plan to implement effective resilience-building programs. This chapter also includes a discussion on the limitations of the study, recommendations for future research, and a summary. The research questions established to guide this examination were:

1. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase psychophysiological resilience, as measured by HRV and POQA?

   H1. The practice of HeartMath coherence-building techniques significantly increases psychophysiological resilience.

2. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days increase the sense of coherence?

   H2. The practice of HeartMath coherence-building techniques significantly increases sense of coherence.

3. To what extent, if any, does the practice of HeartMath coherence-building techniques over thirteen days facilitate a balanced time perspective?

   H3. The practice of HeartMath coherence-building techniques significantly increases balanced time perspective.

4. What are the factors that may improve emotion regulation flexibility?
5. How does the HeartMath coherence-building program compare with other strategies for building resilience?

The findings of these research questions were examined with mixed factorial MANOVA and univariate analyses, paired sample t-test, and a Pearson correlational coefficient analysis of HRV measurements, POQA-R4, SOC-13, and ZTPI with the use of SPSS version 26.0 (IBM Corp, 2019).

Findings

The findings in this study have provided evidence for the benefits that the HeartMath System, with its coherence-building techniques and biofeedback training, has on improving resilience and increasing emotion regulation flexibility. The data analyses distinctly demonstrated evidence that the practice of HeartMath coherence-building techniques over thirteen days can increase psychophysiological resilience, sense of coherence, and achieve a balanced time perspective. The findings in research questions one to four are found to be supported by the literature. Research question five will discuss how the HeartMath System accedes or differs from other resilience-building approaches.

Research Question One

Recent research has concluded that HRV is a primary non-invasive tool that can be used to accurately measure workplace stress (Low & McCraty, 2018), as well as a valid physiological indicator of emotional experiences and a valid measure of neurocardiac function that reflects heart-brain interfaces and ANS dynamics (McCraty et al., 2009). HRV has been considered to be a strong independent predictor of future health and resilience (McCraty, 2017; McCraty & Atkinson, 2012). Additionally, the POQA-R4 (Institute Of HeartMath, 2011) is a subjective self-reported stress questionnaire designed by IHM, also an empirically validated and normed assessment, which has been used to measure psychological health, physical stress symptoms, emotional competencies, resilience, and organization quality. The quest of this study, as guided by this research question was to examine how well, if any, would the practice of HeartMath coherence-building techniques over 13 days, drive measurable increases in HRV coherence as a physiological measure, and POQA-R4 scores as a psychological measure.

While most findings in this section were consistent with previous studies, some mixed results have also been observed. For instance, a study demonstrated that the resting HRV of a group of high school students was found to have a significant increase after practicing the HeartMath emotion self-regulation and coherence-building techniques over four months. The specific HRV measures that were used in this study were Mean Inter-beat Interval (MIBI), SDNN, LnHF, LnLF, LnTotal Power, and LnCoherence Ratio, where significant differences were observed between the experimental and control groups for both pre-post resting baseline and stress preparation phases (Bradley et al., 2010). In the current study, however, ten HRV measures were used to quantify whether the coherence-building system was effective in improving physiological coherence. The data were analyzed with a mixed factorial MANOVA and several multivariate condition x time interactions were observed in both 5-minute resting and 3-minute stress preparation. The univariate tests indicated that the differences between the HMS group and WLG group on the linear combination of these HRV measures were significantly higher at post-test than at pre-test. Among the ten HRV measures, five 5-minute resting HRV measures (MIBI, SDNN, LnLF, LnTotal Power, and Normalized Coherence) and three 3-minute stress prep HRV measures (LnLF, LnLF/HF Ratio, and Normalized Coherence) were found to have significant univariate condition x time interaction effects. These results appear to be consistent with the study as mentioned above, signifying the effectiveness of the HeartMath system.

One contrary outcome between these two studies was the between-groups significance difference in the HF scores, where the univariate tests in the current study did not show any interaction effect in both 5-minute resting HRV (p = .664) and 3-minute stress prep HRV (p =. 227) as compared to the study mentioned above, p = .001. Instead of an expected increase in HF (parasympathetic activity) as observed in the above study as well as several other studies (e.g., McCraty & Atkinson, 2012; Sarwari & Wahab, 2018a), the current study showed reductions in HF scores for both 5-minute and 3-minute HRV measures.

This interesting finding, the researcher argued, can be explained with support from other researchers who also observed this phenomenon. For instance, the LF scores in the current study were significantly higher, which is also consistent with most studies using the HeartMath System (e.g., McCraty & Atkinson, 2012; Sarwari & Wahab, 2018a). As described in chapter two, the LF is a mixture of both autonomic inputs (Ernst, 2017; Malliani et al., 1991; Sztajzel, 2004; Task

Force, 1996). Shaffer, McCraty, and Zerr (2014) asserted that the SNS does not appear to generate rhythms much above 0.1 Hz, whereas the PNS can produce heart rhythms down to 0.05 Hz, which may be aligned with early research suggesting that the PNS contributes to at least 50% of the LF variability while the SNS, at best, basically contributes 25% to this variability (Randall, Brown, Raisch, Yingling, & Randall, 1991). Porges (2007) also posits when individuals perform slow-paced breathing at the resonance frequency (0.1 Hz, 10-seconds rhythm or six breaths per minute), the LF band encompasses the aggregated influence of both myelinated and unmyelinated vagal pathways on the heart, reflecting total cardiac vagal tone. All these are in line with a consultation with Dr. Rollin McCraty, Director of Research with the Institute of HeartMath (Personal communication, 15 November, 2019) where he indicated that there is an increased power in the LF scores and typically decreased power in the HF and VLF scores when a person is in a coherent state. He added that the decreased HF scores become less of an issue as the vagally mediated HRV activity has apparently elevated, in which the frequency of this vagally mediated activity has simply shifted into the LF band. Hence, with the current study that has an observed increase in LF pre- and post-test scores for the 5-minute resting HRV (23%) and 3-minute stress prep HRV (25%) in the HMS group, the results suggest an association with flexibility, psychological well-being, and good performance (McCraty & Shaffer, 2015).

The phenomenon can also be explained with the enormous increase in the LF/HF Ratio in the pre- and post-test scores for both 5-minute resting HRV (289%) and 3-minute stress prep HRV (200%) in the HMS group compared to the decreased scores in the WLG group with -54% for the 5-minute and -68% for the 3-minute HRV measures. Although an increase in this ratio has often been interpreted to suggest an increase in sympathetic activation, as proposed by McCraty and colleagues (2009), a different interpretation is warranted in the light of the coherence-building intervention used in this study. As stated by McCraty (2019) in the above communication, while the increase in LF/HF Ratio could be misinterpreted as a considerable elevation in sympathetic activity in this case, it is predominantly due to an increase in parasympathetic activity and vascular resonance (Tiller et al. 1996). With that, the researcher in this study proposes that immense elevation in the LF/HF Ratio in the HMS group most likely reflects an overall increase in heart rhythm coherence and parasympathetic activity. These were achieved through the use of the coherence-building techniques and biofeedback technology, consistent with earlier research that demonstrated the increased power in LF scores led to significant increases in gratitude and positive outlook after the intervention (McCraty et al. 1995; Tiller et al. 1996; Bacon et al. 2004).

The current study has provided evidence of an improvement in autonomic function as shown in the HRV measures. This is demonstrated in the HMS group, after practicing HeartMath's emotion-restructuring technique, the Heart Lock-in for 13 days. The findings revealed during 5-minute resting baseline phase have very large effect size (MIBI, $p < .05$, ηp2 = .155; LnLF, $p < .05$, ηp2 = .141; LnLF/HF Ratio, $p < .05$, ηp2 = .186; and Normalized Coherence, $p < .01$, ηp2 = .307). Also, the current study has suggested evidence that the HMS group have learned a new skill such as the Quick Coherence technique, one of the HeartMath emotion-refocusing techniques with the ability to shift into and sustain HRV coherence at will, along with very large effect size (LnLF, $p < .05$, ηp2 = .156; LnLF/HF Ratio, $p < .01$, ηp2 = .241; and Normalized Coherence, $p < .001$, ηp2 = .613).

While significant group differences were shown for the HRV findings, the pre to post-test scores changes in self-reported POQA-R4 did not reach significance for group differences, and there were no significant improvements in increasing vitality and reducing stress. These findings, in the context of observed significant improvements in the pre- and post-test scores, were not consistent with the studies conducted with police officers (Weltman et al., 2014) and healthcare leaders (Lackey, 2014). It is imperative to note that there was varied duration of the intervention period in these studies compared to the current one, where the police officers went through a practice period over six weeks, and the healthcare leaders had a six-month time frame, versus 13 days for the current study. However, it is noteworthy to discuss that despite the fact that POQA-R4 did not show multivariate condition x time interaction ($p = .402$), a considerable magnitude of the effect size ($\eta p2 = .420$) was observed, and cannot be overlooked. Like the studies mentioned above (Lackey, 2014; Weltman et al., 2014), the HMS group has also demonstrated the desired changes (see Figure 11 and 12), where improvements were observed in all four primary scales and eight of the nine subscales compared to the WLG group. There was an apparent reduction in the domain that measured stress, such as emotional stress, organizational stress, physical stress that impede performance, and an increase in the domain that measured emotional vitality that improves performance.

