MILITARY-RELATED POSTTRAUMATIC EMOTIONAL NUMBING:

A THREE-ARTICLE DISSERTATION

by

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DISSERTATION

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ABSTRACT

Military-Related Posttraumatic Emotional Numbing: A Three-Article Dissertation

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Three papers on military-related posttraumatic stress and emotional numbing symptoms are proposed for this three-paper dissertation. The first paper will be a systematic review of the literature on the psychosocial impact of combat-related emotional numbing symptoms in veterans. The second paper will utilize a phenomenological approach to analyze veteran's posttraumatic stress stories using transcripts of 'milvlogs' (military video web blogs) and interviews with vloggers. The third paper will present the results of a pilot study analyzing the impact of a single session of heart rate variability biofeedback on military-related emotional numbing symptoms and the use of a mobile phone app to reinforce practice. In aggregate, these three papers underscore the impact of emotional numbing symptoms in military populations with posttraumatic stress injury, and alternative paths to healing that utilize technology.

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DEDICATION

To Don: Your love and humor helped me up when I fell (which was often). There simply are no words to thank you enough for all you unselfishly gave and the sacrifices you made along the way.

To Evan: I am so proud of you and deeply blessed by your presence in my life. It's your turn, my sweet son!

To Mom: I am forever grateful you taught me that hard work and determination pay off. Thank you for always believing in me, endless hours of encouraging words, and everything you did to help me achieve my dreams. If you had even half the opportunities with which I've been blessed in this life, you would have journeyed down this road before me.

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GENERAL INTRODUCTION

Posttraumatic Stress Disorder (PTSD), a chronic, disabling stress disorder, results from

direct or indirect exposure to actual or threatened death, serious injury, or sexual violence

(American Psychiatric Association, 2013). Along with traumatic brain injury (TBI), PTSD is

known as a "signature wound of war," and military members with PTSD are at even greater risk

of suffering deleterious social effects than those who are not afflicted. To provide some sense of

the scope of the problem, as many as 15% of service members of the recent wars in Iraq and

Afghanistan have PTSD (Yarvis, 2011). Experts place the lifetime prevalence rate for PTSD in

Vietnam veterans at 30.9% for men and 26.9% for women (Kulka et al., 1990). Many more

service members and veterans experience partial or subsyndromal PTSD and do not meet full

diagnostic criteria despite incurring severe psychosocial ramifications (Maguen et al., 2013;

Pietrzak et al., 2009; Pietrzak et al., 2011). Military members with PTSD who have prominent

emotional numbing (EN) symptoms appear to suffer the greatest negative psychosocial impacts

(Kerig, Bennett, Chaplo, Modrowski, & McGee, 2016), making the study of EN symptoms

timely and relevant. Thus, the focus of this three-paper dissertation centers on the psychosocial

impact and treatment of EN symptoms in military members with PTSD.

According to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-

5*; American Psychiatric Association [APA], 2013) diagnostic schema, persons with PTSD

experience symptoms that fall into four main categories: re-experiencing; avoidance;

hyperarousal; and (emotional) numbing. Emotional numbing symptoms can be defined as a

"generalized deficit in emotional responding to positive events, in spite of having the intact ability to access negative emotional states" (Litz, 1992, p. 418). Emotional numbing was subsumed under "negative alterations in cognitions and mood" in the *DSM-5* (pp. 271–272). Of the PTSD subclusters, EN may be the most salient symptom group for combat exposed veterans due to the association of EN with especially poor psychosocial and health-related outcomes, coupled with poor treatment outcomes (Kerig et al., 2016). In this three-paper dissertation, where appropriate, the term PTSD will be used to refer to both the *DSM-5* diagnosis as well as the continua of partial or subthreshold symptoms experienced by military personnel. This expanded definition is important because the psychosocial impact of living with PTSD is not fully captured by the number of symptoms required to make a full diagnosis, but rather by the intensity and effect of subcluster symptoms.

This three-article dissertation will describe the psychosocial effects of EN symptoms for military populations with PTSD through an investigation of the literature and survivor's recorded lived experiences, further, it will examine the efficacy of using a single session of heart rate variability biofeedback (HRVB) augmented by use of a mobile app to treat EN symptoms in veterans with PTSD. The first paper will be a systematic review of the literature on the psychosocial impact of emotional numbing systems in service members and veterans with PTSD from military-related stressors (e.g., combat and combat training, military sexual trauma [MST]). The second paper will utilize a phenomenological approach to analyze transcripts from *milvlogs* (military video web blogs). The content of milvlog transcripts and interviews with vloggers will explore the lived experience of EN in military members with PTSD. The third paper will be a pilot study of the impact of a single session of HRVB on EN in veterans with PTSD. This paper will use quantitative data to explore whether veterans will employ a mobile app after a single

session of HRVB training and if the practice of a paced breathing technique results in a reduction in PTSD generally, and EN symptoms in particular. Collectively, these three papers highlight the impact of the EN PTSD subcluster on military populations with PTSD, and point to the potential of HRVB as a somatic, non-trauma focused recovery tool.

<h3 style="text-align:center">Importance to Social Work</h3>

The wars in Afghanistan and Iraq represent the longest combat engagement in U.S. history (Council on Social Work Education [CSWE], 2011). Given the far-reaching societal impact of these hostilities, as well as the challenges of providing services to meet the expanding needs of aging veterans of previous era wars, the CSWE identified military social work practice and research as critical to social workers' relevance. In a professional discipline concerned with promoting social justice and advocating for peace, research on military populations and the psychosocial impact of war presents a paradox and a challenge—how can social workers view military "warriors" as a vulnerable population, particularly in the era of an all-volunteer military? Although social workers do not endorse war, they are called to provide services to those affected by it (CSWE, 2011).

The study of combat-related EN symptoms is critically important to the profession of social work for many reasons. First of all, social workers comprise the largest provider group of military behavioral health care services, and the VA is the largest employer of social workers in the country (National Association of Social Workers [NASW], 2016; CSWE, 2011). As a profession, social work has had a long and esteemed relationship with the Department of Defense (DoD) and the Department of Veterans Affairs (VA)—the first social work program was established in the Veterans Bureau in 1926, placing 14 social workers in psychiatric hospitals and another 22 nationwide in VA Regional offices in the first year of operation (VA,

2016). In the past few years, the VA has been rocked by scandals involving wait list manipulation, records falsification, suicide crisis calls routed to voice mail, and inadequate treatment (Schuman & Schuman, 2016). Given that social workers are the largest providers of behavioral health care services in the VA, addressing these issues are of paramount importance to the profession.

