9-2022

Biology Through the Lens of Trauma: An Empirical Review of Trauma Treatments

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by

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A Project submitted in partial satisfaction of
the requirements for the degree
Doctor of Psychology

September 2022

Each person whose signature appears below certifies that this project in his/her opinion is adequate, in scope and quality, as a project for the degree Doctor of Psychology.

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ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Dr. Arechiga for pitching me this brilliant idea during my time with LLU School of Behavioral Health's International Trauma Team in Samoa. Thank you for inspiring me to always remain curious in the midst of challenging biological uncertainties. I would also like to thank Dr. Vermeersch for taking a chance on me during interview day and continually supporting me throughout my endeavors in graduate school. Lastly, to my family, friends, and Mr. Luiz who through their love, understanding, and reassurance I have been able to persevere.

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ABBREVIATIONS

PTSD	Post-traumatic Stress Disorder
HPA	Hypothalamic-Pituitary-Adrenal
SAM	Sympathomedullary Pathway
CRH	Corticotrophin-Releasing Hormone
ACTH	Adrenocorticotropic Hormone
GAS	General Adaptation Syndrome
ACE	Adverse Childhood Experiences
APA	American Psychological Association
CBT	Cognitive Behavioral Therapy
CT	Cognitive Therapy
CPT	Cognitive Processing Therapy
PE	Prolonged Exposure
BEPP	Brief Eclectic Psychotherapy for PTSD
NET	Narrative Exposure Therapy
EMDR	Eye Movement Desensitization and Reprocessing
AIP	Adaptive Information Processing
SE	Somatic Experiencing
CRN	Core Response Network
SP	Sensorimotor Psychotherapy
TRM	Trauma Resiliency Model
CRM	Community Resiliency Model
DHEA	Dehydroepiandrosterone

SBP	Systolic Blood Pressure
DBP	Diastolic Blood Pressure
HR	Heart Rate
HRV	Heart Rate Variability

ABSTRACT OF THE DOCTORAL PROJECT

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by

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Doctor of Psychology, Graduate Program in Psychology
Loma Linda University, September 2022
Dr. David A. Vermeersch, Chairperson

The present literature review aims at mending the research to practice gap for the treatment of Post-Traumatic Stress Disorder (PTSD). Biological mechanisms of the stress response system are explored as they pertain to trauma and its subsequent effects on the brain and body. In addition, American Psychological Association (APA) recommended evidence-based treatments for PTSD are reviewed as well as more recent emerging somatic therapies. There is a critical need for further development in the area of both top-down and bottom-up interventions. Biological working mechanisms remain unknown for a majority of treatments and physiological measures are scarcely used in treatment outcome research. Somatic therapies contribute beneficial knowledge to the field of trauma treatments, suggesting that physiology may provide additional entry points in therapy. Future directions and clinical implications on the treatment of PTSD are discussed.

CHAPTER ONE

INTRODUCTION

The word trauma, as it pertains to psychological injury, has carried varying connotations in the literature. Achieving a consensus on the definition of trauma has proven difficult due to its altering magnitudes, complexities, and frequencies. Moreover, a stressor cannot be easily distinguished from a traumatic stressor as it is subjective in nature (Courtois & Ford, 2009). Taking into account subjective appraisals, trauma can be defined simply as an event that provokes an individual's perception of threat onto either themselves or others (Miller-Karas, 2015). What is perceived as traumatic to one person, may not be perceived as traumatic to another. Moreover, some individuals may be impacted by a trauma without having experienced the event firsthand. This phenomenon has been termed vicarious trauma and is commonly found in helping professionals (e.g., first responders, law enforcement, social workers) (Miller-Karas, 2015) .

Types of Trauma

Based entirely on social constructs, trauma can be categorized into two types: large "T" traumas and small "t" traumas. Large "T" traumas typically include notable events such as child abuse, sexual assaults, acts of terrorism, or natural disasters. Small "t" traumas on the other hand are viewed as non-life-threatening and typically include adverse life events (e.g., divorce, bullying, infidelity, financial difficulty). It is possible for an individual to accumulate small "t" traumas or a variation of both trauma types overtime, resulting in major traumatic stress reactions (Miller-Karas, 2015).

The term, cumulative trauma, has been inconsistently defined in the literature and can be circumscribed into three distinctive definitions. Cumulative trauma may be described as the number of specific types of trauma experienced throughout one's lifetime (e.g., having experienced both an accident and a natural disaster), the number of times the same type of trauma has been experienced over a length of time (also known as "polyvictimization" in instances of abuse), and the total number of traumatic exposures accumulated over one's lifetime and across all types of trauma (e.g., having experienced three traumatic events) (May & Wisco, 2016). In more recent years, the aggregation of suppression and discrimination (e.g., racism, poverty, and homophobia) has also been used to describe cumulative trauma (Miller-Karas, 2015).

Post-Traumatic Stress Disorder (PTSD)

The most recent version of the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychological Association, 2013) identifies the diagnosis of Post-Traumatic Stress Disorder (PTSD) as meeting five main criteria. Criterion A of the DSM-5 requires that an individual be exposed to actual or threatened death, serious injury, or sexual violence. This exposure may be both direct and indirect in nature and can include vicarious trauma exposures. Criterion B requires the presence of intrusive symptoms which may include distressing memories or dreams of the traumatic event, flashbacks, marked psychological distress, and physiological reactions to cues of the traumatic event. Criterion C requires efforts to be made by the individual to avoid distressing associations of the traumatic event (i.e., thoughts, memories, external reminders) and criterion D includes alterations in cognitions and mood after the traumatic event (i.e., poor memory recall, distorted thinking, persistent negative emotional states).

Lastly, criterion E consists of variations in arousal and reactivity after experiencing the traumatic event. This may include hypervigilance, an exaggerated startled response, anger outbursts, and disturbances in sleep. To meet diagnostic criteria, the symptoms stated above must last more than one month and cause significant impairment in daily functioning (American Psychological Association, 2013).

CHAPTER TWO

BIOLOGY OF TRAUMATIC STRESS

Trauma and the Nervous System

> There are no disembodied minds. Accordingly, no psychological theory is completely independent of physiology.
>
> -Rubinstein (1965)

The symptoms of PTSD appear to reflect a dysregulation of neurobiological systems that accompany traumatic stress. Therefore, an exploration of biological mechanisms is warranted to better understand such effects.

Vagus Nerve

The tenth cranial nerve of the parasympathetic nervous system, referred to as the vagus, is a channel with three vagal pathways consisting of sensory fibers and two types of motor fibers. These fibers function in connecting the brain to the body. The sensory fibers of the vagus terminate in the nucleus of the solitary track of the brainstem and bring information from the viscera to the brain. Approximately 80% of the fibers in the vagus nerve are sensory. The motor fibers of the vagus nerve bring information from the brain to the viscera and consist of two categories: unmyelinated and myelinated (Figure 1).

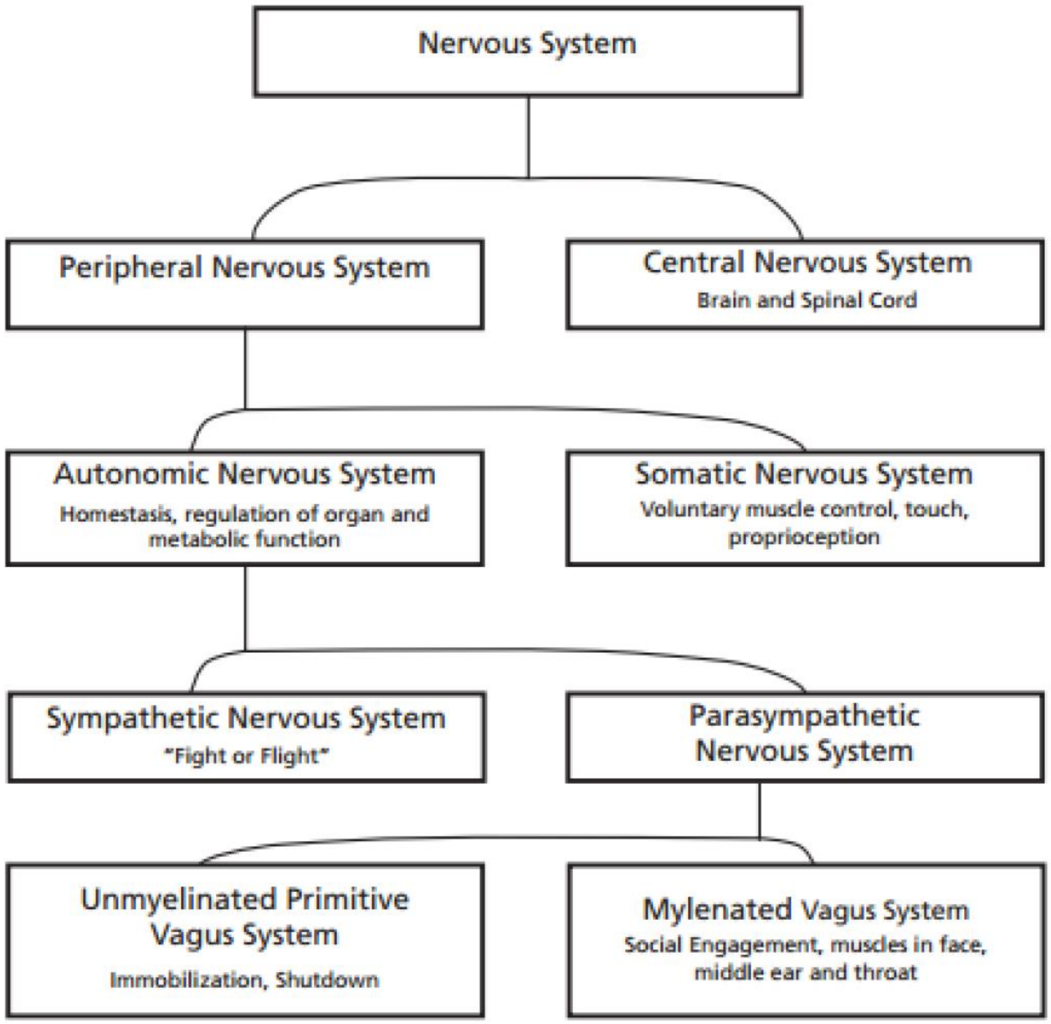

Figure 1. Components of the Vagus Nerve. Adapted from *In an Unspoken Voice* (p. 99), by P. Levine, 2010, Berkeley, CA: North Atlantic Books and ERGOS Institute Press.

The motor fibers of the unmyelinated vagus (also known as the subdiaphragmatic vagus) originate predominantly in the dorsal nucleus of the vagus and travel primarily below the diaphragm, providing vagal regulation of organs such as the gut. The unmyelinated vagus is assumed to be an older circuit, having been the first to evolve, and sharing resemblance to reptiles. Homeostasis is supported by the unmyelinated vagus when an individual is judged to be in a safe environment, however in the face of threat this older defense system supports immobilization. Immobilization is characterized by a conservation of metabolic resources and is behaviorally manifested as a bodily shutdown.

The motor fibers of the myelinated vagus (also known as the supradiaphragmatic vagus) originate predominantly in the nucleus ambiguous and travel primarily above the diaphragm, providing vagal regulation of organs such as the heart. Approximately one-sixth of the motor fibers of the vagus are found to be myelinated. The myelinated vagus is assumed to be a newer, uniquely mammalian, circuit. Due to its myelination, it is more rapid in transferring information and contains more tightly organized responses. Moreover, the myelinated vagus is linked to the brainstem area that regulates the muscles of the face and head and is associated with the social engagement system which is recognized to support social behavior and emotion regulation (Porges, 2011, 2017).

Neuroception

Polyvagal theory, originated by Stephen Porges, proposes an underlying neural process that assesses risk without our conscious awareness (Porges, 2004) . This mechanism has been termed neuroception and is key to understanding polyvagal theory. According to Porges, neuroception takes place in primitive parts of the brain (i.e., subcortical limbic structures) through the processing of sensory information from the environment and the viscera which precedes our cognitive assessments of risk (Fosha & Siegel, 2009). At this time, the exact neural circuits in determining safety and threat are not recognized, however it is proposed that feature detectors of the temporal cortex may be involved (Porges, 2017).

Porges theorized that the nervous system unconsciously attempts to shift into the physiological state that encourages the greatest adaptable behavior. As a result, changes in autonomic state are made to appropriately interact with the detected cues in the environment. Identical life circumstances may evoke different reactions such that individuals triggered by the same event may experience different neuroception reactions and subsequent shifts in physiological states. Porges also identified that our systems may be vulnerable to faulty neuroception in which risk is detected when there is in fact safety and where safety is detected when there is risk (Porges, 2011, 2017).

States of Autonomic Nervous System

Polyvagal theory dismisses the notion that the autonomic nervous system is solely a paired antagonistic system and instead proposes a hierarchy, classified as a function of evolution, in which older circuits are inhibited by newer circuits. Under this proposed system, the two vagal circuits (i.e., myelinated and unmyelinated) of the parasympathetic nervous system work in harmony with the sympathetic nervous system enabling us to enhance physiological processes and health. However, in the fact of threat, the regulation of the autonomic nervous system successively transpires to older circuits as an adaptive attempt at survival.