A notable mention is that there was a univariate condition x time interaction for Relational Tension ($p = .050$, $\eta p2 = .114$), indicating that there was a significant improvement in relationships and communication within their social circles. This is consistent with the polyvagal theory that high HRV activates the ventral vagus complex (VVC), a higher-level and newer neural system that enables people to relate with other people openly and engagingly, as well as acquire effective emotion regulation (Porges, 2001, 2007, 2011). Additionally, as presented in Table 3, participants in the HMS group had only a slight increase of the pre- and post-test scores in the stress scale (2%) and the intention to quit (5%) as compared to the WLG group 5 % and 13% (statistically significant), respectively. The results suggest that participants in the HMS group were able to regulate their emotions more effectively than the WLG group, perhaps by seeking social support in the workplace, which is related to the decrease in the Relational Tension scores.

In conclusion, these results suggest that in the face of stressful events the participants in both groups may encounter during the study period, the HMS group was more likely to have the ability to self-regulate where they were able to achieve a calm, balanced, yet energized and responsive state “in the moment” by using the HeartMath system to increase emotional energy, vitality, contentment, peacefulness, buoyancy, relationships, and communication. There was also a reduction in distress, fatigue, anger, sadness, and physical stress symptoms. Moreover, the physiological findings revealed in the HRV analysis have supported these psychological outcomes that the practice of the HeartMath system over a short duration of 13 days can increase psychophysiological coherence. Participants in such a state would experience a reduction in the depletion of emotional energy that impedes performance; and would experience an improvement in emotion-regulation, flexibility in adapting to stressful situations, and renewing of emotional energy reserves available for work and personal life. These are results of learning strategies that facilitate the establishment of a new, healthier internal baseline reference, as demonstrated in the 5-minute resting HRV measures, and participants have shown to mature through this process as they can more effectively self-regulate their emotions and navigate new situations or challenges as conclusively shown in the 3-minute stress prep HRV measures (McCraty, 2015). All of which are essential keys to building resilience.

Research Question Two

Literature has considered SOC as a resilient factor (Braun-Lewensohn, Idan, Lindstrom, & Margalit, 2017) and individuals with high SOC scores are positively associated with high health-promoting scores, and they are less likely to perceive stressful situations as anxiety aggravating and threatening than individuals with low SOC scores (Suraj & Singh, 2011). The objective of this study, as guided by this research question was to examine how well, if any, would the practice of HeartMath coherence-building techniques over 13 days lead to measurable increases in SOC scores.

The findings of this study using SOC-13 as the dependent variable are comparable to the two studies, as discussed in chapter two. Although both studies used a shortened 9-item version of Antonovsky's (1987) scale where the current study used a 13-item version, these were the closest comparison the researcher could find in the literature that studies utilizing both HeartMath interventions and SOC, so careful interpretation of these results was considered. In the first study, Edwards (2014) investigated the effectiveness of the HeartMath coherence feedback training where the pre-test mean score was 34.23 (SD = 6.18), and the post-test mean score was 43.92 (SD = 8.76), indicating significant increases in SOC scores, Z = 2.668, p = .008. The results were similar to the second study, where the mean estimate of the SOC was 34.23 (SD = 6.18) before the intervention and 43.92 (SD = 8.76) at post-intervention. This difference was statistically significant, $t(12) = 4.40$, $p = .001$, with a very large effect size of 1.57 signifying that participants reported enhanced SOC ensuing the HeartMath interventions (Field et al., 2018). The outcomes of the HeartMath interventions on SOC-13 that were observed in this study were 58.71 (SD = 10.50) at pre-intervention and 62.71 (SD = 8.63) at post-intervention, which also indicate a statistical significance, $t(17) = 3.73$, $p = .002$ (see Table 3). Furthermore, a mixed factorial MANOVA showed a significant condition x time interaction for Total SOC ($p < .01$, ηp2 = .195). The huge effect size in this study that is comparable to the study conducted by Field and colleagues (2018) suggests the large treatment effect of the HeartMath coherence-building program on participants' total SOC.

While significant difference has been found in the Total SOC scores, it is imperative to determine which of the SOC components may facilitate the improvement of SOC from a short duration of intervention period. With this intention to investigate further using the MANOVA analysis, only SOCMA was found to have a significant condition x time interaction ($p < .01$, $\eta p2 = .278$). According to SOC researchers, manageability is the instrumental/behavioral component, which represents the confidence that resources are available for one to meet environmental demands. This is a result of experiencing between environmental demands and available resources (Antonovsky, 1987; Lindstrom & Eriksson, 2005, 2006). These descriptions suggest that during the 13-day study period, participants in the HMS group were more likely to find possible resources to help them to deal with their stressful situations. The researcher posits that this favorable outcome may be attributed to the introduction of a set of self-regulation methods (a generalized resistance resource which underpins the development of a strong SOC), and the recommendation of specific emotion regulation techniques and the use of the biofeedback technology (specific resistance resources that are situation-specific; Antonovsky, 1979, 1987). These are internal resources that were developed during the 13-day period that can be particularly useful during the absence of any external resources (e.g., social support) that can prevent tension from being transformed into stress. An example to describe such a situation is: a participant can immediately use the emotion-refocusing breathing technique (e.g., Quick Coherence or Freeze-Frame) taught by the researcher when one is feeling highly anxious ten minutes before a presentation to the company's most important client. The participant would have the specific skill to prepare oneself before the presentation and may even be able to do self-regulation “in-the-moment” during presenting. This demonstrates that the participant has successfully coped with the stressful event, which provides a platform for one to attain resilience and health.

In this study, the comprehensibility and meaningfulness components did not reach statistical significance. The researcher supposes that the 13-day study period may be too short for the participants to acquire a certain level of insights to perceive the world objectively or to see the value or learning opportunity in the current situation. Nevertheless, the mean scores for the three SOC components have shown a slight upward trend in the HMS group (3% increase in comprehensibility; 19% increase in manageability; and 0% in meaningfulness) as compared to a largely downward fashion in the WLG group (1% increase in comprehensibility; 2% decrease in manageability; and 4% decrease in meaningfulness) (see Table 3). Overall, a multivariate condition x time interaction for all SOC scores ($p < .05$, $\eta p2 = .326$) was observed. This confirms with evidence the positive effects the HeartMath System had on obtaining a high sense of SOC, which is an important mechanism underpinning the development of stress-related resilience and health (Mc Gee, Holtge, Maercker, & Thoma, 2018).

Research Question Three

Numerous studies have considered the Zimbardo Time Perspective Inventory (ZTPI) as a crucial psychological variable associated with plenteous areas of human functioning, such as subjective well-being, health behaviors, risky behaviors, and propensity to become addicted (Carelli, Wiberg, & Wiberg, 2011; Zimbardo & Boyd, 1999, 2008; Zhang & Howell, 2011). The purpose of this study, as guided by this research question was to investigate how well, if any, would the practice of HeartMath coherence-building techniques over 13 days facilitate a balanced time perspective, as indexed by the Deviation from the Balanced Time Perspective (DBTP: Stolarski, Bitner, & Zimbardo, 2011) based on the ZPTI scores.

While the concept of balanced time perspective (BTP; Zimbardo & Boyd, 2008) has been utilized to explain its relationship with emotional intelligence, gratitude, mindfulness, stress, self-control, well-being (Brown, 2017; Drake et al., 2008; Ronnlund et al., 2019; Stolarski et al., 2011; Szczesniak & Timoszyk-Tomczak, 2018), and sense of coherence (Ruzhytska, 2015; Wiesmann et al., 2018), this study may be among the first to examine its association with the effects of HeartMath System. Although there may be an absence of studies examining how the HeartMath System affects BTP, the researcher chose studies that focused on mindfulness practice and BTP (e.g., Ronnlund et al., 2019), given the comparable nature that the techniques used are centered on self-regulation "in the here-and-now." However, it is imperative to note the slight differences between mindful meditation and one of the HeartMath breathing techniques (e.g., Heart Lock-In), such as the active stance in sustaining a non-judgmental attitude towards one's thoughts and feelings (Kabat-Zinn, 2005) in the former, and actively generating a sincere attempt to re-experience a renewing emotion (e.g., appreciation, care) in order to sustain heart coherence, and to radiate that energy to the self and others (Institute of HeartMath, 2014).