Second, military members and their families often represent vulnerable groups and are disparately impacted by severe social problems as a large, diverse population. Military members are disparately impacted by urgently pressing social problems, such as homelessness, poverty, family violence, crime, homicide, and suicide. The sequelae of war devastate families and communities, and reverberate across generations. The toll from war is profound, and unevenly borne by its least powerful participants, oftentimes the young, minorities, and persons from lower socioeconomic backgrounds (Olson, 2015). These vulnerable populations are of particular interest to social workers. The *12 Grand Challenges of Social Work*, spearheaded by the American Academy of Social Work and Social Welfare (2017), is a groundbreaking, science-based initiative aimed at tackling our country's most vexing social problems with 12 areas of focus (e.g. eradicate social isolation, end homelessness, and close the health gap, to name a few). Military suicide is an urgent public health problem and the subject of great national concern (Schuman, Praetorius, Barnes, & Arana; Schuman & Schuman, 2016). The focus of study in this dissertation is important to social work practitioners and policymakers because military members with PTSD, particularly those with EN symptoms, have an elevated risk of suicide (Breslau, Reboussin, Anthony, & Storr, 2005).

Third, there exists a schism between science and some clinical social work practices (Anastas, 2015). Addressing the gap between social work research and practice requires social

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work researchers to step up to meet the need for translational research that will best serve the needs of military members and families who are affected by our nation's longest war period. The *Standards for Advanced Social Work Practice in Military Social Work*, published by the CSWE (2010), emphasizes the importance of research and its bidirectional relationship to advanced military social work practice. Research evidence on military populations is critical to fulfill the mission of military social work to "engage in research-informed practice and practice informed research" (p. 10). To remain relevant, social work researchers must provide cutting-edge translational research for military social workers who are on the front lines treating war-related trauma.

Fourth, current treatment approaches to PTSD that treat all subcluster symptoms as equivalent are not fully effective: Such interventions are plagued by high dropout rates (Grunert, Weis, Smucker, & Christianson, 2007; Schottenbauer, Glass, Arnkoff, & Gray, 2008) and lingering symptoms (Hassija et al., 2012). Current treatment paradigms for PTSD are inadequate, necessitating the need for the study of effective alternatives. More study is needed to determine the disparate impact of PTSD subclusters.

Finally, social workers need more research into PTSD to be able to advocate for policy changes regarding the delivery of PTSD treatment services across the VA and DoD. Current policies that limit military members to exposure-based therapies may not be adequately targeting the full range of PTSD symptomatology. New research, based in better theoretical models, and grounded in an examination of causal factors is needed to craft more effective therapeutic approaches. This research could inform service delivery and contribute to advocacy efforts for policy changes that would make possible a wider range of therapies to military members with combat-related PTSD characterized by treatment-resistant EN symptoms.

Theoretical Foundations

Since the construct of EN emerged as a focus of interest in trauma research, various theories have emerged to explain the origins of numbing symptoms in trauma survivors. Keane, Fairbank, Caddell, Zimering, & Bender (1985) suggested EN symptoms resulted from chronic avoidance of trauma-inducing stimuli which served to suppress emotion. Similarly, Horowitz (1986) attributed numbing symptoms to a reduction in emotional expression as a function of denial associated with trauma recall, characterizing PTSD as cycling between intrusive reexperiencing of trauma and EN.

Van der Kolk (1985; 1987) conceptualized EN as alternating with avoidance to regulate the experience of intrusion symptoms, allowing for the gradual processing of trauma memories. An effort at further explaining this process was made by a biological model—the infrahuman model of inescapable shock—which proposed that EN resulted from trauma-conditioned motivational deficits created by learned helplessness, a depletion of catelcholamines (i.e., adrenalin, norepinephrine, and dopamine), and the release of analgesia producing endogenous opioids (Pitman, van der Kolk, Orr, & Greenberg, 1990; van der Kolk, Boyd, Krystal, & Greenberg, 1984; van der Kolk, 1987). However, the infrahuman model was criticized because it failed to account for psychological mechanisms such as cognitive appraisals and attributions; moreover, it lacked empirical evidence to support the underlying theoretical assumptions of "inescapable shock/learned helplessness" (Litz, 1992, p. 422).

Kolb (1987) proposed that deficits in emotional arousal could be due to changes in neural functioning. Foa, Zinbarg, and Rothbaum (1992) maintained that numbing symptoms were due to an unconscious process resulting from an overstimulated endogenous opioid system, and were separate from effortful avoidance symptoms.

Litz (1992) characterized EN as arising from emotional exhaustion following episodes of hyperemotion in response to trauma cues, later referred to as the "depletion of resources" theory (Flack et al., 2000). In short, persons with PTSD "may expend so much effort coping with reexperiencing symptoms and hyperarousal that they exhaust their affective resources" (Litz, 1992, p. 418), resulting in episodic EN. Litz and Gray (2002) expanded on the depletion of resources theory in later work, clarifying that persons with PTSD are not emotionally numb per se, but rather exhibit a hyper-response to negatively valenced emotional stimuli; requiring greater degrees of positive stimulation to access positive emotional states.

Subsequent research supported Litz' (1992) hypothesis that EN results from emotional depletion spurred by trauma reminders. Flack and colleagues (2000) replicated and extended an earlier study by Litz et al. (1997) on predictors of EN. The study used psychophysiological measurements of PTSD, as well as self-report, and clinical interviews with service-seeking Vietnam veterans. Flack et al. (2000) confirmed the findings of the parent study, showing hyperarousal to be the strongest predictor of the development of EN, followed by depression, re-experiencing, and avoidance. Although those factors did contribute to the model, they did so inconsiderably in magnitude (Flack et al., 2000; Litz et al., 1997). Overall, the study results supported a causal relationship between EN and chronic hyperarousal.

Heart Rate Variability

Classical stress-response models based on the sympathetic dominant state of ANS hyperarousal are popular in the PTSD literature, yet fail to account for the hypoarousal presentation observed in a substantial minority of persons with PTSD (Hauschildt et al., 2011). Learning theory (operant conditioning) and dynamic systems theory (characterized by feedback loops) have also been applied to biofeedback (Zolten, 1989). Patients could bring heart function

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under voluntary control, to include increasing the decreasing heart rate, and decreasing the incidence of premature ventricular contractions (Pickering & Gorham, 1975; Benson, Alexander, & Feldman, 1975) supporting the notion that operant conditioning can affect neurocardiac processes; however, systems theory offers a more complete understanding of the mechanisms through which HRVB works.