There are three broad hierarchical physiological states as described by polyvagal theory: safety, danger, and life threat. Comprising the safety state, the social engagement system is activated under the newer myelinated vagus and the individual has access to the neural regulation of their facial muscles. In addition, the myelinated vagal circuit downregulates defensive responses and individuals are better able to foster social interactions. Comprising the danger state, mobilization is activated under the sympathetic nervous system which results in a fight-or-flight response. Moreover, the functions of both the myelinated and unmyelinated vagus are down regulated by sympathetic activation at this state. Comprising the life threat state, immobilization is activated under the older unmyelinated vagus which results in a freeze response. In response to life threat, both the myelinated vagus and sympathetic nervous system are down regulated, allowing the unmyelinated vagus to be recruited for defense. This freezing response has been well documented in animals, however in more recent years, this temporary state of motor inhibition has been referred to as "tonic immobility" in humans (Abrams, Carleton, Taylor, & Asmundson, 2009; TeBockhorst, O'Halloran, & Nyline, 2015).

As previously stated, the nervous system is continually evaluating risk via neuroception, resulting in shifts of physiological states which are typically involuntary and transpire in a reflexive manner. When faced with a threat or challenge, the newer myelinated vagus attempts to negotiate safety using the social engagement system. When this proves to be unsuccessful, the body shifts to either a mobilized (i.e., sympathetic nervous system, fight-or-flight response) or immobilized state (i.e., unmyelinated vagus, freeze response) dependent on assessment of the environment.

If the immobilization circuit is induced for defense and the threat has subsided, the nervous system does not have an efficient pathway to break out of a state of life threat. According to Porges, this is primarily due to failure of mammals to effectively evolve from shifting between states of immobilization to mobilization or immobilization to social engagement. In addition, individuals may experience symptoms associated with mobilization and remain in a chronic state of danger despite the absence of a threat. Symptoms of PTSD arise when individuals are unable to shift back to a state of safety after having undergone states of danger or life threat. Individuals diagnosed with PTSD may find themselves “stuck” in either a fight-or-flight (i.e., mobilization) or freeze (i.e., immobilization) response. When stuck in these states of mobilization and immobilization, individuals compromise their ability to detect positive social cues and engage in the social engagement system (Fosha & Siegel, 2009; Porges, 2011, 2017).

Tend and Befriend

Often described as the fourth survival strategy, “tend and befriend” is another state worth noting when discussing trauma. It has been found that women have the capacity to attend to children and seek social affiliations for protection by overriding the fight or flight response through the release of a hormone oxytocin. The release of oxytocin during “tend and befriend” may also increase a woman’s chances of survival during an encounter with an aggressor. Although primarily found in women, some men are also prone to this survival state (Miller-Karas, 2015; Taylor et al., 2000).

The Body Under Traumatic Stress

Biological Stress Response System

The body's biological stress response is facilitated by the limbic system which serves to regulate survival mechanisms and emotional behaviors. The limbic system assesses a situation and in the perception of threat releases hormones that prepare the body for defensive action by signaling an alarm from the amygdala to the hypothalamus (Figure 2). The hypothalamus then begins the simultaneous activation of two systems: the Hypothalamic-Pituitary-Adrenal (HPA) system and the Sympathomedullary Pathway (SAM). The HPA system serves as a slow acting response in comparison to the faster reaction facilitated by the SAM. In the fast-acting SAM pathway, the hypothalamus activates the sympathetic nervous system which stimulates the adrenal medulla (a section of the adrenal gland) in releasing epinephrine and norepinephrine (also known as adrenaline and noradrenaline) to mobilize the body for fight-or-flight. In the slower acting HPA system, the hypothalamus releases a corticotrophin-releasing hormone (CRH) that stimulates the pituitary gland to release adrenocorticotropic hormone (ACTH) which in turn activates the adrenal cortex (another section of the adrenal gland) to release a hydrocortisone, namely cortisol. Typically, when the threat has passed, high levels of blood cortisol exert a negative feedback, resulting in the cessation of the stress response, halting hypothalamic production of CRH, and allowing homeostasis of the system to return (Bremner, 2002; Rothschild, 2017).

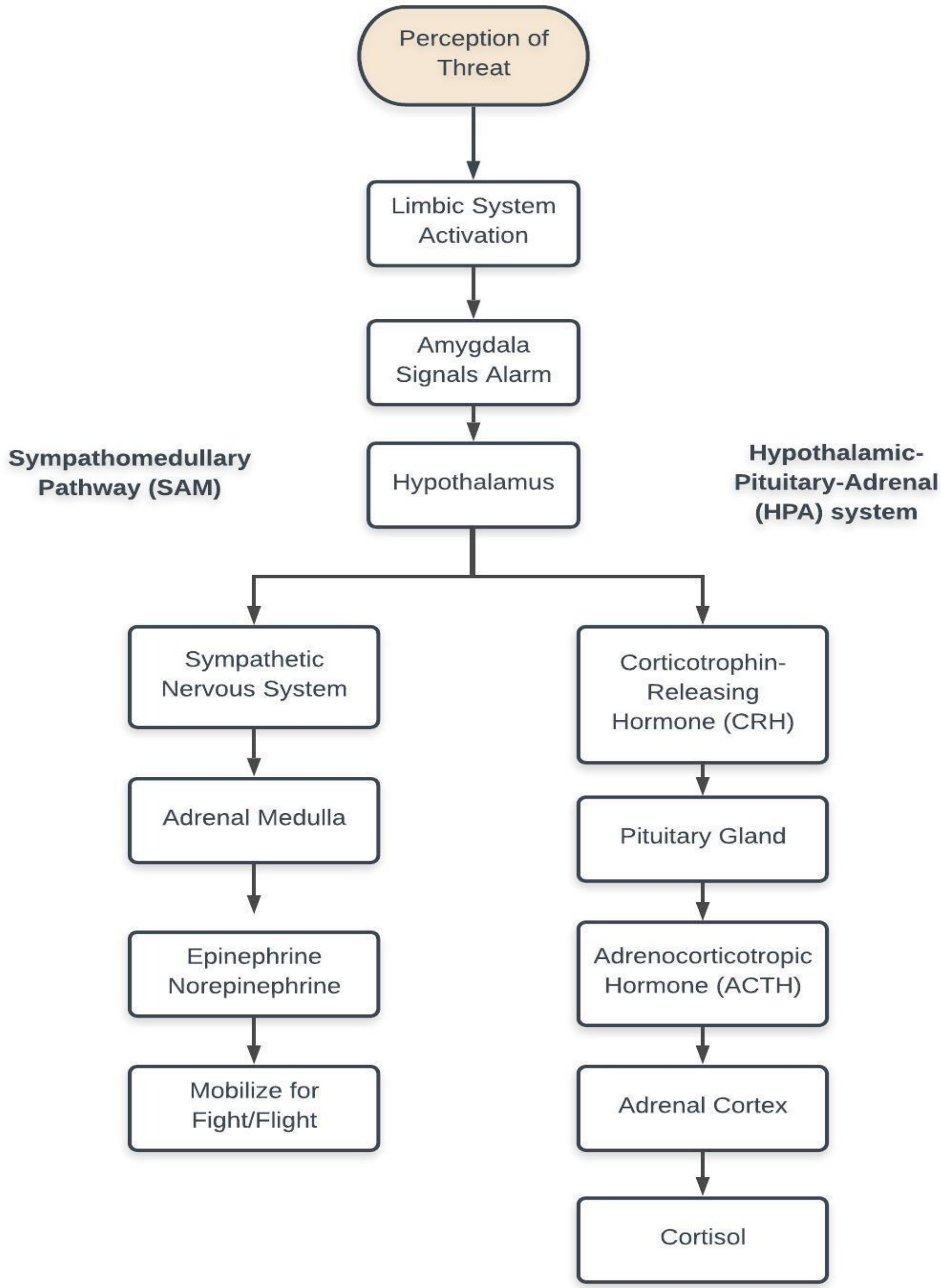

Figure 2. Biological Stress Response System. Created by Adela Gharabeki.

Dysregulation of Stress Response System

Hans Selye, an endocrinologist who studied the side effects of what is now termed stress, found similarities in reactions of stress regardless of type of stressor or circumstance. Moreover, he signified that the reaction was not exclusive to a specific stimulus but rather part of a more universal response to stressful encounters. He compiled this collection of responses and developed a stress model which he termed the general adaptation syndrome (GAS). The GAS is comprised of three distinct stages of physiological response: the initial alarm reaction stage, the resistance stage, and the exhaustion stage (Selye, 1976).

The first phase of the GAS is the initial alarm reaction to threat. During this stage the sympathetic nervous system is activated, and stress hormones are released as the individual prepares itself for fight-or-flight. During this phase, heart rate and blood pressure rise, breathing becomes rapid, digestion slows, pupils dilate, and salvation decreases (Figure 3) (Miller-Karas, 2015).

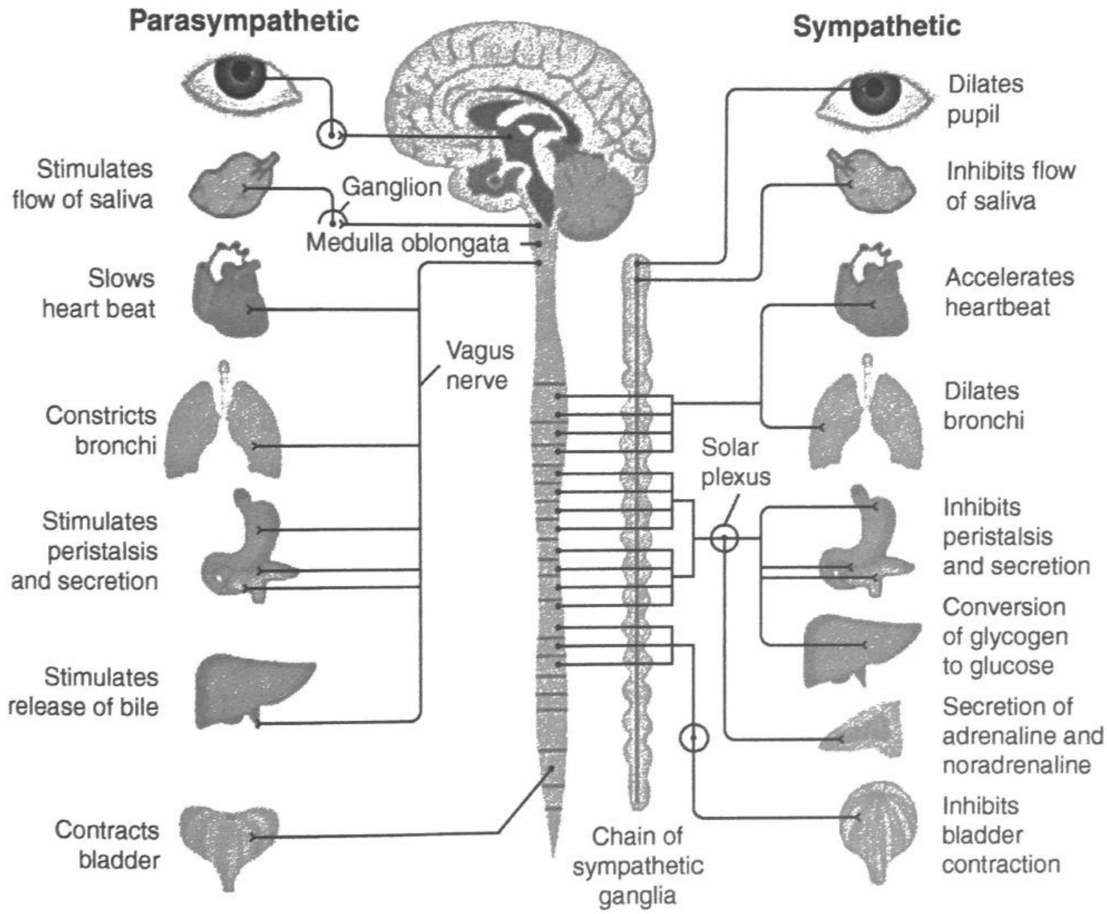

Figure 3. Autonomic Nervous System. Adapted from *Building Resilience to Trauma* (p. 35), by E. Miller-Karas, 2015, New York, NY: Routledge.

The second phase of the GAS is the resistance stage. During this stage the parasympathetic nervous system serves to counteract the physiological effects brought on by sympathetic activation. The parasympathetic nervous system attempts to restore homeostasis, which is the default state in which bodily functions are in equilibrium. During this phase, outcomes of the hormonal changes which transpired during the initial alarm reaction stage remain evident (i.e., increased glucose levels, higher blood pressure). If the stressful encounter has come to an end, stress hormone levels begin to return to baseline (i.e., reduction of cortisol production) and the body is able to shift from a focus of alertness to one of repair, continuing its recovery. During recovery the heart rate and breathing slowly begin to return to baseline, digestion and salivation increase, pupils begin to constrict, and perspiration decreases (Figure 3) (Miller-Karas, 2015). However, if the stressful encounter remains, stress hormone will continue production, and the body will stay in a state of alertness.