As discussed in chapter two, Ronnlund and his colleagues (2019) investigated whether mindfulness promotes a more balanced time perspective in two mindfulness training groups (n = 69). Findings showed significant reductions in the combined data for pre and post DBTP scores ($p < .001$; Cohen's $d = -.46$), with lowered scores on PN ($p < .001$; $d = -.44$) and PF ($p = .002$; $d = -.27$), and a small increase on PP ($p < .001$; $d = 0.28$). However, no difference was found for PH ($p = .87$; $d = -.001$) and FP ($p = .43$; $d = -.005$) (Ronnlund et al., 2019). Consistent with the previous study, the current study has also shown a dramatic decrease in the pre and post

DBTP scores for the HMS group comparing to the WLG group, as demonstrated in a condition x time interaction ($p < .01$, ηp2 = .262). There was also significant reduction in PN ($p = .028$ [one-tailed], ηp2 = .110), and PF ($p < .01$, ηp2 = .235). Similarly, there was no pre- and post-intervention difference for PH ($p = 596$ ηp2 = ..009) and F ($p = .146$, ηp2 = .065). However, PP did not reach any statistical difference (p = .117, ηp2 = .075). In these two studies, it is essential to note the small to medium effect sizes, as shown in the mindfulness study, while the current study portrayed large effect sizes. Moreover, a medium effect size was observed on the time perspectives that did not show statistical significance. These results suggest that the HeartMath System is not only shown to be effective in reducing time perspective biases, thus improving a balanced time perspective, but it may also have a larger treatment effect than the mindfulness training program, as demonstrated in the study mentioned above.

Most findings in this study were as expected. The researcher predicted that participants in the HMS group would experience a reduction in PN and PF due to the use of the emotion-refocusing techniques (e.g., Heart-Focused breathing, Quick Coherence, Freeze Frame) that were designed to help participants to reset and shift away from the negative thoughts and emotions. Along with the conscious regulation of one’s respiration at a 10-second rhythm, this process sets a stage for participants to have the space to increase heart coherence, which allows one to shift into a more coherent state. It was surprising to learn about the insignificant finding of PP because self-generation of positive emotions (retrieving positive aspects of one’s past) is the crucial ingredient of the HeartMath breathing techniques that helps participants to sustain higher levels of coherence for a much longer duration.

Despite these findings, the mean PP scores in the HMS group have shown slight increase from 3.54 ($SD = .52$) at pre-test to 3.64 ($SD = .47$) at post-test as compared to the decreased mean PP scores in the WLG group, 3.68 (*SD* = .32) to 3.63 (*SD* = .34), respectively. The same trend was observed in the mean Future scores for both groups (HMS: 3.74-3.77 vs. WLG: 3.67-3.58), which were also found to be insignificant. To address these findings, it is worthwhile to revisit the ideal time perspective chart (Zimbardo & Sword, 2017), as presented in Chapter 2, where the ideal PP is 3.67, and the Future is 3.69. As revealed in these mean scores, it is apparent that the mean scores for both groups were very close to the ideal scores. This might explain that the participants in both groups could already have the ability to re-experience positive past memories and plan for the future. Nevertheless, the results demonstrate a desired directional change in both PP and F scores for the HMS group.

As for the decrease in the mean scores for PH (the ability to enjoy the present moment), which is also far below the ideal score of 4.33, the researcher posits that the participants might be trying to cope with some very stressful moments during the study period instead of having time to do enjoyable things. It is also interesting to note the higher pre-test mean scores for PN and PF in the HMS group, despite the fact that they also scored slightly higher in PH and F. This might explain why the mean DBTP score is also higher in the HMS group at pre-test. However, considering all other time perspectives, the HMS group has demonstrated a higher ability in downregulating PN and PF while still maintaining relatively high PP and F scores with a slight increase. The findings showed that they possess better flexibility in switching temporal focus; thus, there is a significant increase in a balanced time perspective, which is key to well-being and resilience, both short- and long-term.

Research Question Four

The favorable findings in the above three research questions have shown the effectiveness of the HeartMath System on HRV, POQA-R4, SOC, and BTP, in their own rights.

Echoing Bischof's (2008) postulation that all systems in the organism must be coherent, balanced, ordered, harmonious, and integrated to a certain degree to be functional, the researcher is interested in examining further and desires to determine a more holistic view of what predicts emotion regulation flexibility. The focus should not be limited to one specific theoretical framework or paradigm, but to integrate research-based theories and interventions that add value to the current literature. With that, this research question has attempted to examine what are the factors that may improve emotion regulation flexibility, commencing with the several frameworks that have been researched in this study.

In the current study, what stood out in the results as revealed in the 5-minute resting HRV measures was that participants who scored high in these measures tend to have lower tendency of believing that everything is predestined and they have no power to change their future, fewer complaints on having negative health symptoms (e.g., physical tension, pain), and lower intention to quit their jobs. The results in the 3-minute stress prep HRV measures have established that by using the new self-regulation skills learned in this study (e.g., Quick Coherence, Freeze Frame), participants also have a lower tendency to hold fatalistic thoughts and feelings about the future, and a lower intention of leaving their jobs. What is interesting is the positive relationship between the Mean Heart Rate and Meaningfulness in SOC. The higher mean heart rate, which is commonly associated with lower HRV, may be seen as participants striving to achieve challenging goals, which they may perceive as worthy of their commitment. However, this result may be counter-intuitive to the negative relationship between 3-minute HRV measures and PH, where the participants who have high HRV were less likely to take risks or enjoy the present moments. This can be viewed as two sides of the same coin – participants were careful with proceeding with their work because it was a vital task, and they wanted to avoid any failure, or they were doing a task they did not really enjoy, but the reward was highly worthwhile. Hence, the findings revealed that obtaining a high HRV has positive effects on stress management, sense of coherence, and time perspectives.

Participants with a more balanced time perspective, particularly an increase in PP and F, and a decrease in PN and PF were found to have a better overall sense of coherence. The results showed that they were able to have a higher capacity to gain insights about the situation, better at identifying possible resources to help them to overcome the situation, and were more likely to view stressful situations as worthy of commitment. Additionally, participants with higher BTP also tend to experience an increase in positive emotional energy, including feelings of inner peace and contentment. They would also experience lower emotional stress, including feelings of anxiety, sadness, anger, resentment, and a lower intention to quit their jobs. Likewise, the positive relationships found between SOC and POQA-R4 also demonstrated an increase in emotional vitality and a decrease in all stress measures. Fundamentally, these results have shown that factors that are essential to emotion regulation flexibility are interrelated. This suggests that regular practice in making a sincere attempt to self-generate a positive feeling, along with 10-seconds breathing not only can increase their psychophysiological coherence, but also allow individuals to flexibly adapt between the temporal frames, and be able to see their future as predictable, manageable, and meaningful. All these suggest a new inner baseline reference can be established where individuals can intuitively use the HeartMath self-regulation techniques to make more intelligent decisions by aligning their heart intelligence in the face of demanding circumstances.

Research Question Five

As discussed in Chapter One, mindfulness-based practices are among the most studied and validated interventions that have been integrated into Singapore schools to promote health and well-being (Khng, 2018). The researcher saw the need to further examine more evidence-based interventions on emotion regulation that could be introduced as a nationwide movement to achieve resilience and well-being because there were insufficient published intervention programs. With the positive results, as demonstrated in this study, the researcher also considered the need to briefly discuss the similarities and distinctions between the HeartMath System and the mindfulness-based practices that have been popularly available in Singapore.

Centering into the similarities, the HeartMath breathing techniques and most mindfulness-based practices require practitioners to focus their attention on their breathing and thoughts "in the here and now." On the other hand, while mindfulness practitioners strive to relax and calm their minds, and sustained with a non-judgmental attitude (Kabat-Zinn, 2005), a HeartMath practitioner would try to generate a sincere attempt to re-experience a renewing emotion (e.g., appreciation, care) in order to sustain heart coherence (Institute Of HeartMath, 2014). The outcomes of these practices are very different because coherence and relaxation are two distinct states, as discussed in chapter two. Researchers at the Institute of HeartMath contend that relaxation is a low-energy state in which the individual typically disengages from cognitive and emotional processes, whereas coherence is a state of calm, balanced, yet energized and responsive in navigating through challenging and difficult situations (McCraty & Tomasino, 2006a; McCraty et al., 2009).

Additionally, these distinct states would have very different representations in the HRV power spectrum, where relaxation demonstrates a lower HRV characterized by an overall reduction in autonomic flow and increased power in the HF region, reflecting the increased parasympathetic activity. Conversely, coherence can be achieved with breathing alone, yet the HeartMath breathing techniques raise the level of benefits resulting from an attentional shift and generation of positive emotions (Institute of HeartMath, 2017). This state can be observed in the HRV power spectrum, portrayed by a narrow-band, high amplitude peak near the center of the LF band (see Figure 7). Furthermore, the results in this study have supported that high HRV coherence is associated with high LF scores along with decreased power in the HF and VLF scores. The above implies that the coherence state has increased harmony and synchronization in the nervous system and heart-brain dynamics compared to the relaxation response.