Arising from the fields of biology, psychology, sociology, physics, and engineering, systems theory evolved from the work of North Whitehead (1919), Wiener (1948), and Weiss (1971), and most notably, Ludwig von Bertalanffy (1968), the acknowledged father of systems theory. Emphasizing holism over reductionism, understanding the relationship of system elements over prediction, and the organism over mechanism, Von Bertalanffy held that a system "may be defined as a set of elements standing in interrelation among themselves and with environment," (Bertalanffy, 1968, p. 252). Systems theory has been widely used to explain a variety of social science phenomena, and is particularly useful in assessing the stability of both healthy and diseased systems. Central to systems theory is the understanding that changes in one part of the system impact the other parts in a nonlinear fashion. Dynamical systems retain holistic characteristics, but show changing patterns over time; whereas systems unable to respond dynamically to environmental demands are unhealthy (Lehrer, 2013).

Schwartz (1981; Schwartz et al., 1979) articulated a nonmathematical approach to systems theory that was prominent in earlier biofeedback practice. Schwartz (1981) and Schwartz et al. (1979) applied basic principles of systems theory (i.e., whole/part relationships, level and emergent properties, and self-regulation/dysregulation) integrating psychobiological and behavioral approaches, and proposed all behavioral therapies involved psychobiological processes indirectly impacting physical health, distinguished only by level. Schwartz (1981)

maintained that assessing the interaction of biological, psychological, and social treatment modalities was central to responsible patient care, elucidating the systems concept of behavioral medicine, and an interdisciplinary approach to treatment.

Building on Schwartz's biopsychosocial systems application to behavioral medicine (1981; Schwartz et al., 1979), Lehrer and Eddie (2013) described a method of control systems modeling which could be applied to cardiovascular activity and HRVB. They posited that a control system is a stable system in which the elements of the system work together to preserve its stability and systems were either closed- or open-loop. Whereas closed-loop systems involve internal regulation in which the system monitored and adjusts itself in response to outside stimulation processed through internal feedback loops, open-loop systems involve only a system response to an outside event. Feedback is said to result from oscillatory activity, and feedback from multiple, simultaneous, naturally occurring oscillatory rhythms will result in systems control.

Negative feedback loops, also called *balancing* (as opposed to reinforcing) loops, can be described as common control mechanisms that lead to stability in closed loop systems and may include delays caused by the time necessary for system elements to effect change in each other. According to Lehrer and Eddie (2013), negative feedback loops work by triggering high-amplitude oscillations at a single frequency, resulting in resonance effects. While oscillations require some form of perturbation to maintain amplitude, these perturbations can result from positive (reinforcing) feedback loops. The baroreflex is described as being a good example of a stable oscillatory process. Lehrer and Eddie (2013) describe healthy regulation as being characterized by "sympathetic and parasympathetic activity converging in a limit cycle around a critical value…Thus, sympathetic activity may simultaneously suppress parasympathetic

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activity, but increase parasympathetic reactivity, thereby producing an oscillation" (p. 7). HRVB is theorized to work through stimulation of resonance in an oscillating system—resonance in the cardiovascular system is produced by a baroreflex rhythm. Thus, baroreflex rhythms in the cardiovascular system produce resonance, resulting in the beneficial effects of HRVB.

Simplicity (limited variation) in a system may result from allostatic overload or biological damage (Lerher & Eddie, 2013). Simplicity is reflected in low heart rate variability (HRV) where there is reduced variation in interbeat intervals, and is associated with the development of disease. *Randomness* in a system suggests a lack of modulatory control, such as in cardiac arrhythmias, and is also regarded as a sign of poor systems adaptation. HRV complexity suggests cardiac flexibility and adaptability resulting in rapid recovery. Disease, injury, and aging reduce adaptability and reflect decreased oscillation in control systems and the subsequent decreased ability to recover quickly from external demands. (Lehrer & Eddie, 2013).

Porges' polyvagal theory offers the strongest evidence for how HRVB works to ameliorate numbing symptoms in PTSD. Polyvagal theory also helps to explain how people connect as social beings when they feel safe. Based on systems theory, Porges' Polyvagal theory (Porges, 1997; 2007; 2011) provides a parasympathetic basis for emotional, social, and affiliative responding, as well as a perspective that integrates the reciprocal influences and bidirectional communication between the heart and central nervous system. The Polyvagal theory emphasizes a distinction between the neurophysiological and neuroanatomical branches of the vagus, proposing each branch supports different adaptive behavioral strategies, and offers a systems-based understanding of the development of PTSD. A systems-based understanding is important because of the complexity and interrelatedness of the subsystems and their emergent properties. According to Porges (2011):

The polyvagal theory links the evolution of the neural regulation of the heart to affective

experience, emotional expression, facial gestures, vocal communication, and social

behavior that is responsive to the behavior of others. The theory points out that the

neural control of the heart is neuroanatomically linked to the neural control of the

muscles of the face and head (p. 16).

Porges (2007; 2011) described three phylogenetically ordered autonomic subsystems

developed in humans to adaptively respond to threats, to include immobilization (freeze),

mobilization (fight or flight), and social and affiliative responding. The vagus is the 10th cranial

nerve, and the longest nerve in the human body, with both myelinated and unmyelinated regions

(Porges, 1997). The social and affiliative subsystem is related to the myelinated vagus, and

theorized to have been the most recent evolutionary response to threat. During safe conditions,

there is an inhibition of the sympathetic influences on the heart and decreased activity in the

hypothalamic-pituitary-adrenal axis. Vagal fibers from the ventral vagal nucleus ambiguous

produce cardiac deceleration (slowed heart rate) by inhibiting sympathetic influences on the

heart, leading to calm and social behavioral states. The mobilization system (the second to

evolve) is related to the functioning of the SNS in response to threats whereby heart rate

increases in response to threats through the activation of the central nucleus of the amygdala. The

immobilization system is the most phylogenetically primitive and is dependent on the

unmyelinated vagus, shared with most reptiles and amphibians (Porges, 1997; 2011).

Porges' polyvagal theory is a useful framework to support the neurophysiological

underpinnings of research findings on the existence of different subtypes of PTSD, as well as

explain how approaches that strengthen vasovagal responses, such as HRV biofeedback, can

improve EN symptoms (Porges, 1995; Porges, 1997; Porges, 2011; Lanius, Bluhm, Lanius, &

Pain, 2006). According to polyvagal theory, EN may result from a primitive immobilization response in the face of extended and uncontrollable hyperarousal, leading to marked psychosocial deficits (Ginsberg, Berry, & Powell, 2010).