The final phase of the GAS is the exhaustion stage. According to Selye, the exhaustion stage only occurs if the resistance phase is not followed by recovery (i.e., the stressful encounter remains, and the body stays in a state of alertness). Over time, as the stress continues, the body begins to deplete its resources and fails to cope with the stimulus. This gradual deterioration is characteristic of the exhaustion stage as the body loses its ability to combat the persisting stress. The exhaustion stage has commonly been referred to as an entry point to burnout or stress overload. As a result, the harmful impact of stress begins to show and the individual is at risk of developing stress-related health conditions if the stress is not resolved (Selye, 1976). Certain symptoms found in individuals diagnosed with PTSD may be linked to the exhaustion stage of the GAS due to the persistent nature of traumatic stress.

Eustress vs. Distress

Stress is not what happens to you, but how you react to it.

-Hans Selye (1974)

Upon looking at the impact of stress, Selye recognized that individual differences were apparent such that a stressful situation to one person may not be experienced similarly by another (Selye, 1950). He recognized that these distinctions in stress reactions were due to individual's perceptions and emotional responses (Szabo, Tache, & Somogyi, 2012) and he later coined the terms "eustress" and "distress" to distinguish such differences (Hans Selye, 1974). Eustress (also known as good or positive stress) is characterized as an exciting and invigorating feeling where an individual is motivated and focuses their energy on a given task, thus improving their performance. Distress (also known as bad or negative stress) is characterized as an anxiety provoking and generally unpleasant feeling where an individual is typically unmotivated or displaces their energy on a given task, decreasing their performance as a result. Distress has commonly been associated with both physical and psychological consequences (Anisman, 2015; Bremner, 2002; Schnurr & Green, 2004).

Given that perception serves an important role in determining whether a situation is categorized as eustress or distress, a person's self-efficacy (their perceived coping ability) becomes an essential determinant. In other words, is the individual perceiving the stressor as a negative threat or a positive challenge? Often times, individuals diagnosed with PTSD experience a decrease in self-efficacy such that they deem themselves incapable of handling problems or do not rely on their bodies to take control of a situation (Benight & Bandura, 2004). Furthermore, it is recognized that an overaccumulation of either type of stress is detrimental to an individual's health. As a result, an optimal balance of stress is necessary for healthy functioning. This can be seen as depicted in the Yerkes-Dodson model which proposes an optimal balance of stress represented as a bell-shaped curve (Yerkes & Dodson, 1908).

Allostatic Load

Neuroendocrinologist Bruce McEwen sought to determine the cause of individual differences found in stress reactions as well as attain an explanation as to why systems that react to stress tend to protect the body in the short run but injure and accelerate disease when continually activated. He found that individuals' response to potentially-stressful conditions differed in primarily three aspects including their interpretation of the event (based on their personal experiences), the condition of their body (based on their genetics), and their stress coping behaviors (e.g., diet, alcohol consumption, smoking) (McEwen, 2000).

During his search, McEwen proposed a reinterpretation of Selye's GAS to include concepts he termed allostasis and allostatic load (McEwen, 2005). According to McEwen, when the body encounters a stressor, it adapts to maintain homeostasis through a process called allostasis. He coined the term "allostatic load" to refer to the cumulative effects of allostasis, resulting in the wear and tear on regulatory processes of the body.

McEwen interpreted Selye's first phase of the alarm response as the mechanism leading to allostasis, in which various stress hormones support adaptation to the stressor. In addition, he interpreted Selye's third phase of exhaustion as an accumulation of allostatic load by which the alarm response remains active and allostasis is sustained, resulting in adverse effects on the body (McEwen, 2005). Furthermore, McEwen identified four different types of allostatic load which include continual exposure to multiple different stressors, a lack of adaptation, a prolonged stress response due to delayed shut down, and an insufficient stress response that leads to compensatory overactivity of other facilitators within the body (McEwen, 2000).

Adverse Childhood Experiences (ACEs)

The Adverse Childhood Experiences (ACEs) study conducted by Kaiser Permanente in accordance with the Center of Disease Control and Prevention (CDC) from 1995 to 1997 found various associations between childhood abuse and/or household dysfunction and its long-term impact on adult health risk behaviors, disease, and quality of life ("Adverse Childhood Experiences (ACEs)," 2019). The study included responses to a questionnaire which asked about adverse childhood experiences and completion of a standardized medical evaluation. The questionnaire contained categories of childhood abuse which included psychological, physical, or sexual abuse as well as categories of exposure to forms of household dysfunction while growing up which included violence against mother; or living with household members who were substance abusers, mentally ill or suicidal, or ever imprisoned. Researchers found that the number of adverse childhood exposures had a graded positive correlation between adult health risk behavior (e.g., alcoholism, depression, smoking, severe obesity) and adult disease (e.g., cancer, liver disease, heart disease, lung disease) (Felitti et al., 1998).

Two mechanisms have been proposed to explain the connection found between adverse childhood experiences and the emergence of adult disease. The first mechanism is that disease is a result of a delayed consequence of coping behaviors such that adverse childhood experiences lead to mental health conditions (e.g., anxiety, depression) in which individual's cope through the use of risky health behaviors (e.g., smoking, drug use, overeating). Chronic use of these coping behaviors is thought to lead to the development of disease. The second mechanism proposed is that disease is a result of chronic stress accumulation that is brought on by adverse childhood experiences (Felitti, 2009). This is in agreement with Hans Selye's GAS and the concept of allostatic load proposed by McEwen.

The Brain Under Traumatic Stress

> The areas of the brain that are the most sensitive to stress are the same systems that we call upon for survival
>
> -Bremner (2002)

A detailed account of neurological revelations pertaining to traumatic stress and the brain is beyond the scope of this paper; however, several key findings are highlighted.

Hippocampal Damage

The long-term changes in stress response systems experienced by some individuals who have undergone trauma in their lives, can successively affect their memory functioning. The hippocampus plays a critical role in memory and is believed to be responsible for acting as a “spatial map” that locates the memory of an event to time, place, and context. When the hippocampus experiences damage through long term activation of the stress response system, it may result in the interruption of normal memory, consciousness, or identity (Bremner, 2002).

With chronic stress comes a dysregulation of stress hormones (i.e., norepinephrine, epinephrine, and cortisol) which can result in distortions and other changes in memory. Typically, during instances of threat, norepinephrine and epinephrine can adaptively strengthen the placing of memories whereas cortisol can inhibit these processes. However, with long term exposure to stress, glucocorticoids, such as cortisol, have been associated with damage to the hippocampus, resulting in memory deficits. Moreover, studies have shown a decrease in hippocampal volume in individuals diagnosed with PTSD (Bremner, 2002). One explanation for this hippocampal atrophy is that elevated glucocorticoids may suppress the capability for neuronal regeneration of the hippocampus (Bremner, 2002). Suppression of hippocampal functioning can also result in the impairment of the spatial map, producing the context-free fearful associations commonly found in patient’s diagnosed with PTSD (van der Kolk & van der Hart, 1995).

Heightened Activation of Amygdala

In instances of arousal, the hormones released during the stress response heighten activation of the amygdala. It is understood that during low levels of arousal, the amygdala supports hippocampal learning and promotes neural plasticity. However, during high levels of arousal, the amygdala has been found to interrupt hippocampal learning and instead promote fear-based amygdala learning. This heightened activation of the amygdala during instances of high arousal is theorized to produce the reinforcing and escalating characteristics found in traumatic memories (Cozolino, 2010).

Dysregulation of Hippocampal-Amygdaloid Circuits

The amygdala is viewed as an important mechanism in the emotional and somatic organization of experience, whereas the hippocampus is viewed as an essential component of consciousness and logical functioning. Furthermore, the amygdala is suggested to heighten awareness in a generalized manner and direct attention to particular notions of the environment, whereas the hippocampus is suggested to be discriminatory, moderating amygdala activation by inhibiting stimulus input, attention, and responses. Optimal learning and functioning require a balance of the roles of the amygdala and hippocampus. During instances of high arousal, the hippocampal-amygdaloid circuit may become dysregulated, resulting in the disconnect of amygdala and hippocampal processing. In addition, weakening of the hippocampus may result in the intensified influence of the amygdala in guiding memory, affect regulation, and behavior. This phenomenon has been termed "amygdala hijacking" and has been proposed to inhibit executive functioning (Cozolino, 2010).

Integration of Information

Triune Brain

Paul D. MacLean, a physician and neuroscientist, proposed three organizational levels of the brain which he termed the triune brain (sometimes referred to as the brain within a brain within a brain). The three structures encompassing the triune brain include: the reptilian brain (also known as the survival brain), the limbic brain (also known as the paleomammalian brain), and the neocortex (Figure 4). MacLean presumed an evolutionary perspective and theorized that the reptilian brain resembles the core of the brain and was the first to develop. According to MacLean, the reptilian brain governs arousal, homeostasis, and reproductive drives and emphasizes primitive intrinsic mechanisms. The limbic brain, on the other hand, is related to emotional processing and is said to be found in mammals. It surrounds the reptilian brain and facilitates emotion, memory, regions of social behavior, and learning. MacLean theorized that the neocortex was the last to develop phylogenetically and that it included a large portion of the corpus callosum which is responsible for bridging the two hemispheres of the brain and helping consolidate information. The neocortex is presumed to enable cognitive information processing in areas such as self-awareness and conscious thought and encloses both the reptilian and limbic brain (Ogden, Minton, & Pain, 2006).

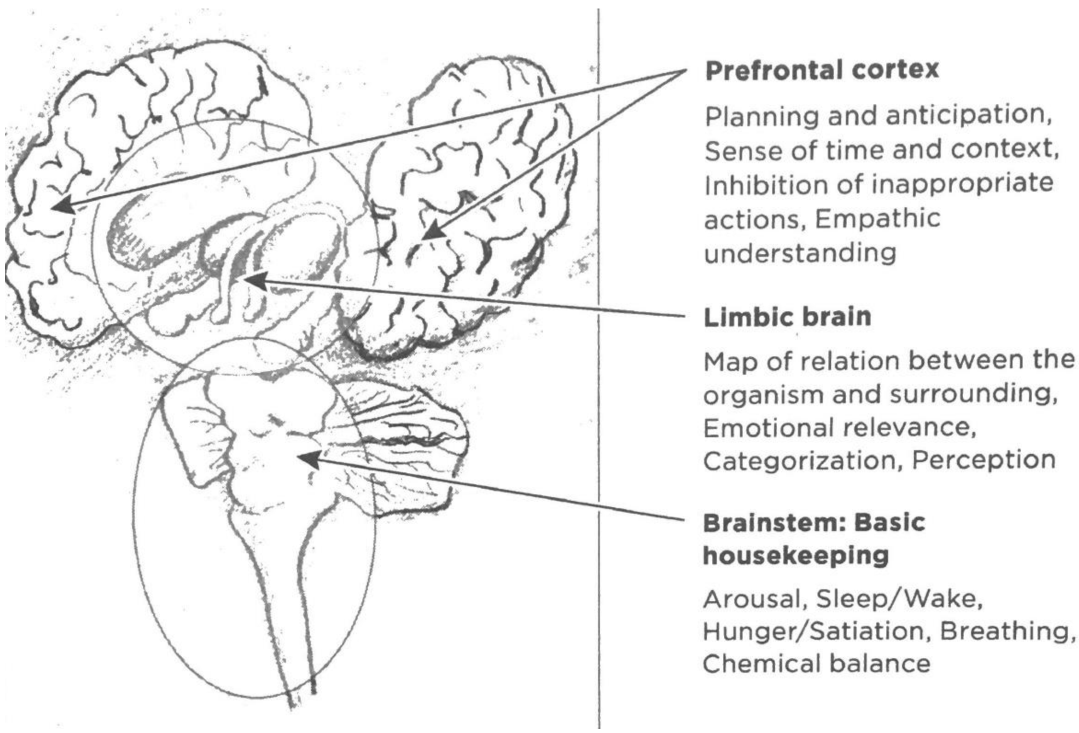

Figure 4. Triune Brain. Adapted from *The Body Keeps the Score* (p.59), by B. van der Kolk, 2014, New York, NY: Penguin Books.

Distinctive types of knowledge have been devised from each of these brain levels. The reptilian brain is stated to produce innate behavioral knowledge which include basic intuitive action tendencies related to primitive survival tasks. The limbic brain constructs affective knowledge which include subjective feelings and emotional reactions to events of daily life. The neocortex generates declarative knowledge which include factual information about the world (Newman & Harris, 2009; Ogden et al., 2006). Furthermore, it has been noted in the literature that abrupt emotionally charged events do not initially engage in complex reasoned decision making typically found in higher cortical areas, but instead respond rapidly at a sub-cortical level (Cozolino, 2010; Levine, 2010; Payne, Levine, & Crane-Godreau, 2015; Raio, Orederu, Palazzolo, Shurick, & Phelps, 2013; van der Kolk, 2014).