Additional search into the literature showed that both HeartMath System and mindfulness-based practices (e.g., MBSR) have similar effects on SOC (Weissbecker et al., 2002) and BTP (Ronnlund et al., 2019). However, some of the most recent meta-analyses revealed that mindfulness-based interventions and other mind-body interventions (e.g., Tai-Chi and Yoga) have none-to-moderate beneficial effects on the HRV measures (Radmark, Sidorchuk, Osika, & Niemi, 2019; Zou et al., 2018). In other words, the HeartMath breathing techniques can induce higher HRV than mindfulness-based practices. Hence, coherence is not relaxation (McCraty et al., 2009).

Another key distinction between the HeartMath System and other mindfulness-based interventions is that HeartMath recommends the use of the assistive biofeedback technology, such as the Inner Balance device, to help them to bring their heart, mind, and emotions into greater alignment. Although participants can still practice the breathing techniques without using the device, just like any other mindfulness interventions, the researcher contends that the device can help participants to repattern the way how they are usually breathing. During the study period, most participants realized how shallow they have been breathing, thus the difficulty in getting a nice sine-wave-like heart-rhythm pattern. It is with this awareness that the participants can start building a new baseline, particularly with the visual aid on their heart rhythm, which empowers them because they can shift how they feel by intuitively changing their physiology.

Limitations

There are various shortcomings within the study. As predicted in Chapter One, the first limitation in the study was the small sample size, even though a sample size required for the study of around 14 to 17 participants was fulfilled without much attrition. However, several other limitations emerged as the study progressed. The lack of diversity may be a factor in this research, as most participants in the research were Chinese. Although the homogeneous ethnicity may not be a confounding factor on HRV which is an objective measurement of stress and physiological coherence, it would have larger effects on the three self-reported questionnaires that may limit generalizability of the study findings to a diverse population in Singapore. Also, the aggregate data obtained through the self-reported questionnaires in this study, including the POQA-R4, SOC, and ZTPI, may not wholly represent participants' feelings, attitudes, or behaviors which may be attributed to the tendency for them to respond in a socially acceptable manner, demonstrating a social desirability bias. Before or during the study period, participants may have gone through high intense difficulties such as bereavement and loss or difficult relationship with a family member or a colleague.

Another limitation pertaining to the self-reported questionnaire is the wordings that were reflected in the POQA-R4. In this questionnaire, participants were required to respond to the questions based on how they think or feel during the last month. As the same questionnaire was used for both pre-and post-test sessions, the responses based on how they think or feel during the last month could not accurately measure how the participant feels on the very day. Hence, the researcher recommends the use of "now" instead of "last month." After all, this study was set to examine state instead of trait.

Having mentioned HRV as an objective measurement, several confounding variables might have been unavoidable. For instance, the difference in HRV readings from participants due to assessments which were conducted at different times of the day. As the two exclusions for the current study was age and having existing heart condition, participants were not required to report whether they are on medication (e.g., for high cholesterol or diabetes) which might reflect a reduction in HRV.

It is also imperative to note that the intervention period in this study was too short, even though the findings were predominantly significant. It was also anticipated to have problems in getting participants to commit to the initial intended six weeks' study, because the study period was near the end of the year when many people may be planning for overseas trips. Hence, the choice of conducting a brief 13-day study period was due to these resource constraints.

Implications for Professional Practice

In the literature, there is no one-size-fits-all methodology that could entirely eliminate one's stress or magically increase one's resilience level to the fullest. Although it has some limitations, the researcher has attempted to study the effectiveness of a resilience-building system within a biopsychosocial paradigm, using POQA-R4, SOC, ZTPI as psycho-social measures, and HRV as the physiological measure. It is important to note that these results have clearly shown circular effects instead of a linear one. Hence, the researcher contends that in order to build resilience and to achieve emotion regulation flexibility, individuals are encouraged to achieve coherence and balance not only in one's mental domain, but also the physical, emotional, and spiritual domains. These include but are not limited to acquiring the awareness, understanding and insights on one's emotions and its effects on the neurobiological functions.

Regarding astuteness to one's self, the researcher refers to the concept of internal attunement as proposed by Siegel (2010, 2012). It is this internal attunement that enables a person to observe one's self in an open, receptive, and caring way based on the here-and-now experience. It creates an internal resonance and a state of safety that actuates the social-engagement system, paving the way to become open to one's self and ready to be one's own best friend. The researcher believes that this is the route towards building and sustain resilience. However, the researcher also contemplates what element is necessary to start this journey to resilience. Also an established flute player, the researcher asserts the importance of being highly proficient in playing one's instrument is to go back to the basics – the way how one breathes can directly influence the sound of the instrument. Most advanced musicians would also recommend the use of a tuner and a metronome to check and increase their sensitivity to intonation and ability to stay in tempo. With regular practice, the musician would have acquired skills that allows one to be able to perform to the highest level while able to adjust one's intonation instinctively to blend with other colleagues in the orchestra.

The above example is akin to individuals who regularly practice the HeartMath System, where breathing directly affects their emotions and HRV. The use of a metronome is comparable to the practice of resonance frequency breathing (10-seconds rhythm or six breaths per minute) that first helps individuals to achieve aggregated influence of both SNS and PNS. The use of the biofeedback technology is parallel to the tuner where the individual can observe the visuals of one's heart pattern rhythm and learn how to use the breathing techniques (e.g., Quick Coherence) to "tune" one's ANS and obtain a good HRV. Additionally, the self-generating of positive emotions that are highly encouraged while practicing the breathing techniques are analogous to musicians practice a beautiful musical passage expressively. Just as experienced musicians do not depend on these gadgets while performing on stage, the individuals who have practiced frequently would also have learned how to intuitively use the breathing techniques “in-the-moment,” enabling them to have the capacity to prepare for, recover from and adapt in the face of stress, challenge or adversity.

In this study, there were large effect sizes that were observed in HRV, POQA-R4, SOC, and ZPTI through a brief 13-day practice of the HeartMath System. These simple and practical breathing techniques and the use of biofeedback technology are tools that have helped individuals to down-regulate stress and up-regulate positive emotions. This study has provided individuals a road map on how they could achieve personal-well-being by simply go back to the basics – breathe, tune, and synchronize their ANS. Hence, the findings in this study have shown that the HeartMath System not only can be considered a single-component intervention, but also an adjunctive therapy for several rehabilitation programs (e.g., chronic pain, addiction, recurrent migraine), given the demonstrated efficacies in reducing stress, negative health symptoms, relational tension; and improving mood, energy, sense of coherence, and social relationships. Practicing clinicians may use the outcomes of this study as an add-on to their clinical work, clinical supervision, and training programs.

Private or government schools could consider integrating the HeartMath System with their current social and emotional learning (SEL) programs, where the key domains of social and emotional skills, such as self and social awareness, self and relationship management, and responsible decision making can be strengthened. Additionally, cooperate organizations could utilize the HeartMath System to integrate into their existing wellness and performance improvement initiatives. Because their staff would have the skills to manage stress response "in-the-moment," they are more resilient and could respond with more presence, flow, flexibility, and connection. Such dynamics would generate a more collaborative working environment, which would result in higher staff retention. Hence, the HeartMath System is potentially expedient for the development and delivery of 21st-century health services and public health programs.

Recommendations for Research

This study has provided some strong evidence on the effectiveness of the HeartMath System for building emotion regulation flexibility and sustaining resilience, derived from the objective findings of this quantitative study. While such a research design is useful for generalizations about the cause-effect relationships between variables, Toomela (2010) argues that quantitative approaches cannot reveal the phenomena (e.g., subjective experience in using the breathing techniques and the biofeedback device). With respect to individual differences, Toomela (2008) added that no quantitative method could differentiate qualitatively different mechanisms (e.g., mental events) that may externally cause the same behavior. Hence, similar research can be conducted using a mixed-methods design as it combines the strengths and minimizes the weaknesses of both quantitative (closed-ended) and qualitative (open-ended) methodologies. It also allows researchers to examine research questions with broader and deeper breadths (Creswell, 2014).

Literature has suggested that mental time travel is a ubiquitous phenomenon, and it is not uncommon for individuals to be stuck in one or two biased TPs (e.g., PF, PN). The results of this study have demonstrated how the HeartMath System is effective in achieving a balanced time perspective. Findings also showed several strong relationships between ZTPI and other variables.

Interestingly, the theory based on ZPTI has been developed into therapy in its own right, known as the Time Perspective Therapy (TPT; Zimbardo & Sword, 2017). Future research, using the mixed-methods design, can integrate both the HeartMath System and the TPT to build individual resilience and social relationships. A recent review on 49 experiments on relation between DBTP and different psychological variables concluded that BTP not only considered as one of the central constructs of positive psychology that serves as valuable idea for researchers, but also offer a robust framework for practitioners supporting people in coping with clinical conditions and in achieving higher levels of well-being (Stolarski, Zajenkowski, Jankowski, & Szymaniak, 2020). Hence, findings in these future studies may add profound value in addressing a wide range of problems, including addictions, anxiety and depressive disorders, domestic violence, eating disorders, insomnia, marital and family conflicts, panic disorder, and workplace stress.