Literature Overview

As noted previously, persons with PTSD and its subclinical symptoms show impaired functioning in key life domains, such as interpersonal relationships (Badour, Gros, Szafranski, & Acierno, 2015). The majority of persons with PTSD report restrictions in their ability to feel (Amdur, Larsen, Liberson, 2000). Experts describe these deficits in feeling as emotional numbing (EN), while sufferers have characterized them as a kind of "emotional anesthesia." Symptoms of EN refer to a "diminished responsiveness to the external world," which is hypothesized as an "automatic biological response to an extended state of uncontrollable hyperarousal" (Bensimon et al., 2013, p. 84).

Symptoms of EN typically include markedly diminished interest in significant activities, feelings of detachment or estrangement, and restricted range of affect (Feeny, Zoellner, Fitzgibbons, & Foa, 2000). Ernest Hemingway's 1925 short story, "Soldier's Home," which in many ways parallels his own life, provides a famous literary example. Hemingway (2014) tells the story of Harold Krebs, a recently returned World War I soldier exposed to the savagery of war. Struggling with reacclimation to civilian life, he apathetically and aimlessly wanders his hometown. Krebs rejects intimate relationships and tells his mother he does not love her because he cannot love anyone. He rejects his prewar family values, traditions, and religious beliefs, no longer finding them important.

The phenomenon of emotional deficits experienced by persons with PTSD is a broad and rather loosely defined concept, reflecting the heterogeneity of its presentation (Amdur et al.,

2001). EN refers to a "generalized deficit in emotional responding to positive events, despite the intact ability to access negative emotional states" following a trauma, resulting in a diminution of emotional responsiveness to others as well as to external events (Litz, 1992, p. 418). Glover (1992) described the experience of EN as feeling "dead," "shut down," "hollow," "empty," and "ice cold," Barglow (2014) described patients' subjective experience of numbing in the case of trauma as being, "…captured by colloquial concrete adjectives such as 'zombified,' 'spaced out,' 'stunned,' 'deadened,' 'lifeless,' and 'empty.'" (p. 130). In a qualitative study of OIF/OEF soldiers and potential suicide risk factors, soldiers described EN as protective armor on the one hand, and feelings of isolation from friends and family, reduced ability to feel joy, and emotional disconnection on the other (Lusk et al., 2015).

Related Constructs

Several constructs are closely related to EN, calling into question whether numbing symptoms are a distinct construct with a singular etiology. Symptoms of emotional numbing in PTSD have been correlated with alexithymia (Bujarski, 2012) anhedonia (Badura, 2003), apathy (Glover et al., 1994), and dysphoria (Simms, Watson, & Doebbeling, 2002; Zoellner, Pruitt, Farach, & Jun, 2014).   Persons with alexithymia are said to exhibit externally oriented thinking and experience difficulty identifying and labelling emotions (de Vente, Kamphuis, & Emmelkamp, 2006). The concept of alexithymia originated with Sifneos (1973) and was used to describe persons who were poor psychotherapy candidates (Bujarski, 2012). Badour (2002) concluded that alexithymia was best conceptualized as EN in PTSD, rather than as a related or distinct construct. A meta-analytic study by Frewen, Dozois, Neufeld, and Lanius (2008) found persons with PTSD experienced alexithymia at higher levels compared to persons without PTSD.

Anhedonia is the loss of pleasure or interest, and is also associated with depression, schizophrenia and other psychiatric disorders. Research shows anhedonia to have a unique relationship to EN in combat veterans with PTSD distinct from other PTSD symptoms (Kashdan, et al., 2006). Also, studies show considerable overlap between anhedonia and depression (Armour et al., 2012). Researchers have also related the constructs of apathy and dysphoria to EN. Apathy is described as a lack of motivation, and has also been associated with a variety of psychiatric disturbances (Marin, Biedrzycki, & Firinciogullari, 1991). Regarded to be a prominent component in PTSD and closely related to depression, dysphoria refers to the "absence of positive mood and pleasurable experiences" (Zoellner et al., 2014, p. 98). Having documented the blurred edges of these constructs, EN remains a useful concept for capturing the cluster of symptoms that are particularly pernicious in their effects on psychosocial functioning.

Overlapping Diagnoses

Some researchers consider EN to be a cardinal PTSD feature, while others believe numbing symptoms are representative of overlapping PTSD, depression, and dissociation. Traumatologists have noted the overlap of symptoms characterizing PTSD and depression (Feeny et al., 2000). However, EN is distinguished from depression because it denotes the absence of feelings, to include those of sadness and depression. Glover and colleagues (1994) posited that EN "denotes an absence of feelings, including depression, worry, and guilt. In contrast to a depressed individual who lacks feelings of care and concern for himself/herself, an emotionally numb individual lacks feelings of concern for both self and others," (p. 71). Further expanding on the relationship of EN to depression and providing an early but apt description of the current *DSM-5* classification of EN as "negative alterations in cognitions and affect," (Glover, 1992; Glover et al., 1994) the authors state:

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Hostile feelings may be the only emotions that numb individuals may be able to experience. Once enraged, they continue to experience a lack of concern for themselves and others, and they feel indifferent about the destructive consequences of their violent acts. The majority of emotionally numb individuals have also been described to readily and involuntarily switch back and forth from the condition in which they experience no feelings to one in which they feel depressed (p.71).

In a study of service-seeking and service-using Vietnam veterans, Flack, Litz, Hsieh, Kaloupek, and Keane (2000) found no association between EN and depression after controlling for other variables. The finding that EN and depression are distinctly separate constructs was also confirmed in a study by Litz, Orsillo, Kaloupek, and Weathers (2000). However, other studies have yielded mixed results on the degree of overlap between depression and EN (Feeny et al., 2000; Litz et al., 1997).

Research has also shown an overlap between dissociation and EN. Dissociation involves alterations in memory, identity, and consciousness (Feeny et al., 2000). Spiegel (1997) conceptualized dissociative symptoms as an extreme end of the numbing continuum. Barglow (2014) suggested that the dissociative subtype of PTSD containing symptoms of depersonalization (i.e., feeling detached from one's mind and body) and derealization (i.e., experience of unreality of surroundings) should be considered "more malignant aspects of severe numbing, as they were in *DSM-IV"* (p. 39).

Evolution of Emotional Numbing in the Diagnostic and Statistical Manual (*DSM)*

In the mid-nineteenth century U.S., trauma syndromes emerged to describe the individual impact of the invisible wounds of war, with each name change reflecting our greater understanding of combat-related trauma. From U.S. Civil War times to the present hostilities,

the trauma injury we now know as PTSD has been previously known as soldier's heart; Da Costa's syndrome, shell shock, combat fatigue, and traumatic neurosis (Friedman et al., 2011b). In the age of the *DSM*, PTSD has been known as anxiety-related posttraumatic stress, and most recently, as trauma and stressor-related posttraumatic stress.