Hierarchical Information Processing

Sharing similarities to MacLean's triune brain, Ken Wilber, a writer of transpersonal psychology and integral theory, proposed a hierarchical information processing which describes the operational hierarchy of three evolutionarily based levels: sensorimotor, emotional, and cognitive. These three levels of information processing can be loosely associated with the three levels of brain construction proposed by MacLean such that the reptilian brain can be associated with the sensorimotor level of information processing, the limbic brain can be associated with the emotional level of information processing, and the neocortex can be associated with the cognitive level of information processing.

According to Wilber, the brain functions as an integrated whole consisting of hierarchically organized systems such that lower structures of the brain are conceptualized as developing before the higher-level structures. The higher brain structures are believed to be responsible for thought, perception, interpretation, language, and learning whereas the lower brain structures are believed to be responsible for sensory integration and intersensory association (Ogden et al., 2006). In addition, the functioning and growth of higher-level structures are considered to be dependent on the functioning and growth of lower-level structures. Sensorimotor information processing serves foundational to the other two types of information processing and acts more primitive than its evolved counterparts. Due to its association with older brain structures, it is more directly linked to overall body processing (e.g., changes in breathing and muscular tone) and is governed by various fixed sequences (e.g., autonomic nervous system activation).

The feedback between layers of information processing are regarded as bidirectional such that cognitive and emotional information processing influences the body, and sensorimotor processing influences cognitions and emotions (Ogden et al., 2006; Wilber, 1996, 2000). Moreover, it has been proposed that problems in behavioral state regulation are indicators of problems in autonomic regulation such that difficulties in processing higher cognitive functions are a result of unregulated physiological states (Porges, 2011).

Arousal Impacts Integration

Traumatic events have been shown to synthesize differently in the brain when compared to mundane sensory events (Nijenhuis, Hart, & Steele, 2004; van der Kolk, 2014; van der Kolk & van der Hart, 1995). During the encoding of traumatic events, sensorimotor and emotional experiences appear to remain unintegrated with cognitive levels of experiencing, thus producing a failure in routine information processing (Ogden et al., 2006; van der Kolk & van der Hart, 1995). In addition, impairments in the domains of memory have also been linked to a separation in the tracks of sensation, emotion, behavior, and conscious awareness- areas which would have otherwise been integrated (Cozolino, 2010).

Integrative failure is proposed to be a result of excessive levels of stress hormones brought on by intense arousal which subsequently affect the brain regions associated with integrative functions and lead to compartmentalization of experience (Nijenhuis et al., 2004). This compartmentalization of experience can be witnessed in instances of “speechless terror”, a term coined by Bessel van der Kolk to describe individuals who are unable to assemble the memory of a traumatic event in words and symbols, but rather organize them on a sensorimotor level (van der Kolk, 2014; van der Kolk & van der Hart, 1995). Failure in personification is another consequence of a lack of integration brought on by overwhelming events. This failure is characterized by a sense of separation from the self and the experience such that the traumatic event appears to remain as factual knowledge with a lack of association to one’s self (Nijenhuis et al., 2004).

CHAPTER THREE

CURRENT APA EVIDENCE-BASED TRAUMA TREATMENTS

Currently, the American Psychological Association (APA) strongly recommends the use of cognitive behavioral therapy (CBT), cognitive therapy (CT), cognitive processing therapy (CPT), and prolonged exposure (PE) for the treatment of PTSD. Moreover, according to their analysis, the use of brief eclectic psychotherapy for PTSD (BEPP), narrative exposure therapy (NET), and eye movement desensitization and reprocessing (EMDR) is conditionally recommend for the treatment of PTSD (American Psychological Association, 2017).

Cognitive Behavioral Therapy (CBT)

Cognitive Behavioral Therapy (CBT) is an umbrella term that encompasses a diverse array of treatments. CBT emphasizes the learned and conditioned relationship between thoughts, feelings, and behaviors. For the treatment of PTSD, CBT aims at reconceptualizing an individual's understanding of the traumatic event, the self, and their ability to cope. CBT functions by reducing maladaptive associations of the traumatic experience and avoidant behaviors. Components of CBT can include psychoeducation on the effects of trauma, cognitive restructuring, exposure of the trauma narrative, behavior change, and development of coping skills (American Psychological Association, 2017).

Cognitive Therapy (CT)

Cognitive Therapy (CT), a derivative of CBT, focuses on recognizing how traumatic experiences alter thoughts and beliefs, and how they can influence the perception of present and severe threat. During CT, the patient identifies relevant evaluations, memories, and triggers of their traumatic experience. The therapist then helps the patient arrive at a different consensus of the trauma through the incorporation of similar strategies found in CBT (e.g., Socratic questioning, cognitive restructuring), however in CT they are emphasized and used differently. This new appraisal is typically incorporated into the patient's narrative through various methods (e.g., written trauma account, imaginal reliving, revisiting the traumatic location) in attempts to minimize re-experiencing and confront maladaptive thinking connected to the trauma (American Psychological Association, 2017; Schnyder & Cloitre, 2015).

Ehlers and Clark's Cognitive Model

Cognitive Therapy can be linked to Ehlers and Clark's cognitive model of PTSD (Ehlers & Clark, 2000, 2008). According to this theory, PTSD is brought on by faulty processes that create a sense of current threat. This experience of current threat is maintained by negative appraisals of the trauma and disruptions in autobiographical memory brought on by selective retrieval of information. In addition, individuals partake in certain dysfunctional cognitive and behavioral strategies (e.g., thought suppression, avoidance of trauma reminders, safety behaviors) which further reinforce feelings of current threat and prevent change (Ehlers & Clark, 2008; Zalta, 2015).

CT aims at addressing distorted thinking and associated maintaining behaviors by 1) creating more adaptive appraisals of the trauma, 2) assimilating memory of the trauma into the patient's autobiographical memory, and 3) reducing maladaptive coping behaviors. Multiple techniques are implemented in CT to reach these goals, some of which include behavioral activation, reconstructing the trauma narrative, and cognitive restructuring.

Cognitive Processing Therapy (CPT)

Cognitive Processing Therapy (CPT), developed by Patricia Resick, is a specific type of CBT that helps individuals learn how to challenge unhelpful thoughts and beliefs relating to their trauma. CPT typically includes psychoeducation about PTSD, teaching approaches to challenge dysfunctional cognitions (e.g., “stuck points”) about the traumatic experience, and encouraging a more adaptive set of beliefs about the self, others, and the world. Moreover, the trauma is processed by encouraging the expression of natural emotions and through the use of a written trauma narrative

During the written trauma narrative exercise, the therapist helps the patient create a new understanding of the traumatic event by allowing the patient to compose a detailed account of their worst traumatic experience, as well as share their existing understanding of why the traumatic event occurred and an impact statement explaining the effect it has had on their belief systems. The patient then attempts to break the pattern of avoidance by reading their statements out loud in subsequent sessions. The therapist works with the patient to alter any dysfunctional thoughts pertaining to the traumatic experience that may arise in session through the use of traditional CBT techniques (e.g., Socratic questioning). Moreover, practice assignments are dedicated outside of session to enforce the use of skills for more adaptive thinking beyond a therapeutic setting (American Psychological Association, 2017; Schnyder & Cloitre, 2015).

Social Cognitive Theory

Cognitive Processing Therapy is founded in social cognitive theory proposed by Albert Bandura which focuses on cognitions and its subsequent effects on an individual's emotions and behaviors (Bandura, 1989; Bandura, 1999). According to social cognitive theory, individuals merge new information with their prior schemata by either assimilation, accommodation, or over-accommodation. Accommodation is considered to be the ideal method of integration where prior schemata are altered enough to incorporate the new information. Both assimilation and over-accommodation have been proposed to maintain dysfunctional cognitions about oneself, others, and the world after a traumatic incident. During assimilation, new information is altered to match the prior schemata whereas during over-accommodation, prior schemata is altered entirely to match the new information (Zalta, 2015). In addition, when individuals are unable to incorporate the experience of trauma into their existing beliefs, their perceptions of control over themselves and their ability to cope with their environment may also become altered (Benight & Bandura, 2004). CPT aims at identifying and revising dysfunctional cognitions found during assimilation or over-accommodation through the use of cognitive restructuring techniques.

Prolonged Exposure Therapy (PE)

Prolonged Exposure (PE), another derivative of CBT, is developed by Edna Foa and aims at confronting fears and breaking the reinforcing behavior of avoidance through gradually approaching the memories, feelings, and situations associated with a trauma. Throughout treatment, patients are taught that the trauma-related memories or cues are not threatening and that there is no need to avoid them. In the initial sessions of PE, patients are provided psychoeducation on treatment, therapists gain a better understanding of patients' past experiences, and breathing techniques are taught to manage anxiety that can arise during exposure exercises.

There are two type of exposures used in PE, namely imaginal and in vivo exposure. In imaginal exposure, the patient repeatedly revisits the traumatic memory by describing the event in detail and in the present tense. Any emotions that come up during the exposure are processed with the therapist. Moreover, the patient is typically recorded during this exercise so that they are able to practice outside of session. During in vivo exposure, the therapist and patient collaboratively identify possible stimuli and triggers of the trauma and devise a plan to gradually confront the feared stimuli outside of session. The patient then challenges their feared stimuli in session (if applicable) or via homework assignments. These exposure exercises are implemented to provide patients with the realization that they are able to tolerate the temporary distress accompanied with confrontation of traumatic memories (American Psychological Association, 2017; Schnyder & Cloitre, 2015).

Emotional Processing Theory

Prolonged Exposure is founded in emotional processing theory (also known as information processing theory) developed by Foa and Kozak (1986) which suggests that emotions are represented in networks of memory. Networks for fear are theorized to contain information about the feared stimuli, the meaning behind that stimuli, as well as its subsequent response (Wachen, Dondanville, Macdonald, & Resick, 2017). Moreover, there is a distinction between normal fear structures and pathological fear structures found in patients with PTSD. It is proposed that the fear structures associated with PTSD contain excessive stimulus and response processes as well as problematic meaning making (Rauch & Foa, 2006; Zalta, 2015). Two types of dysfunctional cognitions associated with PTSD are proposed: 1) the world is entirely dangerous and 2) the self is absolutely incompetent (Foa & Kozak, 1986). The pathological fear structure is maintained through a cyclical pattern of these dysfunctional cognitions that reinforce avoidance behaviors and prevent the input of disconfirming information.

PE aims at modifying the pathological components of the fear network. First the fear network is activated through the use of in vivo and imaginal exposure which hinder avoidance of trauma reminders. Next, more realistic information are integrated into the fear network, thus disconfirming the dysfunctional cognitions that were originally set in place.

Various mechanisms have been proposed that contribute to the effectiveness of PE including perceived helpfulness, modification of dysfunctional cognitions, and distress tolerance (Aaron et al., 2010; Bluett, Zoellner, & Feeny, 2014; Sripada & Rauch, 2015; Zalta, 2015). Despite ambiguity found in the literature, habituation remains the most widely discussed construct when referencing exposure therapies. Habituation, as defined by Foa and Kozak, is a response decrement of a given stimulus. It is argued that habituation does not act as a mechanism of change for PE but rather an indicator of emotional processing such that habituation informs therapeutic process, but is not necessary for treatment benefit to occur (Foa & Kozak, 1986). Fear activation, within-session habituation, and between-session habituation are listed as the three indicators that emotional processing is occurring (Brown, Zandberg, & Foa, 2019). As of to date, data remains conflicted on the necessity of within- and between- session habituation in PE. In addition, the necessity of distress during exposures has been called into question (Aaron et al., 2010; Bluett et al., 2014; Sripada & Rauch, 2015).

Brief Eclectic Psychotherapy for PTSD (BEPP)

Brief Eclectic Psychotherapy for PTSD (BEPP), founded by Berthold Gersons, is a structured 16 session treatment that combines aspects of cognitive-behavioral and psychodynamic therapy. BEPP functions by altering painful thoughts and feelings (paying special attention to feelings of shame and guilt) that are associated with a trauma. In addition, BEPP also emphasizes the therapeutic relationship.

BEPP is intended to be used for individuals who have faced a single traumatic event as each session contains an identified objective. Session one consists of psychoeducation pertaining to PTSD, an overview of treatment expectations, and an intake which includes a brief description of the traumatic event provided by the patient. Sessions two through six consist of an exposure component where the patient speaks about the traumatic event in the present moment and with more detail. Patients are taught relaxation techniques (i.e., progressive muscle relaxation and deep breathing) prior to exposure exercises in order to provide comfort for the patient and in the hopes of increasing concentration during the exposure. The therapist then works with the patient to process any distressing emotions or memories that may arise during these sessions via imaginal exposure. Patients are encouraged to bring in items that trigger memories of the traumatic event. If applicable, homework may also be assigned in which the patient is encouraged to express feelings of anger via a written letter to the person(s) or organizations of whom they hold responsible for the traumatic event or to express feelings of sorrow to lost loved ones. Session seven serves as a check-in point where the patient and therapist work collaboratively in assessing the progress made thus far and any challenges that still remain. Sessions eight through fifteen aim at exploring how the traumatic event has affected the patient's beliefs about the self and the world. During the final sixteenth session, the therapist and patient work collaboratively to produce a relapse prevention plan by reviewing insights gained in prior sessions. A unique aspect of BEPP is that a farewell ritual is held during the last session where the patient acknowledges that the traumatic event and its associated symptoms are now in the past (American Psychological Association, 2017; Gersons, Nijdam, Meewisse, & Olff, 2011).