Conclusions

This study has examined the practice of HeartMath coherence-building techniques over thirteen days on psychophysiological resilience, sense of coherence, and balanced time perspective. The findings were quantified by the use of an objective physiological assessment that measures HRV with the use of the emWave Pro Plus® software program, and self-reported psychological assessments which were POQA-R4, SOC-13, and ZTPI. The findings were examined with mixed factorial MANOVA, univariate analyses, paired sample t-test, and Pearson's correlational coefficient analysis of HRV measurements, POQA-R4, SOC-13, and ZTPI with the use of SPSS version 26.0 (IBM Corp, 2019).

Findings in this study have demonstrated that vitality, resilience, and emotion flexibility can be achieved and sustained by generating an increase in psychophysiological coherence, which is embodied by increased synchronization between the activity of heart and brain. For instance, there were significant improvements in the LF power (5-minute resting HRV and 3-minute stress prep HRV), which encompasses the aggregated influence of SNS and PNS and has also been associated with flexibility, psychological well-being, and good performance. Moreover, instead of accumulating allostatic load or completely shutting down the SNS to reduce stress, the high LF effect allows the activation of regulation in the SAM and HPA axes, which have been found to inhibit the PNS and neurovegetative functions. Solely practicing on relaxation would not enable individuals to summon the energy needed to counter stressful situations intuitively. This is because coherence is not relaxation. Findings have further shown that even a brief period of practicing HeartMath interventions can yield positive effects on participants' BTP and overall SOC, both of which are essential psychological variables that represent references to one's internal time perspectives that may affect how individuals comprehend themselves as resourceful and view the world as meaningful.

In conclusion, the HeartMath System, as studied in this research, was consistent with the literature. The desired directional changes in both physiological and psychological data have shown measurable and sustainable improvements in personal health and performance. With that, this study has supported a research-based resilience-building program for Singapore agencies who work with either or both clinical and non-clinical populations. The HeartMath System consists of simple, practical techniques that Singaporeans can use "in-the-moment" and "on-the-go," helping them in building coherence and increasing emotion regulation flexibility towards resilience.

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APPENDIX A

Invitation to Participate in the Research Project Titled

BUILDING COHERENCE AND INCREASING EMOTION REGULATION FLEXIBILITY TOWARDS RESILIENCE: AN EXPERIMENTAL STUDY IN SINGAPORE

Dear participant,

My name is Sim Yih Shyang Andy, and I am a graduate student at California Southern University. I am undertaking a research project focusing on the effectiveness of the HeartMath System on both physiological and psychological measures, which are related to improved emotion regulation flexibility and personal resilience for Singaporeans. Studies have shown that the HeartMath System has helped people to increase their well-being, quality of life, and potential effectiveness. This doctoral project serves as the partial fulfilment of the Doctor of Psychology degree, and I would like to extend an invitation to you to participate in this research.

If you decide to participate, there will be a pretest session which will be held on a weekend morning following a 2-hour resilience training workshop on the next day afternoon. A posttest session will be held on a weekend morning, which is one week after the pretest session. These sessions will be held at my office. During the training workshop, you will be taught emotion regulation techniques where you will be required to practice them for 15 minutes daily for 6 days. During the pre- and post-tests, there will be a measurement on your heart rate variability and three resilience-related questionnaires. This study will commence on the __ week of October 2019 _(will confirm upon approval of IRB).

In order to protect your confidentiality, your name will not appear on the survey, I will only use data and results from the survey, without including your name. Instead, you will be given a false name and identifiable information for my personal reference, and it will never be used in a publication or presentation.

This research includes compensation for your participation. All participants will receive a $20 supermarket vouchers upon completion of all required processes of this study. Your participation will be a valuable addition to the research on ways to obtain and sustain resilience, particularly in the Singapore context. Please note that participation in this study is entirely voluntary, and you may choose to withdraw from the study at any time if you do not feel comfortable with the required processes.

Please read the attached information sheet for your reference. Please feel free to contact me if you have additional questions about this study. Thank you for your time, and I look forward to working with you.

Yours sincerely,

Sim Yih Shyang Andy, PsyD Candidate

APPENDIX B

Demographic Information Form

Building Coherence and Increasing Emotion Flexibility Towards Resilience: An Experimental Study in Singapore

Doctoral Project Principal Researcher: Sim Yih Shyang Andy (California Southern University)

Demographic Data Form

Description (optional)

Name (Only Initials. e.g., Mei Hua - MH) *

Short-answer text

Last Name/Surname *

Short-answer text

Preferred Email Address *

Short-answer text

Mobile Phone Number *

Short-answer text

Okay to text? *

- ◯ Yes
- ◯ No

Gender *

- ◯ Female
- ◯ Male

Marital Status *

- ◯ Single
- ◯ Married
- ◯ Partnered
- ◯ Separated
- ◯ Divorced
- ◯ Widowed

Race *

- ◯ Eurasian
- ◯ Indian
- ◯ Malay
- ◯ Chinese
- ◯ Other...

Do you reside in Singapore? *

- ◯ Yes
- ◯ No

Highest Education Level *

- ◯ Primary
- ◯ Secondary
- ◯ JC/Polytechnic
- ◯ Bachelor Degree
- ◯ Postgraduate Degree

Do You Have A Heart Condition? *

- ◯ Yes
- ◯ No
- ◯ Maybe

Do You Own a Smartphone? *

- ◯ Yes
- ◯ No

If yes, please indicate whether it is

- ◯ Android
- ◯ iOS
- ◯ Other...

Thank you for your interest. I will contact you when you are considered suitable for the study. Please be assured that the information you have entered in this form is entirely confidential.

APPENDIX C

Participant Consent Form

Participation in a Research Study
California Southern University
3330 Harbor Blvd, Costa Mesa, CA 92626

School of Behavioral Sciences

Principal Researcher: Sim Yih Shyang Andy, PsyD Student. Phone No.: XXX-XXXXXXX

E-mail: yihshyang.sim@my.calsouthern.edu Date: XX/09/2019

Please read the following information:

1. You are invited to participate in a research project. This information sheet provides you with information about the research. The Principal Researcher (PR), Sim Yih Shyang Andy who is a graduate student at California Southern University, will describe this research to you and answer all of your questions. Please read the information below and ask questions about anything you don't understand before deciding whether or not to take part in the study.
2. The project is titled *Building Coherence and Increasing Emotion Regulation Flexibility towards Resilience: An Experimental Study in Singapore.*
3. The purpose of this experimental study is to examine the effectiveness of HeartMath self-regulation techniques and tools on physiological measures such as heart rate variability, and psychological measures such as sense of coherence and time perspective over one week during the month of October.
4. If you consent to participate, you will be involved in the required procedures which will take about 5 hours of your time for the whole study, in regardless to whether you are randomly chosen for the HeartMath System intervention group or the wait-list group. The study will take place at the PR's office, which is located in Maxwell House.

5. If you consent to participate, you will be involved in the following process, which will take 3 sessions:
    a. The PR will arrange for a short video call with you, which will last about 10 – 15 minutes at a mutually agreed date and time. You will be sent a link to access to an online demographic form that contains age, gender, marital/ relationship/family status, race, level of education, and current health status.
    b. Participants who meet the inclusion/exclusion criteria will be asked to participate in the study. The eligible participants will be divided into two groups: the HeartMath System intervention group (HMS) and the wait-list control group. The wait-list control group will be offered HMS intervention training after the HMS intervention group completes their required study.
    c. All eligible participants will be informed a specific time to meet with the PR at his office, which is located in Maxwell House. This is the first session which will be conducted in the morning. Participants will sign the consent form, fill out the Personal and Organizational Quality Assessment-Revised 4 (POQA-R4), the Orientation to Life (SOC-13), the Zimbardo Time Perspective Inventory (ZTPI). The PR will also collect data from assessments of your heart rate variability (HRV) which entails three protocols such as a 5-minute resting HRV assessment, a 3-minute stress preparation, and a one-minute deep breathing assessment.
    d. While the wait-list control group will leave after session one, the HMS intervention group will return the next day afternoon for session two where you will attend a 2-hour resilience training session, which includes learning how to use the portable HRV Inner Balance device. During the training session, the HMS intervention group will

be taught how to incorporate HMS self-regulation techniques on a daily basis for the following 6 days. Specific instructions will be given to participants on adhering to the same daily practice protocols to ensure consistency. To ensure the provision of support to the group, the PR will also contact each participant in the HMS group every three days, via phone, email, or in-person, to discuss any questions or concerns with the HMS techniques or technology.

e. One week after the first assessment, the PR will arrange another session with all participants at his office, which is located in Maxwell House. This will be session three for the HMS intervention group and session two for the wait-list control group. Each participant will be given a specific time to attend the meeting. Each participant will again fill out the POQA-R4, SOC-13, and ZTPI. The PR will also collect the HRV data from each participant based on the same three protocols at the first session. Participants in the HMS intervention group will return the Inner Balance devices.

f. For the wait-list control group, you will return in the afternoon for session three, where you will be offered the 2-hour HMS intervention training.