The forerunner to the diagnosis now known as PTSD was dubbed, "Gross Stress Reaction" in the *DSM-I* (1952) 1st ed., in response to the psychological damage mental health professionals observed in World War II soldiers. Gross Stress Reaction was classified under the category of Transient Situational Personality Disorders and previously normal sufferers were expected to recover once they left the battlefield (APA, 1952; Scott, 1990).

Intensified interest generated by the women's movement and public interest in Vietnam led to diagnostic improvements. When the *DSM-II* (1968) 2nd ed. was published, the symptoms most closely resembling what we now know as PTSD were no longer grouped with personality-related disorders, but instead recognized as a *transient situational disturbance* and classified as *adjustment reaction of adult life*." One particularly pejorative example provided by the *DSM-II* described a combat stress reaction as "fear associated with military combat and manifested by trembling, running, and hiding" (p. 39). Prior to any specific PTSD diagnostic criteria, specific trauma syndromes were dubbed with labels causally referencing the index trauma (e.g., war sailor syndrome, rape trauma syndrome, post-Vietnam syndrome, concentration camp syndrome) (Friedman et al., 2011b).

In the *DSM-III* (1980) 3rd ed., a number of discrete trauma syndromes were collapsed into a single diagnostic classification under the first appearance of the PTSD diagnostic criteria (Friedman et al., 2011b). The construct of emotional numbing (EN) was described as a symptom category. However, the distinct numbing cluster was eliminated with the publication of the

DSM-III-R (1987) 3rd ed., revised and combined into a cluster with avoidance symptoms. In the *DSM-III-R*, EN was characterized as a type of "psychic numbing" or "emotional anesthesia" accompanied by a diminished responsiveness to the outside world not present before the trauma and the use of avoidance as a coping mechanism. The *DSM-IV* (1994) 4th ed. and the *DSM-IV-TR* (2000), 4th ed., text rev. retained these symptom clusters.

Confirmatory factor analytic (CFA) investigations showing how PTSD factor structures should best be grouped together are limited due to the use of different trauma samples (e.g., military veterans, motor vehicle accident survivors, cancer survivors), but most studies indicate the separation of avoidance and numbing symptoms into distinct clusters because they play unique roles in the psychopathology of PTSD (Asmundson, Stapleton, & Taylor, 2004; Bensimon et al., 2013; Biehn, Elhai, Fine, Selgiman, & Richardson, 2012; Friedman, Resick, Bryant, & Brewin, 2011a; King, Leskin, King, & Weathers, 1998). Four-factor CFA structural models containing reexperiencing, avoidance, numbing, and hyperarousal clusters showed superior model fit compared to alternative models (including the *DSM-IV* three-factor model) (Bensimon et al., 2013; King et al., 1998; McDonald et al., 2008; Mansfield, Williams, Hourani, & Babeu, 2010).

Of the four-factor PTSD models, two have garnered the most empirical support from factor analytic research and are described in conceptually distinct models—the EN (King et al., 1998) and dysphoria (Simms et al., 2002). The four-factor intercorrelated model proposed by King et al. (1998) includes reexperiencing, avoidance, EN, and hyperarousal. Although both models separated EN and avoidance into separate clusters, the most notable difference in the Simms et al. (2002) four-factor model is that EN symptoms were collapsed into a newly identified dysphoria cluster combined with three hyperarousal symptoms (Hassija et al., 2012;

Liu et al., 2016). Neither model has found support by a clear majority of studies, with results differing depending on whether self-report or clinician-administered measures were used, and whether clinical or nonclinical samples were used (Biehn et al., 2012; Elhai et al., 2011; Elhai & Palmieri, 2011).

As a result of extensive debates on the latent dimensionality of PTSD, the American Psychiatric Association (APA, 2013) revised the diagnostic criteria for PTSD in the *DSM-IV-TR* from a 3-cluster (i.e., intrusion, avoidance/numbing, and hyperarousal) to a 4-cluster model (intrusion, avoidance, negative alterations in cognitions and mood, and negative alterations in arousal and reactivity) with the publication of the *DSM-5*.

The revised four-factor model adopted in the *DSM-5* was based on the model put forth by King and colleagues (1998) with additional emphasis on dysphoria and externalizing symptoms (Friedman, 2013). In the *DSM*-5, Posttraumatic Stress Disorder was moved to a new section, "Trauma- and Stressor-Related Disorders," reflecting a positive change in the portrayal of PTSD. The Criterion A2 requirement that "the person's response to the event must involve intense fear, helplessness, or horror" was eliminated (APA, 2000, p. 463).

The EN cluster was separated from effortful avoidance, and reconceptualized into a new cluster named "negative alterations in cognition and mood," (Criterion D) that included most of the *DSM-IV* numbing symptoms (i.e. "markedly diminished interest or participation in significant activities," "feelings of detachment or estrangement from others," and "a persistent inability to experience positive emotions") but added new symptoms (i.e. persistent negative emotional states) (APA, 2013, p. 79). This refinement in the concept of psychic numbing reflected difficulties in experiencing positive emotions for persons with PTSD, despite the continued ability to access negative emotional states (Friedman et al., 2011a). In addition, the

C5 symptom in the *DSM-IV-TR* (i.e. "restricted range of affect," e.g., "unable to have loving feelings) (APA, 2000, p. 468) was reworded as D7 in the *DSM-5* to "persistent inability to experience positive emotions (e.g., "inability to experience happiness, satisfaction, or loving feelings") (APA, 2013, p. 72). Kerig et al. (2016) criticized the current *DSM-5* structure which limits EN to experiences of positive affect, likely overlooking other forms of EN.

More recent research has not supported earlier generalized numbing models of EN and findings have been inconsistent regarding more recent models (Orsillo et al.,2007). Advancements, such as functional magnetic resonance imaging (commonly known as fMRI), are transforming what we know about the brain and the neurobiological underpinnings of PTSD and EN (Blank, 2013). In light of emerging evidence, the EN model clearly requires a reconceptualization that will cluster the symptoms differently.

Neurophysiology of Emotional Numbing

Although early attempts to understand the construct of EN were based on participant self-report, neurophysiological studies have informed more recent conceptualizations of EN as deficits in the reward system of the brain, increasing the concept's robustness. Similar to drug addiction, researchers have linked the underlying mechanisms of EN symptoms to dopamine reward dysfunction (Enman, Arthur, Ward, Perrine, & Unterwald, 2015). Felmingham et al. (2014) linked reward-system deficits to EN symptoms, finding an association between EN and reduced amygdala and ventral striatal activity in response to happy faces in persons with PTSD. Persons with PTSD perceived happy facial expressions as being less intense. A greater level of severe EN symptoms was negatively correlated with lower ventral striatal-limbic activation, and this effect remained significant even after controlling for depression. Felmingham and colleagues (2014) noted the importance of the finding because reduced facial perception results

in reduced social functioning and EN is associated with significant functional and social impairment observed in chronic PTSD. The researchers' provided further evidence that PTSD results in diminished responsiveness to positive cues.