Theoretical Underpinnings of BEPP

The three central themes of BEPP include acceptance of emotions, understanding the meaning of emotions, and facing the reality of the traumatic event. In BEPP, denial and suppression of emotions are viewed as contributing to the development of pathology and the ability to tolerate and accept emotions is essential for healthy processing of trauma. The high level of arousal associated with PTSD is considered to be a result of the energy taken to suppress and avoid emotions, such that the diminishment of such energy aids in relaxation. Moreover, after acceptance of emotions are established, understandings of emotions, such as grief and anger, begin to emerge. These newly found understandings are viewed as essential components of self-compassion and self-acceptance. Although not a prerequisite in BEPP, some therapists may choose to explore the origins of patients' childhoods to gain insight into their expectations of themselves, others, and the world. Furthermore, patients face the reality of the traumatic event through imaginal exposure exercises. Imaginal exposures differ in BEPP compared to other treatments, as emphasis is put on addressing affective load and discharging emotions linked to the traumatic event. Moreover, posttraumatic growth is emphasized in BEPP such that patients learn to adopt a more realistic view of the world, redefining themselves as both vulnerable and resilient (Gersons, Meewisse, & Nijdam, 2015).

Narrative Exposure Therapy (NET)

Narrative Exposure Therapy (NET), developed in Germany by Maggie Schauer, Thomas Elbert, and Frank Neuner, is a structured intervention that takes aspects of exposure found in cognitive behavioral approaches and combines them with a reconstruction of autobiographical memory through the development of a coherent life narrative. NET is often used for individuals who have undergone complex or multiple traumas in their lives and can be delivered in both group and individual settings, typically in as little as four to ten sessions. (Schauer, Neuner, & Elbert, 2011)

During NET, the therapist helps the patient establish a chronological narrative of their life, incorporating both traumatic and positive aspects. The patient talks in detail about each traumatic event they have undergone as the therapist explores the sensory, cognitive, emotional, and physiological elements of their fear structure. The narrative is reread several times throughout treatment and cognitive restructuring is implemented where needed by the therapist. This allows for reprocessing of the event, facilitating meaning making, and filling in details of fragmented memories. The therapist guides the patient through this process and a final documented account of the patient's life narrative is produced at the end of treatment which serves to evoke the patient's sense of worth and acknowledge their human rights (American Psychological Association, 2017; Schauer, 2015).

Theory of Dual Representation

Narrative Exposure Therapy is built on the theory of the dual representation of traumatic memories. According to this theory, PTSD is a result of fragmented traumatic memories such that HOT memories are not integrated with COLD memories. A HOT memory includes sensory information, cognitions, emotions, and physiological elements at the time of the trauma, whereas a COLD memory includes context and facts (i.e., "when" and "where"). In the case of repeated exposures to multiple traumatic events, a distortion of an overarching structure of memory storage and retrieval is theorized such that the more frightening the survived experience, the greater the degree of disorganization (Elbert, Schauer, & Neuner, 2015). The goal of NET is to activate HOT memories through the use of exposure (i.e., describing the traumatic events) and link them with COLD memories to create a contextualization (Elbert & Schauer, 2002).

Eye Movement Desensitization and Reprocessing (EMDR)

Eye Movement Desensitization and Reprocessing (EMDR) is a structured 6-12 session treatment, developed by Francine Shapiro, that focuses directly on the memory of a traumatic event by implementing bilateral stimulation in the form of eye movements, tones, or taps in an attempt to change the method in which the memory is stored. Unlike other approaches, EMDR is distinct in that it does not include extensive exposure to distressing memories (processing of memory is typically completed within one to three sessions), a detailed description of the traumatic memory is not necessary, dysfunctional beliefs are not challenged by the therapist, and there are no homework assigned (American Psychological Association, 2017; Shapiro, 2018). EMDR is described as an integrative psychotherapy, combining different modalities and emphasizing physical responses with body-based work.

EMDR consists of eight phases which follow a subsequent order. Phase one includes evaluating the patient's presenting problems and assessing their personal stability and fit for treatment. In addition, the therapist determines targets to be addressed in treatment (i.e., past childhood events, current triggers, coping skills). The second phase of EMDR includes preparing the patient for treatment which primarily involves explanation of the theory behind treatment and what to expect. The therapist focuses on maintaining a strong therapeutic alliance and developing a safe environment for the patient. One unique feature of EMDR is that the therapist teaches the patient certain relaxation procedures to self-regulate during and in-between sessions. Some of these relaxation procedures include safe/calm place imagery, resource development and installation, recorded visualizations, the light stream technique, and breathing shifts (refer to Shapiro, 2018 for a detailed description of relaxation procedures). These regulating procedures are aimed at providing the patient with a sense of self-efficacy and self-reliance. Phase three of EMDR includes an assessment of the distressing target memory and creates a baseline to measure progress throughout treatment. During this phase, the patient is asked to identify components of the target (i.e., image, negative cognitions, emotions, physical sensations), their Subject Units of Distress (SUD), as well as an alternate positive cognition and its validity score.

Phases four through six involve the processing of the target memory using bilateral stimulation. The fourth phase of EMDR consists of desensitization which aims at dispelling all associated channels of the target memory and is measured through SUDs scores. The fifth phase consists of installation which incorporates positive cognitions with the target memory and is measured through validity scores. The sixth phase consists of a final body scan in which the patient tunes into sensations within their body to eradicate any remaining somatic disturbances.

The seventh phase of EMDR includes the closure portion of treatment in which the patient is debriefed, instructed to keep a log of disturbances between sessions, and is dismissed of any disturbances that remain at the end of session (through the use of relaxation techniques stated previously). The final phase of EMDR takes place the following session where the therapist reviews the patient's log, identifies whether there are other targets to assess, reevaluates the previously processed memory, and determines if there is still a need to continue processing (Shapiro, 2018; Shapiro & Solomon, 2017).

Adaptive Information Processing (AIP) Model

EMDR is guided by the Adaptive Information Processing (AIP) model which considers PTSD symptomology to emerge from past distressing memories in neural networks that have not been sufficiently processed (Hase, Balmaceda, Ostacoli, Liebermann, & Hofmann, 2017). According to the AIP model, symptoms of PTSD arise from blockage of the information-processing system, resulting in trauma information being stored in the same format that it was initially experienced in. EMDR attempts to activate the blocked information-processing system through the use of bilateral stimulation. The information- processing system is thought to be physiologically designed to naturally resolve psychological disturbances in the same way the human body is able to self-heal a physical wound.

Currently, there is a limited understanding of brain physiology to verify the exact mechanisms behind activation of the information-processing system, however several hypotheses are proposed: 1) deconditioning may be prompted by a relaxation response, 2) a shift in brain state may augment the activation and consolidation of weak associations, and 3) factors may be involved in the patient's dual focus of attention (i.e., concurrently attending to present stimuli and past trauma) (Shapiro, 2018). Unlike cognitive treatments which aim at memory extinction, EMDR's ultimate goal is that of memory reconsolidation. EMDR aims at assimilating new adaptive information into the memory network with each subsequent set of activations.

The validity of the bilateral stimulation used in EMDR has received controversy over the years (Renfrey & Spates, 1994). Various mechanisms of action are hypothesized for the use of bilateral stimulation, including: 1) afflicting working memory 2) stimulating the orienting reflex via a parasympathetic response (Sack, Lempa, Steinmetz, Lamprecht, & Hofmann, 2008), and 3) producing identical or comparable processes that represent rapid eye movement (REM) sleep. Additionally, it is also speculated that there may be more than one mechanism activated during processing of the trauma (Shapiro, 2018).

CHAPTER FOUR

SOMATIC THERAPIES

In more recent years, somatic therapies have established implementation for the treatment of trauma. These therapies function by executing a bottom-up approach, typically by incorporating the interoceptive system into their treatments and using internal bodily sensations as entry points for processing.

The interoceptive system (commonly referred to as interoception) is the subjective experience of the internal state of the body (Ceunen, Vlaeyen, & Van Diest, 2016; Craig, 2003). Interoception signals the feedback from our viscera to our brain and can often occur outside of our awareness (Cameron, 2001; Porges, 2011, 2017). Somatic therapies use mechanisms of interoception to provide patients with awareness into their bodily sensations. Three promising somatic therapies that are highlighted in this paper include Somatic Experiencing, Sensorimotor Psychotherapy, and the Trauma Resiliency Model.

Somatic Experiencing (SE)

Somatic Experiencing (SE), developed by Peter Levine, provides therapists with a set of nine steps or "building blocks" which act as basic tools for reconstructing trauma. The ultimate goal of SE is "biological completion", allowing the individual to partake in actions that were denied to them during the time of their trauma. Steps in SE are intended to be used in any desired order and may also be accessed repeatedly during the course of treatment. In addition, it is suggested that the first three steps occur initially and in a sequential pattern as to develop a strong foundation for subsequent skills (Levine, 1997, 2010).

The first three steps include establishing a safe environment, supporting initial exploration and acceptance of bodily sensations, and establishing pendulation. The therapist must first form a state of relative safety through the use of their soothing therapeutic tone and working alliance. This in turn will provide the patient with feelings of hope and protection. The second step of SE is aimed at helping the patient begin to establish their own agency and develop the ability to self-soothing, thus evading overdependence on the therapist. The patient begins to learn how to access, endure, and operate their internal bodily sensations and the therapist aids in allowing the patient to recognize any positive sensations that may arise during session. The concept of pendulation is introduced during the third step of SE. Pendulation is a term coined by Levine to describe the innate internal pattern of two polarities, namely contraction and expansion. People affected by traumatic stress and who later go on to develop PTSD may be stuck in the contraction phase, unable to access the expansion phase. The therapist helps these patients get “unstuck” by guiding them to shift their focus onto an opposite sensation in the body, typically one that is pleasant or neutral. This allows the patient to acknowledge that their body can become their ally and recognize the time-limited nature of distress. The patient gradually learns to shift their awareness between areas of ease to those of distress until they are able to find a tolerable balance between the two.

The remaining steps of SE continue to address trauma through the use of body-based work. Titration is another term coined by Levine to describe a steady stepwise process of trauma renegotiation where the therapist pays special attention to activating the correct amount of arousal and unpleasant sensations in a manner that prevents retraumatization. Titration acts as the fourth step in SE and is used to provide the patient with increased stability and resilience.

The fifth step of SE consists of restoring active defense responses. The therapist does this by guiding the patient towards a corrective response which primarily involves replacing the original passive responses of failure and powerlessness with an active, empowered, defensive response. Patients are taught to counter their passive responses by generating specific tension patterns via interoceptive awareness which “suggest” distinct movements. According to Levine, dismissing the physical attitude of defeat restores active defense systems and contributes to “biological completion”.

The sixth step of SE aims at separating the conditioned association of fear from the response of immobility. Levine lists two typical fears that fuel immobility: the fear of entering immobility (i.e., fear of paralysis, entrapment, helplessness, and death) and the fear of exiting immobility (i.e., fear of intense energy via "rage-based" sensations of counterattack). The therapist uses the skills of pendulation and titration to aid the patient in gradually accepting intense sensations with the hopes of restoring a self-paced dissolution of immobility.

The seventh step of SE involves promoting discharge of vast survival energy in order to resolve hyperarousal states. This includes autonomic nervous system release which can take on various forms (e.g., involuntary trembling, shaking, spontaneous changes in breath, changes in skin temperature). It is speculated that these stored energies are a result of mobilization or other self-protective responses either not being carried out or being incomplete during the time of the trauma.

The eighth step of SE aims at restoring “dynamic equilibrium”, a term used to describe the continual reacting and resetting pattern of the nervous system. This is done by engaging the patient in self-regulation and maintaining a state of relaxed alertness such that they are able to feel secure in the midst of unpleasant arousal.

The last step of SE focuses on reorienting the patient to the here and now. Once restoration of dynamic equilibrium is established, the patient is better able to tune into the present reality of their surroundings. This in turn increases their capacity for social engagement which is viewed by Levine as an essential component to well-being (Levine, 1997, 2010; Porges, 2011, 2017).

Core Response Network (CRN)

As of date, one possible rationale for the mechanisms involved in SE has been proposed. According to this rationale, trauma results in the functional dysregulation of a complex dynamical system termed the Core Response Network (CRN). The CRN consists of four subcortical structures, namely the autonomic nervous system, the emotional motor system, the reticular arousal systems, and the limbic system. The autonomic nervous system is comprised of the sympathetic nervous system including the hypothalamus which activates the stress response system. The emotional motor system includes portions of the basal ganglia which are involved in movements and postures that are specific to emotions. The reticular arousal systems monitor alertness and orientation in different settings and the limbic system, which includes the amygdala and hippocampus, is essential in the recollection of emotionally salient events as well as fear- and pleasure-based experiences.