6. Participation in this research is voluntary. You have the right to withdraw at any time. If you have any questions, you may contact the PR at the number as listed above.

7. The risks to your participation in this study may include possible recollection of stressful life experiences when filling out the questionnaires. If you have ongoing anxiety or health issues after or during the study, you may contact the following the organizations for assistance:

Samaritans of Singapore
24-hour hotline: 1800-221-4444
Email Befriending: pat@sos.org.sg
Website access: https://www.sos.org.sg/contact-us

Counselling and Care Centre
Blk 536 Upper Cross Street
#05-241 Hong Lim Complex
Singapore 050536
Telephone: 65-65366366
Email: info@counsel.org.sg

8. The benefits to you may include decreased stress, increase psychological and emotional flexibility, regain vitality and increase energy, and increase resilience.
9. There is compensation for your participation in the study. All participants in both groups where each will receive a $20 supermarket voucher. In order to receive the compensation, you must complete the pre- and post-HMS intervention sessions of the above-described study.
10. Your response are strictly confidential. When the data and analysis data are presented, you will not be linked to the data by your name, title, or any other identifiable item.
11. All data collected online will be transferred into a physical hard-drive, which will be encrypted. All physical documents will be stored in a secure and locked location. All data will be kept under lock and key for five years and will be destroyed thereafter.

As a research participant, I have read the above, have had any questions answered, and agree to participate in the research study. I will retain a copy of this form for my reference.

Participant's Signature ________________________________ Date _____________

Principal Researcher's Signature ________________________ Date _____________

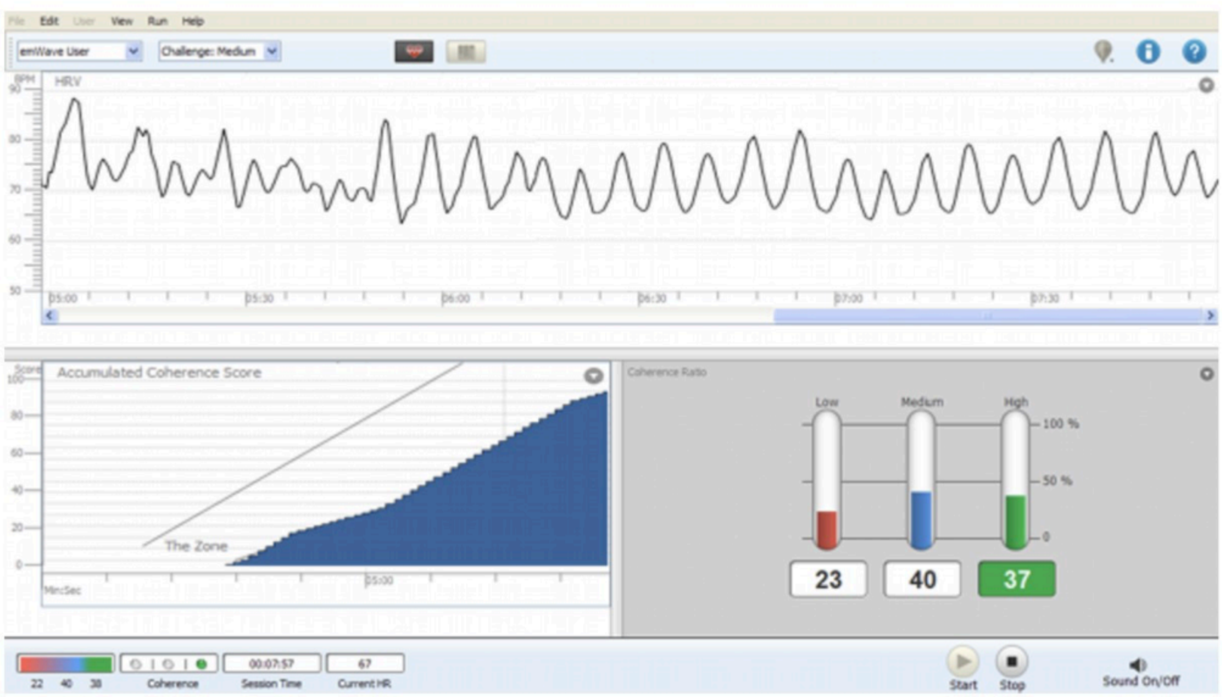
If you have questions about the study or about your rights as a research subject, you may contact the Chairperson of the California Southern University Institutional Review Board, c/o Dr. Linda Fischer at California Southern University, 3330 Harbor Blvd, Costa Mesa, CA 92626, irb@calsouthern.edu.

Additionally, if you would like to make a formal complaint at any point, you may contact my research supervisor, Dr. Daniel Levinson at daniel.levinson@my.calsouthern.edu.

This project is seeking approval from the California Southern University Institutional Review Board.

APPENDIX D

emWave Pro Plus Computer Hardware and HRV Monitor Reading



(HeartMath Inc, 2018)

APPENDIX E

HeartMath Photoplethysmographic Monitors - Ear Sensor (top) and Finger Sensor (below)

(HeartMath Inc, 2018)

APPENDIX F

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

POQA-R4 **Personal and Organizational Quality Assessment-Revised**

This survey is voluntary and confidential.
Only summary, anonymous data will be provided to your organization.

INSTRUCTIONS: Please fill in the boxes below with the requested dates and ID number. For the remaining items, FILL IN THE NUMBER of the response that describes you.

TODAY'S DATE
Month Day Year

UNIQUE ID NUMBER

Please enter the last four digits of your social security number. This number is used for matching your responses over time.

1. What is your GENDER?
① Male ② Female

2. What is your MARITAL STATUS? (fill in one only)
① Single ③ Partnered ⑤ Divorced
② Married ④ Separated ⑥ Widowed

3. Roughly how old are you?
① Under 21 ③ 31-40 ⑤ 51-60 ⑦ Over 70
② 21-30 ④ 41-50 ⑥ 61-70

4. What is your approximate salary range?
① Under $20,000
② $20,000 - 29,999
③ $30,000 - 39,999
④ $40,000 - 49,999
⑤ $50,000 - 59,999
⑥ $60,000 - 69,999
⑦ $70,000 - 79,999
⑧ $80,000 - 89,999
⑨ $90,000 - 99,999
⑩ $100,000 - 149,999
⑪ $150,000 or more

5. What is your highest level of EDUCATION? (fill in one only)
① Elementary
② Junior/Middle School
③ High School
④ Technical School
⑤ Some College/Associate's Degree
⑥ Bachelor's Degree
⑦ Some Graduate
⑧ Master's Degree
⑨ Doctorate Degree

6. Which of the following best describes your EMPLOYMENT STATUS? (fill in one only)
① Student
② Laborer
③ Skilled or Clerical
④ Management
⑤ Professional
⑥ Executive
⑦ Engineer/Technical
⑧ Retired
⑨ Unemployed
⑩ Other

7. How many HOURS PER WEEK do you usually work?
① Less than 25 hours
② 26-35 hours
③ 36-40 hours
④ 41-50 hours
⑤ 51-59 hours
⑥ 60 or more hours

8. How long have you been with this COMPANY or ORGANIZATION?
① 0 - 6 MONTHS
② 6 MONTHS - 1 YEAR
③ 1 YEAR - 2 YEARS
④ 2 YEARS - 5 YEARS
⑤ 5 YEARS - 10 YEARS
⑥ 10 YEARS - 20 YEARS
⑦ 20 YEARS OR MORE

9. How long have you been in your CURRENT JOB or POSITION?
① 0 - 6 MONTHS
② 6 MONTHS - 1 YEAR
③ 1 YEAR - 2 YEARS
④ 2 YEARS - 5 YEARS
⑤ 5 YEARS - 10 YEARS
⑥ 10 YEARS OR MORE

Please turn to the next page

SAMPLE

PLEASE DO NOT WRITE IN THIS AREA

65208

POQA-R4 Personal and Organizational Quality Assessment-Revised

INSTRUCTIONS:
Following is a list of words that describe feelings people sometimes have. Please FILL IN THE NUMBER which reflects how frequently you have felt the following during the LAST MONTH.