Enman and colleagues (2014) maintain that persons with PTSD show deficient hedonic or reward capacity. Studies of monetary rewards, and time spent viewing attractive faces show that persons with PTSD manifest deficits in reward capacity as demonstrated by expending less effort to achieve rewards, lower expectancies of receiving rewards, and lower satisfaction with received rewards (Elman et al., 2005; Hopper et al., 2008), These deficits in reward function suggest alterations in mesolimbic circuitry in striatal brain regions associated with the dopamine reward system leading to PTSD symptoms of anhedonia and EN (Enman et al., 2014).

Neuroimaging studies offer insight into brain regions that may be associated with phasic (alternative hyperarousal and EN) or PTSD subtypes, and can help explain why persons with prominent EN symptoms may not respond as well to traditional, exposure-based psychotherapeutic approaches. Compared to controls, persons displaying dissociative PTSD showed significantly increased activity in the right medial frontal and prefrontal regions, as well as right anterior cingulate activity, and a dampened amygdala response. The dissociative response may reflect greater emotional regulation and increased inhibition of limbic networks. Conversely, persons displaying a hyperarousal response showed excessive amygdala activity with reduced bilateral medial frontal and left anterior cingulate activity in comparison to controls (Lanius et al., 2002). Thus, EN appears to be a function of limbic inhibition, as opposed to hyperarousal, which involves limbic overactivation.

Building on research supporting different PTSD subtypes, Lanius and colleagues (2010) described a type of PTSD characterized mainly by dissociative symptoms that manifested as

chronic EN. Unlike in more hyperaroused subjects, heart rate did not increase in these persons

when recalling traumatic memories, suggesting corticolimbic inhibition. Lanius et al. (2010)

suggested that persons who display the dissociative subtype of PTSD and present with

overmodulated physiological responses to trauma-related stimuli may not benefit from exposure

therapy because limbic inhibition (i.e., hypoarousal and dissociation) represents a protective

response to overwhelming trauma. According to polyvagal theory, limbic inhibition represents

the activation of the immobilization ("freeze") system in the face of what is perceived to be

certain death. This primitive autonomic response, below the level of conscious awareness,

paralyzes the social response system. Thus, EN symptoms are the ultimate psychophysiological

defense, preparing the human organism to cope with overwhelming pain and fear.

Neurochemicals such as oxytocin, serotonin, and endogenous opioids are released and neural

changes occur which are believed to have a protective function. According to this perspective,

therapeutic interventions that stimulate the vagal system (i.e., those that involve intentional

manipulation of the breath) could restore autonomic nervous system balance and bring the social

engagement system back online (Porges, 2011).

    Recent studies are questioning the factor structure of PTSD in its current *DSM-5* (APA,

2013) form. Due to advances in brain imaging and genetics, we have an enhanced understanding

of the neurobiological mechanisms underlying PTSD in general, and EN in particular. Our

emergent knowledge that individual PTSD clusters have different underlying neurological and

genetic findings is of great importance to future research efforts, assessment, and clinical

practice, and any future *DSM* factor structure of PTSD must have the support of dimensional

research informed by brain imaging and genetics. Although still far from clinical reality,

neuroimaging could extend our understanding of EN, and could enable diagnostic precision and

guide the choice of treatment approaches. We need to focus our efforts on dimensional research approaches into PTSD and its latent factor structure because "posttraumatic responses also exist in a continuum rather than in a traditional dichotomous model of health and disease" (Lobo et al., 2014, p. 234).

How Emotional Numbing Fits into Proposed Models

Changes in the factor structure of the PTSD diagnostic criteria are certain to be made in the next *DSM* iteration—*DSM-5-TR* or *DSM-6*—because the current four-factor model does not reflect recent advances in our understanding of the underlying neurobiological mechanisms of PTSD (Armour, Műllerová, & Elhai 2016; Kerig et al., 2016; Liu et al., 2016; Pietrzak et al., 2015; Tsai et al., 2014). A recent systematic review by Armour et al. (2016) found two six-factor models showed the best fit for PTSD using *DSM-5* criteria. Liu et al. (2014) proposed a six-factor anhedonia model comprised of intrusion, avoidance, negative affect, anhedonia, anxious arousal, and dysphoric arousal that separates negative alterations in cognitions and mood into negative affect and EN symptoms into anhedonia. According to Liu et al. (2014) this model is based on substantial theoretical and empirical evidence but was based on pain patients, rather than veterans.

Tsai et al. (2014; 2015) also proposed a six-factor model based on intrusion, avoidance, negative alterations in cognitions, and mood, externalizing behavior, anxious arousal, and dysphoric arousal. This six-factor model, which separated internalizing and externalizing symptoms, showed significantly better model fit in a representative sample of U.S. veterans than previous *DSM-IV* models. Armour et al. (2015) proposed a seven-factor model consisting of the following factors: intrusion, avoidance, negative affect, anhedonia, externalizing behavior, anxious arousal, and dysphoric arousal. Armour and colleague's (2015) hybridized model also

showed significantly better model fit in a nationally-representative sample of veterans, and was further supported in a study by Pietrzak et al. (2015) with a veteran sample.

The range and complexity of PTSD symptomatology is much greater than currently reflected in the factor structure of the *DSM-5*. Further, even though the *DSM-5* treats all PTSD symptom clusters as equal, research does not bear this out. To illustrate this point, EN symptoms appear to exact a much greater psychosocial toll than do symptoms of avoidance. Research supports that each PTSD cluster has different neurobiological and genetic underpinnings. To appropriately target treatment efforts, we need to advance our understanding of the differential impact and effect of PTSD subcluster symptoms, rather than treating symptoms as if they share a common etiology.

Measurement of Emotional Numbing

Historically, research on EN has lagged behind the other PTSD cluster symptoms (e.g. hyperarousal) due to the lack of an operational definition and likely because deficit symptoms are harder to measure. Some experts consider the presence of EN to be pathognomonic of PTSD, and to more reliably distinguish cases of PTSD than other symptoms because numbing symptoms are the least reported (McMillen, North, & Smith, 2000). Global PTSD measures, as well as several specific numbing scales, are used to assess the presence and severity of EN symptoms arising from combat-related PTSD. Based on the association of EN symptoms with more severe psychosocial dysfunction, combined with the relative rarity of EN compared to other symptom clusters, higher levels of EN (as indicated by frequency and intensity) should be equated with PTSD severity. The presence and severity of EN should inform outcome assessments for treatment response and attrition, as well as risk assessments for the more serious comorbidities associated with PTSD (e.g., substance use disorders and suicide).