It is hypothesized that the systems comprising the CRN interact strongly and establish instinctive responses to arousing stimuli. The CRN is theorized to respond quickly to such stimuli with minimal input from extensive cortical processes. During instances of mild acute stress, the CRN is able to respond accordingly (i.e., sympathetic activation) and resume to normal functioning via parasympathetic activation and return of vagal tone (Figure 5).

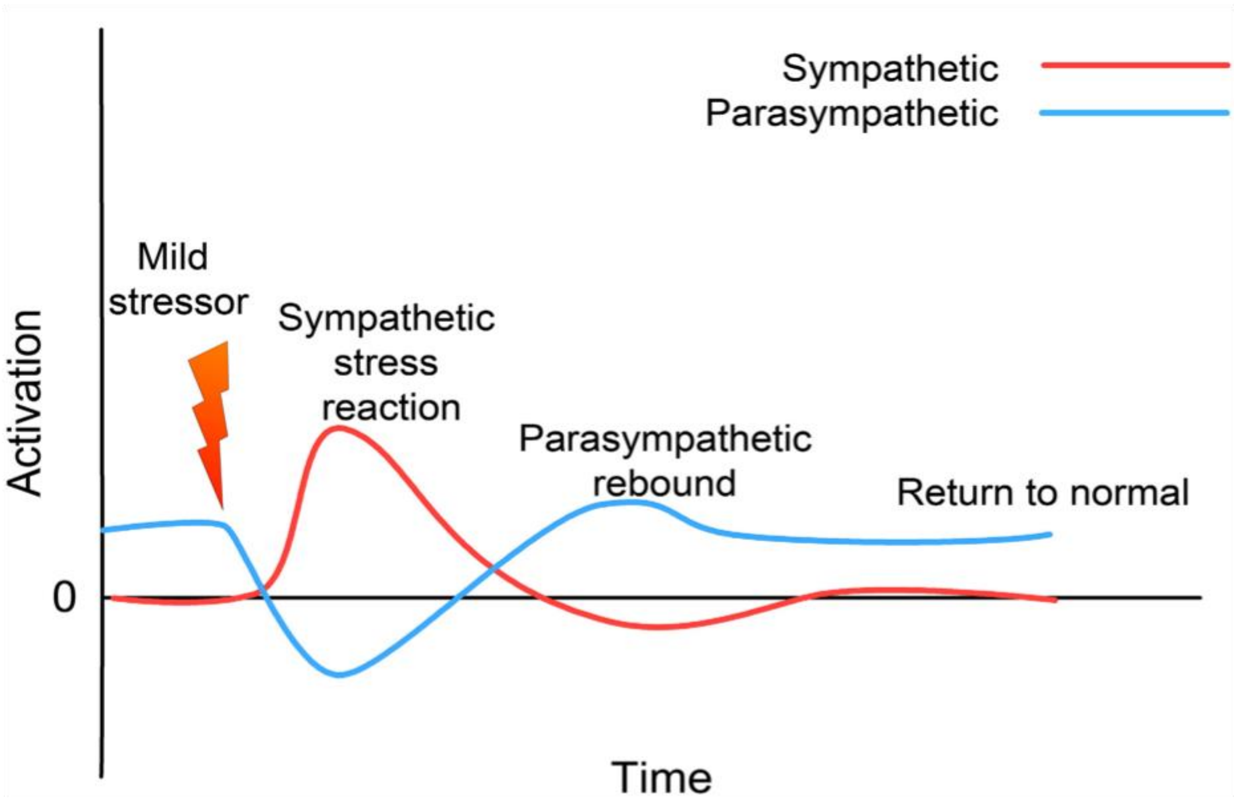

Figure 5. Mild Acute Stress Reaction. Adapted from 'Somatic Experiencing: Using Interoception and Proprioception as Core Elements of Trauma Therapy', by Payne et. al., 2015, *Frontiers in Psychology*, *6*, p. 1-18.

Under conditions of intense or prolonged stress, particularly with inadequate defensive responding, the functions of the CRN may become dysregulated and enter an altered state. Such a state has been proposed to contribute to allostatic overload. In this altered dysregulated state, systems of the CRN fail to reset to normal functioning and continue responding to their environment with inappropriate sympathetic and parasympathetic activation (Figure 6, 7).

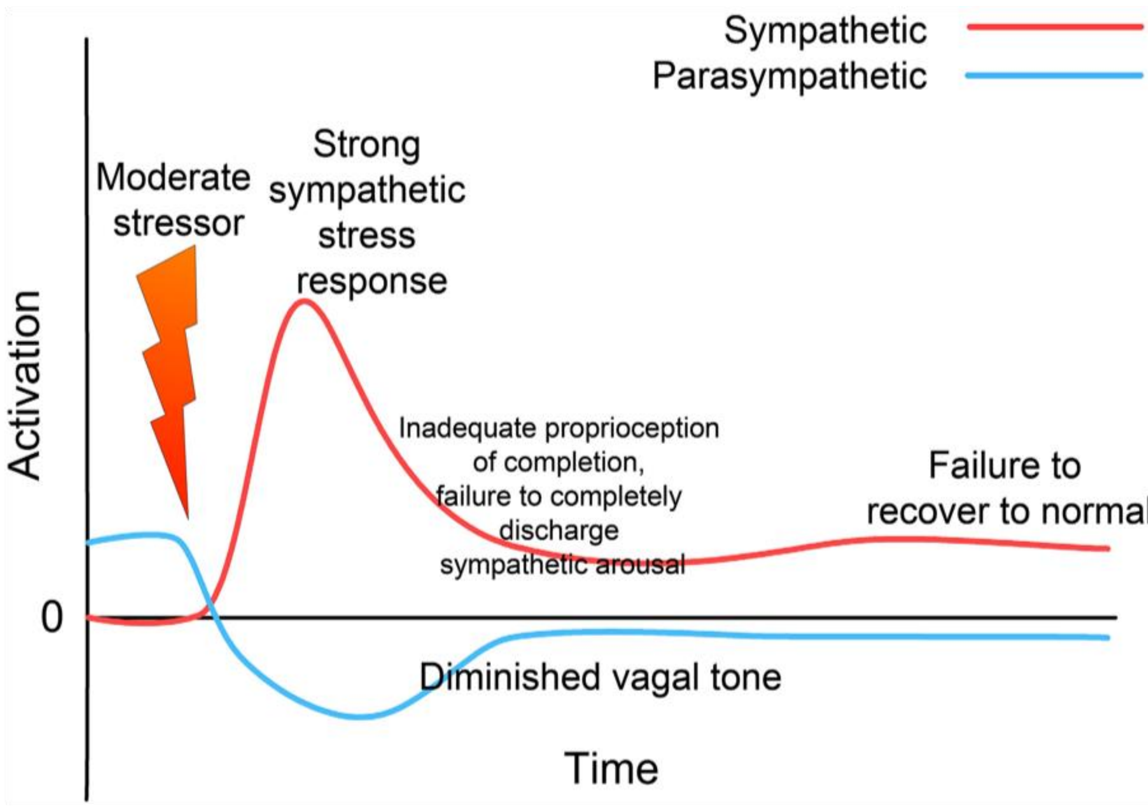

Figure 6. Chronic Stress Response. Adapted from 'Somatic Experiencing: Using Interoception and Proprioception as Core Elements of Trauma Therapy', by Payne et. al., 2015, *Frontiers in Psychology*, *6*, p. 1-18.

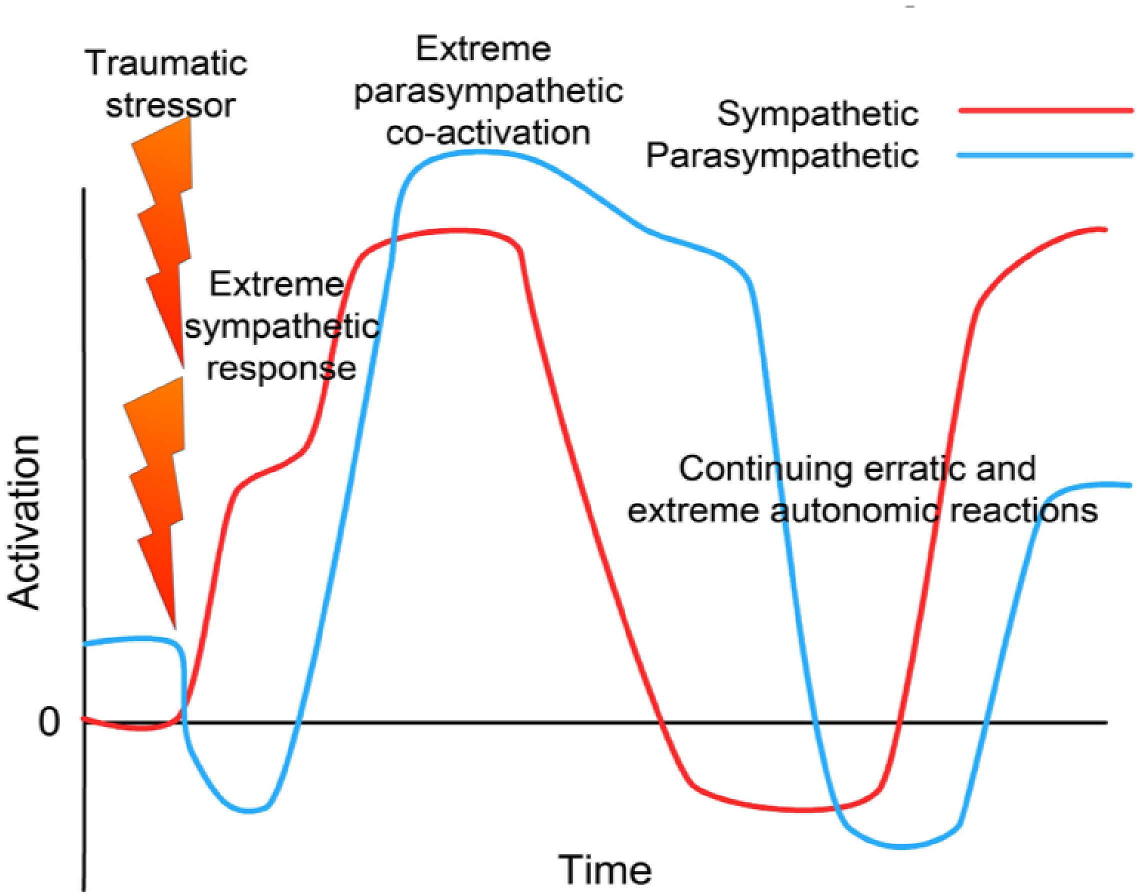

Figure 7. Traumatic Stress Response. Adapted from 'Somatic Experiencing: Using Interoception and Proprioception as Core Elements of Trauma Therapy', by Payne et. al., 2015, *Frontiers in Psychology*, *6*, p. 1-18.

Moreover, it is suggested that the effects of conscious rational thought processes on the CRN are fairly weak and indirect. According to this rationale, the methods implemented in SE help reinstate functionality to the CRN through more strong and direct means (Payne et al., 2015).

Sensorimotor Psychotherapy (SP)

Sensorimotor Psychotherapy (SP), developed by Pat Ogden, is a body-oriented talk therapy that combines aspects of both bottom-up and top-down processes. Having been developed entirely from clinical practice and just starting to emerge in research, there are currently no prominent mechanisms of change identified for SP.

The first phase of SP involves developing somatic resources for stabilization. Stabilization is defined as being within the "window of tolerance", a term derived by Daniel Siegel to describe an optimal arousal zone where information received can be successfully integrated without disrupting the functioning of the system (i.e., hyperarousal, hypoarousal) (Figure 8). The window of tolerance has also been connected to Stephan Porges's polyvagal theory with the hyperarousal zone being associated with mobilization of the sympathetic nervous system, the hypoarousal zone being associated with the immobilization response of the unmyelinated vagus, and the optimal arousal zone being associated with the social engagement system via the myelinated vagus (Figure 9). During this phase, the therapist promotes the patient's personal awareness of their movements, impulses, and internal bodily sensations. The therapist also focuses on building a safe environment for therapy and recognizing any triggers that may arise.