Item	NOT AT ALL	ONCE IN A WHILE	SOMETIMES	FAIRLY OFTEN	OFTEN	VERY OFTEN	ALWAYS
1. Resentful	1	2	3	4	5	6	7
2. Fatigued	1	2	3	4	5	6	7
3. Annoyed	1	2	3	4	5	6	7
4. Sad	1	2	3	4	5	6	7
5. Body aches (Joint Pain, Backaches, etc.)	1	2	3	4	5	6	7
6. Headaches	1	2	3	4	5	6	7
7. Rapid Heartbeats	1	2	3	4	5	6	7
8. Depressed	1	2	3	4	5	6	7
9. Exhausted	1	2	3	4	5	6	7
10. Blue	1	2	3	4	5	6	7
11. Appreciative	1	2	3	4	5	6	7
12. Relaxed	1	2	3	4	5	6	7
13. Anxious	1	2	3	4	5	6	7
14. Tired	1	2	3	4	5	6	7
15. My sleep is inadequate	1	2	3	4	5	6	7
16. Thankful	1	2	3	4	5	6	7
17. Indigestion, heartburn or stomach upset	1	2	3	4	5	6	7
18. Calm	1	2	3	4	5	6	7
19. Cynical	1	2	3	4	5	6	7
20. Muscle Tension	1	2	3	4	5	6	7
21. Grateful	1	2	3	4	5	6	7
22. Worried	1	2	3	4	5	6	7
23. Unhappy	1	2	3	4	5	6	7
24. Uneasy	1	2	3	4	5	6	7
25. Angry	1	2	3	4	5	6	7
26. Peaceful	1	2	3	4	5	6	7

27. Over the last month my health has been:

Excellent	Good	Average	Fair	Poor
1	2	3	4	5

28. Fill in the bubble on the line below that indicates how stressed you have been in the past month:

Most Calm I've Ever Been — Most Stressed I've Ever Been

Please turn to the next page

Following is a list of statements that describe the way people sometimes feel or think about themselves. Please FILL IN THE NUMBER which reflects how frequently you have felt or thought the following during the LAST MONTH.

	NOT AT ALL	ONCE IN A WHILE	SOMETIMES	FAIRLY OFTEN	OFTEN	VERY OFTEN	ALWAYS
29. My life is deeply fulfilling	1	2	3	4	5	6	7
30. Dynamic	1	2	3	4	5	6	7
31. I get upset easily	1	2	3	4	5	6	7
32. I find it difficult to calm down after I've been upset	1	2	3	4	5	6	7
33. I feel loved by my spouse/partner	1	2	3	4	5	6	7
34. I feel optimistic about the future	1	2	3	4	5	6	7
35. I wake up and look forward to each day	1	2	3	4	5	6	7
36. Motivated	1	2	3	4	5	6	7
37. I am pleased with my life	1	2	3	4	5	6	7
38. I sometimes have urges to break, throw or smash things	1	2	3	4	5	6	7
39. I sometimes have a short fuse	1	2	3	4	5	6	7
40. Enthusiastic	1	2	3	4	5	6	7

We are asking about your feelings and experiences over the LAST MONTH. Please FILL IN THE NUMBER which reflects how much you AGREE or DISAGREE with the following statements as they apply to you, your job and place of employment during the LAST MONTH.

	STRONGLY DISAGREE	DISAGREE	SLIGHTLY DISAGREE	NEUTRAL	SLIGHTLY AGREE	AGREE	STRONGLY AGREE
41. I am satisfied with my life	1	2	3	4	5	6	7
42. I am satisfied with my job	1	2	3	4	5	6	7
43. There is tension between management and staff	1	2	3	4	5	6	7
44. I feel there is never enough time	1	2	3	4	5	6	7
45. I feel pressed for time	1	2	3	4	5	6	7
46. The pace of life is too fast and I can't keep up	1	2	3	4	5	6	7
47. I feel like leaving this organization	1	2	3	4	5	6	7
48. I feel conflict between work and personal priorities	1	2	3	4	5	6	7
49. It takes a lot of effort to sustain my performance level	1	2	3	4	5	6	7
50. I feel like quitting my job	1	2	3	4	5	6	7
51. I work with people who don't get along with each other	1	2	3	4	5	6	7
52. I'm aware of power struggles between co-workers that damage morale	1	2	3	4	5	6	7

Thank You Very Much For Your Participation!

APPENDIX G

Partial Example of Orientation to Life Questionnaire (SOC-13)

ORIENTATION TO LIFE QUESTIONNAIRE

Here is a series of questions relating to various aspects of our lives. Each question has seven possible answers. Please mark the number which expresses your answer, with numbers 1 to **7**. If the words under 1 are right for you, circle 1; if the words under **7** are right for you, circle **7**. If you feel differently, circle the number which best expresses your feeling. Please give only one answer to each question.

1. Do have the feeling that you don't really care about what goes on around you?

1	2	3	4	5	6	7
very seldom or never						very often

2. Has it happened in the past that you were surprised by the behavior of people whom you thought you knew well?

1	2	3	4	5	6	7
never happened						always happened

3. Has it happened that people whom you counted on disappointed you?

1	2	3	4	5	6	7
never happened						always happened

4. Until now your life has had:

1	2	3	4	5	6	7
no clear goals or purpose at all						very clear goals and purpose

(Antonovsky, 1987)

APPENDIX H

Zimbardo Time Perspective Inventory

Subject Number:________________

Read each item and, as honestly as you can, answer the question: "How characteristic or true is this of you?" Check the appropriate box using the scale. Please answer ALL of the following questions on both sides.

	Very Untrue 1	2	Neutral 3	4	Very True 5
1. I believe that getting together with one's friends to party is one of life's important pleasures.					
2. Familiar childhood sights, sounds, smells often bring back a flood of wonderful memories.					
3. Fate determines much in my life.					
4. I often think of what I should have done differently in my life.					
5. My decisions are mostly influenced by people and things around me.					
6. I believe that a person's day should be planned ahead each morning.					
7. It gives me pleasure to think about my past.					
8. I do things impulsively.					
9. If things don't get done on time, I don't worry about it.					
10. When I want to achieve something, I set goals and consider specific means for reaching those goals.					
11. On balance, there is much more good to recall than bad in my past.					
12. When listening to my favorite music, I often lose all track of time.					
13. Meeting tomorrow's deadlines and doing other necessary work comes before tonight's play.					
14. Since whatever will be will be, it doesn't really matter what I do.					
15. I enjoy stories about how things used to be in the "good old times."					
16. Painful past experiences keep being replayed in my mind.					
17. I try to live my life as fully as possible, one day at a time.					
18. It upsets me to be late for appointments.					
19. Ideally, I would live each day as if it were my last.					
20. Happy memories of good times spring readily to mind.					
21. I meet my obligations to friends and authorities on time.					
22. I've taken my share of abuse and rejection in the past.					
23. I make decisions on the spur of the moment.					
24. I take each day as it is rather than try to plan it out.					
25. The past has too many unpleasant memories that I prefer not to think about.					
26. It is important to put excitement in my life.					
27. I've made mistakes in the past that I wish I could undo.					
28. I feel that it's more important to enjoy what you're doing than to get work done on time.					
29. I get nostalgic about my childhood.					
30. Before making a decision, I weigh the costs against the benefits.					