The *Clinician-Administered Posttraumatic Stress Disorder scale for DSM-5* (Weathers et al., 2013a; CAPS) and the *Posttraumatic Stress Disorder Checklist* (PCL; Weathers et al., 2013cPCL) are the measures most widely used for detecting PTSD in combat veterans and are based on current *DSM-5* diagnostic criteria. The PCL is best used for screening, provisional diagnosis, and to measure treatment response. The CAPS is considered the gold standard for making a clinical diagnosis of PTSD, because scores are not solely based on self-report, but include behavioral observations made by the clinician during the interview.

Several measures have emerged to specifically detect the presence and severity of EN, specifically the *Glover Numbing Scale* (Glover et al., 1994) and the *Emotional Reactivity and Numbing Scale* (Orsillo, Theodore-Oklota, Luterek, & Plumb, 2007; ERNS). The *Morel Numbing Scale for Posttraumatic Stress Disorder* (Morel, 1998) will not be discussed here because it was developed to differentiate authentic from simulated PTSD symptoms in veterans, rather than assess for EN.

Posttraumatic Stress Disorder Measures

PTSD Checklist for the DSM-5 (PCL-5). The 20-item PCL-5 (Weathers et al., 2013) is a widely-used self-report measure that corresponds to the 20 symptoms of PTSD included in the *DSM-5*, an increase from the 17 items included in the PCL for the *DSM-IV*. The scale can be completed in 5-10 minutes and must be interpreted by a clinician. It can be used for screening, making a provisional PTSD diagnosis, and to monitor changes in symptoms during and posttreatment. Although the PCL for the *DSM-IV* included three versions (military, civilian, and specific), there is only one PCL-5.   However, the PCL-5 has three formats—one that includes the Criterion A component (i.e., "exposure to actual or threatened death, serious injury, or sexual violence," APA, 2013, p. 271), one that does not, and one that includes the Life Events

Checklist-5 (LEC-5; Weathers et al., 2013b) along with an extended Criterion A component. The version without a Criterion A component is appropriate to use when the trauma exposure is being assessed by another method. The EN cluster can be assessed by separately summing Criterion D (i.e. negative alterations in cognitions and mood) scores.

Unlike the previous PCL (Weathers, Litz, Herman, Huska, & Keane, 1993), which ranked items on a 1-5 scale, PCL-5 items are rated 0-4 (0 = Not at all; 1 = A little bit; 2 = Moderately; 3 = Quite a bit; and 4 = Extremely). Due to changes in the number of items and scale rankings, scores cannot be directly compared. While further psychometric work is in progress, Weathers and colleagues (2013c) suggest a clinical cut-point of 33 out of a total possible symptom severity score of 0-80. Reliable change (i.e. not due to chance) requires a 5–10-point score change, and score changes between 10–20 points suggest a clinically significant change. The PCL-5 demonstrated high internal consistency reliability and sound psychometric properties with a population of treatment-seeking military service members (Wortman et al., 2016).

Clinician-Administered PTSD Scale for DSM-5 (CAPS-5). The CAPS-5 (Weathers et al., 2013a), is a 30-item structured clinical interview that relies on self-report and clinician observation of behavior. The CAPS-5 is intended to assess adults for a current (past month) diagnosis, lifetime diagnosis of PTSD, and/or symptoms during the past week. The LEC-5 (Weathers et al., 2013b) should be used at the outset to establish the Criterion A index trauma, which will be the focus of the CAPS-5 interview. The LEC-5 includes a list of 16 potentially traumatic life events rated on a 6-point nominal scale (1 = "happened to me," 2 = "witnessed it," 3 = "learned about it," 4 = "part of my job," 5 = "not sure," and 6 = "doesn't apply"). The LEC-5 is nearly identical to previous scale versions that show good reliability and validity. The

CAPS-5 assesses for the 20 *DSM-5* PTSD symptoms as well as onset and duration of symptoms, subjective distress, impact on social and occupational functioning, symptom improvement, overall response validity, overall PTSD severity, and dissociative symptoms of depersonalization and derealization.

Unlike the CAPS for *DSM-IV* (Blake et al., 1995), which asked respondents to keep up to three traumatic events in mind and assessed for separate frequency and intensity scores, the CAPS-5 (Weathers et al., 2013a) refers to a sole index trauma as the basis for response and assesses for a single severity score. The CAPS-5 was comprised of standardized prompts and follow-up probing questions using a five-point ordinal rating scale: 0 = absent; 1 = Mild (subthreshold); 2 = Moderate (threshold); 3 = Severe (markedly elevated); and 4 = Extreme (incapacitating) corresponding to symptom frequency and intensity (except for amnesia and diminished interest, which are based on amount and intensity). The CAPS-5 was designed for administration by a clinician or clinical researcher with a working knowledge of PTSD, but can be administered by a trained paraprofessional. Administration takes approximately 45–60 minutes.

The 20 *DSM-5* PTSD scores are summed to calculate the total symptom severity score. Separate scores for *DSM-5* clusters can be obtained by summing individual item severity scores corresponding to a particular *DSM-5* Cluster. A diagnosis of PTSD requires at least one Criterion B (i.e., intrusion symptoms), one Criterion C (i.e., persistent avoidance), two Criterion D (i.e., negative alteration in cognitions and mood, including EN symptoms), and two Criterion E (i.e., alterations in arousal and reactivity) symptoms rated at moderate or greater severity. Criterion F (duration exceeds one month), Criterion G (significant distress/impairment), and Criterion H (not due to substance or medical condition) must also be met. There are three

versions of the CAPS-5: past week, past month, and worst month (lifetime). Although a

relatively new measure, researchers consider the CAPS-5 to have "excellent reliability and

validity" (Schnurr et al., 2015).

Emotional Numbing Measures

There is no current "gold standard" measure for assessing EN. Most studies have relied

on self-report or measures that define EN using *DSM* criteria (Orsillo et al., 2007). The EN

scales in existence reflect the theoretical stances of their respective authors. Glover et al. (1994)

made the first attempt to operationalize the concept of the numbing response with the

development of a scale to measure EN. The Glover Numbing Scale (Glover et al., 1994; GNS)

was based on the theory that EN stems from an endorphin response to depression and

vulnerability, in line with the theory proposed by Foa et al. (1992) suggesting EN results from an

overstimulated endogenous opioid system. The Emotional Reactivity and Numbing Scale

(ERNS) is consistent with the depletion of resources theory (Litz, 1992; Litz et al., 1997),

wherein EN is hypothesized as a reaction to emotional exhaustion in response to episodic

hyperemotionality. The key difference between the GNS and the ERNS is that the ERNS

explores numbing in the face of both positive and negative domains, reflecting more recent

theoretical advances in the understanding of EN.