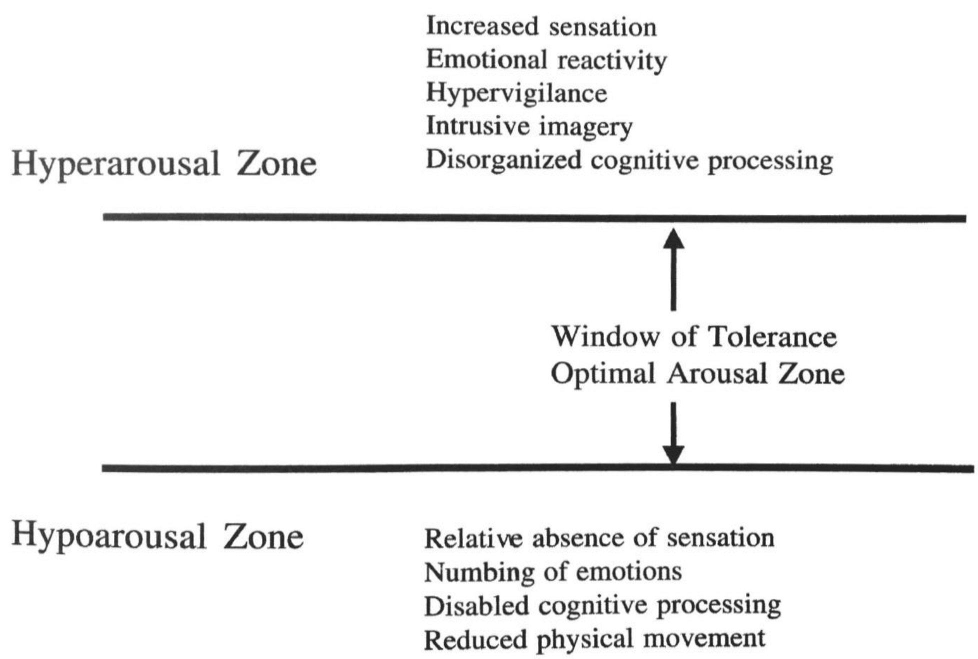

Figure 8. Window of Tolerance Adapted from *Trauma and the Body* (p. 27), by P. Ogden et. al, 2006, New York, NY: W.W. Norton & Company.

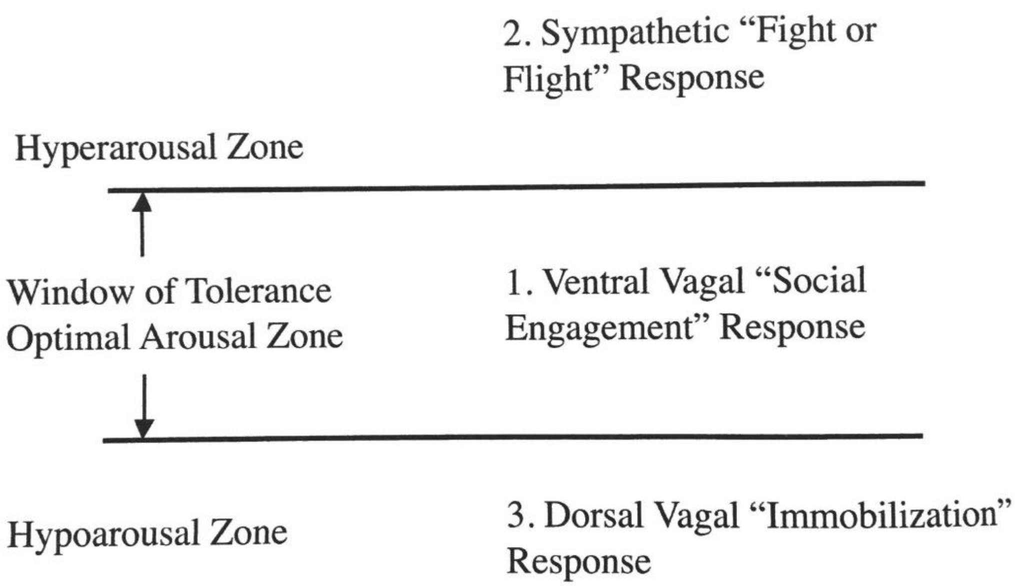

Figure 9. Arousal Zones. Adapted from *Trauma and the Body* (p. 32), by P. Ogden et. al, 2006, New York, NY: W.W. Norton & Company.

The second phase of SP includes processing the traumatic memory and restoring "acts of triumph". This primarily involves disrupting procedurally learned implicit memories by integrating nonverbal fragments from past trauma. Integration of these nonverbal fragments involve addressing the physical sensations, sensory intrusions, emotions, and actions associated with the traumatic event. The therapist remains attentive to ensure that the patient is working at the edge of their window of tolerance and the patient is encouraged to implement the somatic resources that were taught in phase one of treatment. This typically involves the patient mindfully tracking (a top-down cognitive process) the physical sensations that emerge when the traumatic memory is evoked and shifting their focus to more resourced or present-time experiences (a technique that has been termed oscillation). Moreover, during retelling of the traumatic story, positive resources are uncovered, strengthened, or installed to help assimilate the memory. In addition, the therapist helps the patient participate in "acts of triumph" which involve the patient reenacting the mobilizing defenses that were ineffective at the time of the traumatic event, thus providing the patient with a sense of mastery. This is similar to the "biological completion" component found in SE. SP works under the assumption that once implicit procedural memories are activated through somatic exploration, then a verbal representation can emerge in the form of an explicit narrative.

The third phase of SP involves continual use of skills learned in prior phases and reintegration of the patient into conventional life. This reintegration consists of the therapist reinforcing the patient to participate in healthy risk-taking and more active social interactions. During this phase, the therapist's primary goal is to empower the patient to develop a life after the trauma and take on new perspectives. Meaning is established by addressing and altering any distorted cognitions that should arise. In addition, themes of self-development and relations with others are explored (Ogden et al., 2006).

Trauma Resiliency Model (TRM)

The Trauma Resiliency Model (TRM), developed by Elaine Miller-Karas, consists of a set of nine skills which aim to stabilize the nervous system and counteract the effects of traumatic stress. The first six skills have been designed to be implemented by nonprofessionals and are viewed as a set of wellness skills (referred to as the Community Resiliency Model (CRM)) whereas the latter three skills consist of deeper trauma-based work and require the aid of a mental health professional. At the core of this model is the concept of the "resilient zone", which is used to describe an individual's optimal level of functioning for which they are able to effectively cope with the daily stressors of their lives (Figure 10). The resilient zone is comparable to Daniel Siegel's "window of tolerance" and it is proposed that when an individual is within their resilient zone, they are able to think clearer and concentrate more effectively. As such, their nervous system is thought to signify equilibrium. According to this model, when individuals begin experiencing symptoms of traumatic stress, they have become "bumped out" of their resilient zone. They may find themselves bumped on a high zone, low zone, or a combination of both (Figure 11). Encompassing the high zone are symptoms of anxiety, irritability, and pain whereas symptoms of sadness, fatigue, and numbness are associated with the low zone. TRM is designed to aid individuals in determining whether they are bumped out of their resilient zones through the use of internal bodily sensations.

Figure 10. The Resilient Zone. Adapted from 'The Trauma Resiliency Model: A "Bottom-Up" Intervention for Trauma Psychotherapy', by L. Grabbe and E. Miller-Karas, 2018, *Journal of the American Psychiatric Nurses Association*, *24*, p. 76-84.

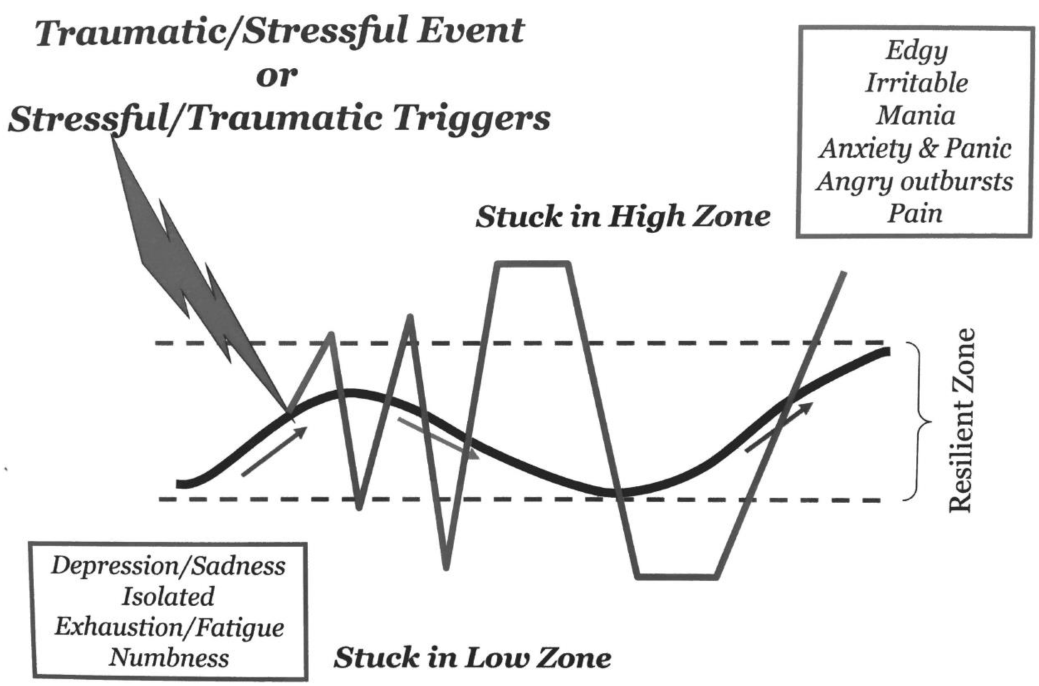

Figure 11. Getting "bumped out" of the resilient zone. Adapted from 'Community Resiliency Model', by E. Miller-Karas, 2018, Community Resiliency Model Skills Training Workshop [PowerPoint slides]

The first skill taught in TRM is tracking and involves teaching patients how to differentiate between pleasant, unpleasant, and neutral physical sensations within their bodies via interoceptive awareness. The second and third skills of TRM (i.e., resourcing and grounding) are techniques that can be implemented when patients determine that they are bumped out of their resilient zone and are experiencing unpleasant sensations. Resourcing requires a patient to identify and expand on a personal resource. Resources can be categorized as external (e.g., people or places that elicit feelings of joy or support), internal (e.g., positive characteristics one enjoys about themselves), or imagined. The therapist aims to intensify the patient's chosen resource through a multitude of questions in hopes of enhancing its description and connecting the resource to a positive or neutral sensation within the patient's body. Grounding functions to bring awareness into the present moment as patients are invited to mindfully track the contact they are making with their physical world. Gesturing is the fourth skill of TRM and involves various spontaneous movements which symbolize self-soothing mechanisms. Patients are taught to recognize any gestures that may occur during sessions as well as identify any gestures that bring them comfort and safety. The fifth skill of TRM is called "Help Now!" and is intended to be used when patients are stuck in either the high or low zone. Strategies that encompass the "Help Now!" skill are more immediate in nature (e.g., drinking a glass of water, naming six colors in the room) and help patients divert from overwhelming sensations by activating parts of the body that restore balance. "Shift and stay" is the sixth skill of TRM (and the last skill of CRM) and serves to integrate the skills learned thus far. Shifting attention is emphasized during this skill as the patient learns to shift their awareness from distressing sensations to ones that are pleasant and neutral through the use of tracking, grounding, resourcing, gesturing, and Help Now! skills.

Titration serves as the seventh skill of TRM and is derived from Peter Levine's SE. Similar to SE, titration includes helping the patient bring awareness to small manageable sensations associated with their trauma. The eighth step of TRM includes pendulation (another derivative of Peter Levine's SE and sharing similarities to oscillation techniques found in SP) in which the therapist aids the patient in altering from the distress of traumatic activation to areas within the body that are less tense, less painful, neutral, or pleasant. The last skill of TRM consists of the completion of survival responses and is adapted from Peter Levine's SE. Therapists determine at what phase their patients are in the survival response continuum and begin to reprocess the traumatic experience. Similar to "biological completion" described in SE, once the patient has successfully completed their survival response, their nervous system is assumed to be restored to equilibrium and the patient returns back into their resilient zone (Grabbe & Miller-Karas, 2018; Miller-Karas, 2015).

CHAPTER FIVE

CONCLUSIONS

Empirical Review of APA Evidence-Based Trauma Treatments

A majority of the APA evidence-based trauma treatments can be categorized as top-down interventions due to their reliance on higher cortical systems in regulating lower level physiological mechanisms. However, little is known about these top-down processes and their relation to the stress response system. This could be in part due to the fact that language of the nervous system is lacking in both the theories and experimental literature of these interventions.

Empirical studies that incorporate the use of physiological measures when testing the efficacy of these top-down interventions are scarce and findings pertaining to the treatment of PTSD remain relatively unexplored. Of the empirical studies that include such measures, the biological mechanisms that underlie their significance are either unknown or unaddressed (Rozek, Smith, & Simons, 2018; Tafet, Feder, Abulafia, & Roffman, 2005; Thieme, Turk, Gracely, & Flor, 2016). This can be seen in a study conducted by Tafet et.al. (2005) looking at treatment efficacy for 20 outpatient participants diagnosed with Generalized Anxiety Disorder who received CT once a week for 24 weeks. HPA function of the participants were measured via cortisol levels from two blood samples taken at the beginning of the study and two samples at the completion of the study. Researchers found clinical improvement amongst the participants with a significant reduction in cortisol levels and anxiety-related symptoms. CT was observed to effect the physiology of the participants, however the mechanisms by which this was achieved remained unexplored (Tafet et al., 2005).