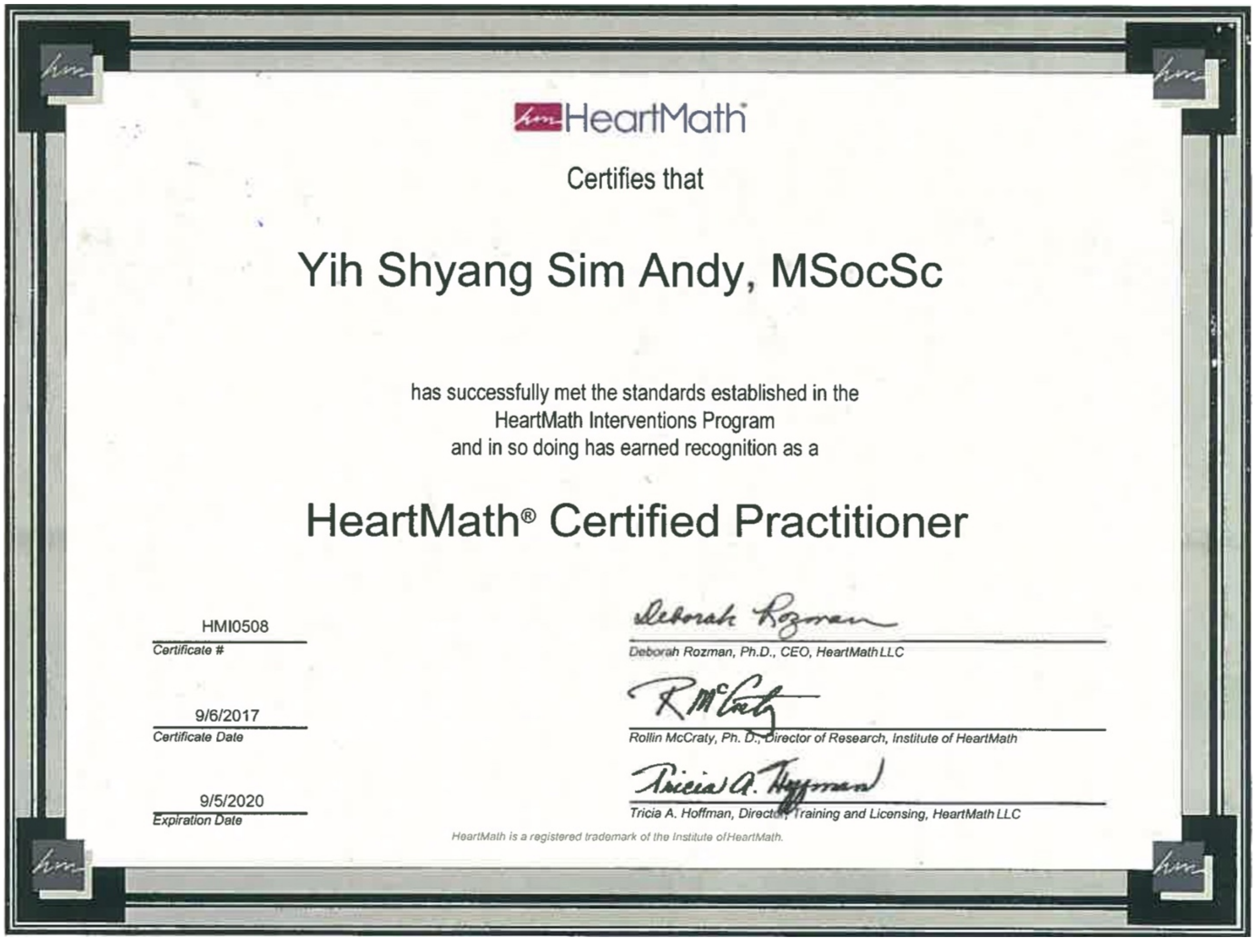
	Very Untrue 1	2	Neutral 3	4	Very True 5
31. Taking risks keeps my life from becoming boring.					
32. It is more important for me to enjoy life's journey than to focus only on the destination.					
33. Things rarely work out as I expected.					
34. It's hard for me to forget unpleasant images of my youth.					
35. It takes joy out of the process and flow of my activities, if I have to think about goals, outcomes, and products.					
36. Even when I am enjoying the present, I am drawn back to comparisons with similar past experiences.					
37. You can't really plan for the future because things change so much.					
38. My life path is controlled by forces I cannot influence.					
39. It doesn't make sense to worry about the future, since there is nothing that I can do about it anyway.					
40. I complete projects on time by making steady progress.					
41. I find myself tuning out when family members talk about the way things used to be.					
42. I take risks to put excitement in my life.					
43. I make lists of things to do.					
44. I often follow my heart more than my head.					
45. I am able to resist temptations when I know that there is work to be done.					
46. I find myself getting swept up in the excitement of the moment.					
47. Life today is too complicated; I would prefer the simpler life of the past.					
48. I prefer friends who are spontaneous rather than predictable.					
49. I like family rituals and traditions that are regularly repeated.					
50. I think about the bad things that have happened to me in the past.					
51. I keep working at difficult, uninteresting tasks if they will help me get ahead.					
52. Spending what I earn on pleasures today is better than saving for tomorrow's security.					
53. Often luck pays off better than hard work.					
54. I think about the good things that I have missed out on in my life.					
55. I like my close relationships to be passionate.					
56. There will always be time to catch up on my work.					

C:\1stanfrd\Winter97\ZTPI.doc
January 1997

(Zimbardo & Boyd, 1999)

APPENDIX I

HeartMath Certified Practitioner Certificate



HeartMath

Certifies that

Yih Shyang Sim Andy, MSocSc

has successfully met the standards established in the
HeartMath Interventions Program
and in so doing has earned recognition as a

HeartMath® Certified Practitioner

HMI0508
Certificate #

9/6/2017
Certificate Date

9/5/2020
Expiration Date

Deborah Rozman
Deborah Rozman, Ph.D., CEO, HeartMath LLC

R McCraty
Rollin McCraty, Ph. D., Director of Research, Institute of HeartMath

Tricia A. Hoffman
Tricia A. Hoffman, Director, Training and Licensing, HeartMath LLC

HeartMath is a registered trademark of the Institute of HeartMath.

APPENDIX J

HeartMath Certified Trainer Certificate

HeartMath® Institute

HeartMath®

Sim Yih Shyang Andy

is hereby a licensed

HeartMath® Certified Trainer

and has successfully completed

The HeartMath Certified Trainer Program

on February 11, 2019

Sara Childre

President
HeartMath Institute

HeartMath is a registered trademark of Quantum Intech, Inc.
For all other HeartMath trademarks go to www.heartmath.com/trademarks

Deborah Rozman

Chief Executive Officer
HeartMath Inc.

APPENDIX K

HeartMath Photoplethysmographic Monitor

Also used as the Inner Balance Monitor

(HeartMath Institute, 2019)

APPENDIX L

Heart Lock-In Technique

Heart Lock-In® Technique

The Heart Lock-In Technique is a powerful method for helping you shift your baseline to create beneficial and sustained changes at the physiological level, which is imperative for building a new baseline of resilience.

Activating and sustaining coherence trains the nervous system to a new "normal." The nervous system begins to recognize this more resilient and energy-efficient state as the familiar one, so it becomes your new internal set point: In other words, it becomes more automatic.

Building a new baseline is similar to laying a new foundation or downloading a new operating system. In practical terms, it means that things that once triggered you don't get under your skin as easily. You "operate" from a new set point. You also may find you have more energy and that you flow through your day, handling what comes up with greater ease.

Heart Lock-In Technique

Step 1. Focus your attention in the area of the heart. Imagine your breath is flowing in and out of your heart or chest area, breathing a little slower and deeper than usual.

Step 2. Activate and sustain a regenerative feeling such as appreciation, care or compassion.

Step 3. Radiate that renewing feeling to yourself and others.

Use the Heart Lock-In Technique for 5 to 15 minutes several times a week to sustain and build your coherence baseline. It helps to accumulate energy and recharge your emotional system.

Heart Lock-In Quick Steps

- **Heart-Focused Breathing**
- **Activate a regenerative feeling**
- **Radiate**

(Institute Of HeartMath, 2014)

APPENDIX M

Completion of CITI Training Certificate

CITI PROGRAM

Completion Date 19-May-2019
Expiration Date 18-May-2022
Record ID 31509699

This is to certify that:

Yih Shyang Sim

Has completed the following CITI Program course:

Human Subjects Research (HSR) (Curriculum Group)
Doctoral Students (Course Learner Group)
1 - Basic Stage (Stage)

Under requirements set by:

California Southern University

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?w4b1cba69-722f-4f0d-902f-ba136e17fc74-31509699

Doctoral Project Assessment Rubric

Student: Yih Shyang Sim **Committee Chair: Dr. Daniel Levinson**	**Date:**				
	Rating Scale				
Second Member: **Third Member:**	**4 Outstanding**	**3 Very Good**	**2 Acceptable**	**1 Unacceptable**	
Holistic Assessments	**L-Learner**	**1-Chair**	**2-2d Member**	**3-3d Member**	**Comments**
The doctoral project follows a professional scholarly appearance	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Correct grammar used with proper punctuation, spelling, and APA formatting	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Written in a scholarly language that is clear, precise, and logically organized	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Abstract					
Abstract follows APA guidelines.	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Chapter One - Introduction					
The introduction Includes a clear problem statement	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Presents issues or challenges related to the problem –Background of the Problem	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Describes the context in which the question arises – Statement of the Problem	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Describes the purpose of the study	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
The research question to be addressed is clearly presented	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Articulates benefits of the study or contribution-Significance	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Provides a roadmap for readers	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Chapter Two - Review of Selected Literature					
The review Is comprehensive and current (5 years)	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Shows a command of the literature	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	

Highlights issues/concerns from the current literature	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Includes a discussion of the literature that is selective, thematic, and reflects synthesis	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Chapter Three - Research Design & Methodology					
The methods applied or developed are appropriate	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
An understanding of the methods' advantages/disadvantages are clearly presented	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
In alignment with the question addressed and the theory	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Instruments (Protocols) detailed and presented	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Data Collection Procedures are detailed and clear	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Data Analysis is sound and clearly described	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Chapter Four - Results					
Results logically interpreted	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Aligns with the research questions	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Reflects application of results with theoretical framework	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Chapter Five - Discussion					
Asserts findings clearly from results and with detail	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Findings linked to literature	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Highlights alignment or misalignment with Theoretical Framework	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Modifications to Limitation or Delimitations highlighted	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Implications for Practice linked to findings and detailed	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Recommendation for Research to extend or improve study	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	
Conclusion is insightful and compelling and clearly articulates the significance of the research	4 3 2 1	4 3 2 1	4 3 2 1	4 3 2 1	