Furthermore, two studies were found implementing BEPP using physiological measures on populations of patients diagnosed with PTSD. The first study conducted by Gersons et. al. (2000), administered 16 sessions of BEPP to civilians and police officers with PTSD and found that patients with PTSD had a higher reactivity (i.e., heart rate response) to trauma scripts compared to controls and that their elevated heart rate response was normalized after completion of BEPP. Researchers speculated that this may be due to emotional adaptation which lead to a decrease in autonomic arousal during exposure, however mechanisms of change were not explored (Gersons, Carlier, Lamberts, & van der Kolk, 2000; Lindauer et al., 2006). Similarly, another study conducted by Olff et.al. (2007), found that BEPP improved low cortisol and dehydroepiandrosterone (DHEA) levels- both stress-related hormones found in patients with PTSD. These researchers speculated that one method in which BEPP may have affected these physiological responses to trauma was through the use of cognitive appraisals and coping styles, however this was left unexplored (Olff, de Vries, Güzelcan, Assies, & Gersons, 2007).

Of the APA recommended evidence-based treatments for PTSD, EMDR remains the only treatment that directly includes the language of the stress response in its practice. Due to its inclusion of nervous system language and the incorporation of body-based work, there have been more empirical studies testing the efficacy of EMDR with physiological measures. EMDR has continuously been shown to reduce heart rate, increase heart rate variability, decrease skin conductance, and reduce muscle tension (Aubert-Khalfa, Roques, & Blin, 2008; Forbes, Creamer, & Rycroft, 1994; Sack, Hofmann, Wizelman, & Lempa, 2008; Sack, Lempa, & Lamprecht, 2007; Sack, Lempa, et al., 2008; Wilson, Silver, Covi, & Foster, 1996). One study using five different physiological measures found that one to four sessions of EMDR regulated respiration, slowed heart rate, decreased systolic blood pressure, increased skin temperature, and decreased galvanic skin response- all indices of parasympathetic drive (Wilson et al., 1996). Similarly, Sack et.al. (2007) found reductions in heart rate and an increase in heart rate variability in participants six months after treatment of PTSD using EMDR, suggesting that an increase in parasympathetic tone may be a necessity for successful resolution of traumatic memories (Sack et al., 2007).

Another study conducted by Sack et.al. (2008) used physiological measures in testing the treatment outcomes of EMDR and also found a decrease in heart rate and an increase in parasympathetic tone (measured via heart rate variability). Researchers were able to identify that during-session habituation of psychophysiological activation occurred in their participants; however, they were unable to conclude the underlying mechanisms (Sack, Hofmann, et al., 2008). Further investigation was needed to determine whether EMDR lead to decreases in physiological measures or whether decreased psychophysiological tone was a prerequisite for successful treatment of EMDR. This study unlocks several interesting questions regarding whether habituation is occurring due to the unique bilateral stimulation of EMDR, typical activation of a trauma memory, or possibly the regulatory effects of certain body-based techniques (i.e., body scan).

Incorporation of Relaxation and Biofeedback

In more recent years, psychophysiological components and methods to facilitate relaxation have been incorporated into traditional top-down interventions (e.g., CBT, CT) (American Psychological Association, 2017; Kar, 2011). There have been promising findings with these inclusions, however their working mechanisms in treatments remain fairly unexplored (Brand, Annen, Holsboer-Trachsler, & Blaser, 2011; Rabe, Dörfel, Zöllner, Maercker, & Karl, 2006; Rosnick C.B. et al., 2016). One study conducted by Rabe et.al. (2006) looked at motor vehicle accident survivors who met diagnosis for PTSD. They measured participants' baseline heart rates and their reactivity to positive, negative, and neutral stimuli, in addition to an image of a motor vehicle accident. Elevated baseline heart rates were found for participants who met criteria for PTSD compared to controls. Moreover, heart rate reactivity was increased in response to the trauma-related picture and no such increase was found towards the positive, or non-trauma related negative pictures. Participants then underwent a CBT intervention group which included relaxation training (although the specific type of relaxation was not explicitly listed). They found a significant decrease in heart rate reactivity in relation to the trauma-related picture compared to the wait-list control group (Maercker, Zöllner, Menning, Rabe, & Karl, 2006; Rabe et al., 2006). Although significant findings were identified in this study, it remained unclear whether the inclusion of relaxation techniques in the CBT intervention served as a working mechanism. Future replications would benefit from a third comparison group consisting of the CBT treatment without integration of relaxation training.

Furthermore, therapeutic tools used in practice and the literature to encompass the term “relaxation” either vary widely (e.g., mindfulness meditation, progressive muscle relaxation, deep breathing) or remain unspecified and open to interpretation- as shown in Rabe et.al. (2006). Despite the ambiguity, these relaxation techniques share a commonality that is, they are theorized to activate the parasympathetic nervous system inducing a relaxation response. This can be seen by a study conducted by Hinton et. al. (2009) which delivered a manualized CBT intervention for 12 Cambodian refugees diagnosed with PTSD. The manualized CBT intervention included various relaxation techniques (i.e., muscle relaxation, diaphragmatic breathing, guided imagery, mindfulness training, and yoga-like stretching) in addition to traditional CBT practices (refer to Hinton et al., 2005 for intervention used). Participants were assessed for physiological adjustment using systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) which were measured at three different points in time throughout the treatment. Researchers found significant improvement in SBP adjustment- a measure of vagal tone. Based on these findings, they proposed a model stating that the CBT intervention administered to participants improved their emotion regulation capacity which directly increased their vagal tone. This increase in vagal tone was then associated with the reduction in PTSD symptomology found in the participants (Hinton, Hofmann, Pollack, & Otto, 2009). As the inclusion of relaxation techniques into top-down interventions continue to grow, more research is needed in the field similar to the one conducted by Hinton et.al. (2009).

Another emerging area in trauma treatments is the inclusion of biofeedback to traditional top-down interventions for PTSD (Rosaura Polak, Witteveen, Denys, & Olff, 2015; Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011). Biofeedback aims at teaching individuals various relaxation exercises in which they are able to monitor and normalize their automatic bodily functions (e.g., heart rate, breathing, skin temperature). Heart rate variability (HRV) has been shown to be a reliable measure of autonomic nervous system functioning and depicts an individual's capacity to cope with stress (Tan et al., 2011). Low HRV has been associated as a risk factor for developing PTSD (Gillie & Thayer F., 2014; Minassian et al., 2015) and an increase in HRV has shown reductions in PTSD symptomology (Tan, Wang, & Ginsberg, 2013). One study conducted by Tan et.al. (2011) looked at the addition of HRV biofeedback to treatment as usual for 20 veterans diagnosed with PTSD and found that HRV biofeedback significantly increased HRV and reduced PTSD symptoms after eight 30 minute weekly sessions (Tan et al., 2011). The inclusion of biofeedback has shown promising results and its effectiveness is theorized to be due in part by the bidirectional relationship between cognitions and physiology (Gevirtz & Dalenberg, 2008).

Empirical Review of Somatic Therapies

Due to their recency, literature on somatic therapies is lacking in the field. Additionally, clinicians are implementing these interventions without a clear understanding of their biological underpinnings. Multiple views of the nervous system in relation to trauma have been proposed (i.e., Stephen Porges's polyvagal theory, Peter Levine's CRN, Daniel Siegel's window of tolerance, Elaine Miller-Karas's resilient zone). As of date there appears to be no agreed upon universal view of the biological foundations behind somatic treatments.

Although it is theorized that "biological completion" through the use of various mechanisms of SE (i.e., interoception, proprioception) will regulate the CRN and restore normal functioning, there have been no empirical studies which have tested this. Two studies have been conducted to date looking at the efficacy of SE (Andersen, Lahav, Ellegaard, & Manniche, 2017; Brom et al., 2017). One study organized over a period of three years, delivered 15 sessions of SE to 63 participants diagnosed with PTSD in Israel. Researchers found significant improvement in PTSD and depression symptomology; however, it should be noted that participants experienced ongoing collective trauma and dangerous conditions during the duration of the study (Brom et al., 2017).

Looking at SP, there have been two studies conducted as of date (Gene-Cos, Fisher, Ogden, & Cantrell, 2016; Langmuir, Kirsh, & Classen, 2012). Both studies implemented SP in a group setting and found significant improvements in body awareness, dissociation, and receptivity to soothing (Langmuir et al., 2012), as well as reductions in PTSD and depression measures, and improvements in daily life activities and close relationships (Gene-Cos et al., 2016).

CRM, a byproduct of TRM, has been implemented in a variety of international settings typically following natural or man-made disasters (L. Leitch & Miller-Karas, 2009). More research is underway for these settings, however one notable study evaluated the effectiveness of CRM to survivors of the 2010 Haitian earthquake and found significant reductions in depression scores after two years (Miller-Karas, 2015). Similar to CRM, TRM has conducted limited empirical studies. One study looking at social service workers who were survivors of Hurricanes Katrina and Rita found significant reductions in psychological symptoms and higher resiliency scores among participants who received one to two treatments of TRM in relation to a comparison group who received only psychoeducation (L. M. Leitch, Vanslyke, & Allen, 2009). As of date, there have been no published studies using physiological measures to test treatment outcomes for either SE, SP, or TRM.

Future Directions

Top-down interventions have acquired significant empirical support for the treatment of PTSD; however, they have not been universally effective, having low outcome rates, with some patients continuing to endure lingering PTSD symptomology (Tan et al., 2013; van der Kolk, 2014). In addition, precise working mechanisms remain unknown for a majority of these top-down interventions.

Some researchers and clinicians have argued that individuals are only able to process horrific encounters if it does not overwhelm them and that the continual re-exposure of traumatic memories, typical of exposure therapies, are extreme and unnecessary, calling for integration rather than systematic desensitization (van der Kolk, 2014). As a result, alternatives to continual re-exposure have been presented, such as EMDR which works with an individual's trauma without recollection of its entire narrative.

Compared to specific irrational fears (i.e., phobias), fears associated with PTSD consist of an interplay of complex systems and feedback loops (Payne et al., 2015). As Bessel van Der Kolk (2014) states:

> Post-traumatic stress is the result of a fundamental reorganization of the central nervous system based on having experienced an actual threat of annihilation, (or seeing someone else being annihilated), which reorganizes self-experience and the interpretation of reality (van der Kolk, 2014).

Furthermore, there is bidirectionality between cognitions and physiology such that unconscious physiological mechanisms are influenced by rational thought processes and biological drives frame conscious thought. As such, addressing both the psyche and the soma are essential components to psychotherapy. Despite this, its assimilation appears lacking in many of the APA recommended evidence-based treatments for PTSD. In addition to recognizing the influence of cognitive aspects, the awareness of internal bodily sensations is also necessary. These treatments would likely benefit from the inclusion of interoceptive awareness techniques proposed in somatic therapies that directly treat autonomic dysregulation commonly associated with traumatic stress. Of the proposed interventions listed in this paper, EMDR and SP remain the only two treatments that combine both cognitive top-down and physiological bottom-up processes. EMDR consists of the inclusion of a body scan as well as various relaxation techniques and SP includes cognitive restructuring after the patient is regulated. Furthermore, there have been promising findings for the incorporation of relaxation and biofeedback into traditional top-down interventions, although more comparative research is needed in this area.

Somatic therapies are gaining recognition as alternative treatments for PTSD due to their unique bottom-up processes. Despite this success, empirical findings remain nonexistent with only a few studies to date and clinicians continue to implement these interventions without a clear understanding of their biological underpinnings. Future studies would benefit from testing treatment efficacy and implementing comparison studies with conventional treatments. Additionally, more research into the methods and mechanisms of somatic therapies are needed, particularly with their relation to the nervous system and the various models proposed.

Patients diagnosed with PTSD have been found to have elevated psychophysiological baseline measures and disproportionate reactivity. Moreover, there have been promising findings for the inclusion of physiological measures in testing the efficacy of trauma treatments (Sack et al., 2007). Both APA recommended top-down interventions and somatic therapies lacked physiological measures in testing treatment outcomes. Although it should be noted that the lack of physiological measures found for somatic therapies could be in part due to the recency of such interventions. EMDR remained the most physiologically researched amongst all interventions presented in this paper. Future research should look into the incorporation of physiological measures to determine arousal and stress response effects of treatments.

Principally, there is a critical need for further development in the field of both top-down and bottom-up interventions for trauma treatment. Biological mechanisms underlying treatment should be explored starting with the inclusion of physiological measures in research. Researchers and clinicians must ask themselves: how are these treatments regulating the nervous system? Furthermore, somatic therapies contribute beneficial knowledge to the field of trauma treatments, suggesting that physiology may provide additional entry points in therapy. One proposed procedure to improve the effectiveness of PTSD treatments is to merge interventions that target autonomic nervous system dysregulation (via bottom up processing) and cognitive appraisals (via top-down processing). Renegotiating the way in which we comprehend trauma, with the inclusion of the biological stress response system, has the potential to modify the way we discuss PTSD and enhance the delivery of treatments.

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