Glover Numbing Scale. The GNS (Glover et al., 1994) contains 35 items measuring five

orthogonal factors (dead/alive feelings, e.g., "I feel dead or shut down"; somatic experiences,

e.g., "my body feels numb"; cognition, e.g., "My memory is adequate for everyday things";

destructive anger, "When I get angry, I feel destructive"; caring for others, e.g., "I care about my

friends") as determined by a principal components factor analysis (p. 117). Scale items are rated

for the preceding week on a Likert scale from 1 to 7 (1 = never; 2 = very rarely; 3 = rarely; 4 =

occasionally; 5 = frequently; 6 = very frequently; 7 = always). To avoid any kind of response set

bias, half of the items are rated toward health and half toward psychopathology. Positively

worded items are reverse scored and scores on each factor are summed to obtain an overall

index. Although the scale was constructed to assess the frequency of the numb response, rather

than intensity, the authors maintain that scores are sensitive indicators of level of functioning and

severity in populations with PTSD. A test of the psychometric properties of the GNS yielded

satisfactory results. In a study of inpatient Vietnam combat veterans with PTSD ($n = 323$) and

PTSD diagnosed Veterans Affairs (VA) outpatient and outreach center veterans ($n = 208$), the

scale's internal consistency was .93. Test-retest reliability was .80 (Glover et al., 1994).

A study of the psychometric properties of the GNS conducted by Clapp and Beck (2009)

found the 5-factor structure proposed by Glover et al. (1994) to be a poor model fit. In their

exploratory factor analysis, the authors proposed that a one-factor model consisting of 30 items

best fit the sample data. However, this study was conducted with community members recruited

for possible PTSD treatment following a motor vehicle accident, rather than with combat

veterans (Clapp & Beck, 2009).

Emotional Reactivity and Numbing Scale. The ERNS was developed by Orsillo and

colleagues (2007), and normed on U.S. military veterans. The 62-item scale includes five

subscales (positive, sad, anger, fear, and general) and is rated on a 5-point Likert-type scale (1 =

"not at all," and 5 = "entirely typical of me"). Specific cutoff scores have not been determined;

however, mean scores from the psychometric study conducted by Orsillo et al. (2007) can be

used as a guide. Higher scores on subscales indicate greater emotional reactivity and lower

scores suggest greater levels of EN.

Compared to persons without PTSD, the ERNS scores of those with PTSD indicated higher general numbing symptoms and greater numbing in response to positive cues. Scores on the General subscale were significantly lower for persons with PTSD ($M = 24.62$, $SD = 7.83$) compared to persons without PTSD ($M = 28.25$, $SD = 6.43$); Positive subscale scores for persons with PTSD ($M = 97.98$, $SD = 15.05$) were significantly lower than for those without ($M = 97.98$, $SD = 15.05$). Persons with PTSD also showed greater responsivity to negative scale items of anger ($M = 38.10$, $SD = 7.40$) and sadness ($M = 43.21$, $SD = 6.99$) compared to persons without ($M = 34.61$, $SD = 8.81$; $M = 39.35$, $SD = 7.30$). Psychometric evaluation of the ERNS showed good test–retest reliability, and demonstrated convergent and discriminate validity (Orsillo et al., 2007).

Neurophysiological Measures

Currently, like most psychiatric disorders, the diagnosis of PTSD relies on a limited *DSM* categorization scheme that is based on self-report and behavioral observation. Studies conducted since the advent of the *DSM-5* show a lower prevalence of PTSD than when the *DSM-IV* criteria were used for assessment (Rosellini et al., 2015), reflecting changes in diagnostic criteria (i.e., separation of avoidance and EN criteria). Under the *DSM-IV* and the *DSM-IV-TR* it was possible to meet the diagnostic criteria by endorsing EN symptoms only; however, both avoidance and numbing symptoms are separately required for a diagnosis under the *DSM-5*, consistent with factor analytic studies indicating the structural distinctiveness of EN and avoidance (King et al., 1998; Naifeh, Elhai, Kashdan, & Grubaugh., 2008; Palmieri, Weathers, Difede, & King, 2007; Simms et al., 2002).

The Research Domain Criteria (RDoC) project developed by the National Institute of Mental Health is an initiative intended to transform diagnostic science by classifying brain

disorders using empirical evidence from cognitive, imaging, and genetic markers (Insel et al.,

2010). The RDoC "seeks to define basic transdiagnostic constructs across multiple units of

analysis from genes to neural circuits to behaviors in order to rapidly develop an integrative

understanding of psychopathology and improve treatment development" (Zoellner et al., 2014, p.

97). Consistent with recommendations by the RDoC, efforts are underway to develop PTSD

diagnostic tools using biomarkers. While the discovery of a single biomarker that reliably

distinguishes the heterogeneous symptomatology of PTSD is unlikely, the presence of

neuroanatomical, genomic, and other physiologic differences can provide some diagnostic

clarification. Composite measures thus hold more promise than single-pathway measures.

Given that the brain is the chief organ implicated in stress, diagnostic tests using neural

imaging generate the most research interest (Lobo et al., 2015). Most PTSD neuroimaging

studies have focused on the amygdala, hippocampus, and prefrontal cortex (PFC) and have

concluded that abnormalities in these brain areas are reliable findings (Meyer et al., 2015).

Robust evidence shows PTSD is associated with hypothalamic-pituitary-adrenal axis

dysfunction. Also, plasma levels of cortisol are lower and glucocorticoid receptors show greater

responsiveness in persons with PTSD (Ruiz, Barbosa Neto, Schoedl, & Mello, 2007). However,

studies of endocrine markers for PTSD, such as salivary cortisol, have yielded mixed results

insofar as predictive value (Savic, Knezevic. Damjanovic, Spiric, & Matic, 2012). Compared to

controls, persons with PTSD show higher levels of amygdala activity and reduced levels of

medial PFC activity in response to trauma stimuli, as well as lower hippocampal and anterior

cingulate volume (O'Doherty, Chitty, Saddiqui, Bennett, & Lagopoulos, 2015).

Without a doubt, advances in brain imaging have greatly increased our understanding of

PTSD. However, modern imaging techniques, such as functional magnetic resonance, are still

expensive, unwieldy, intrusive, and unaffordable for clinical practice in most cases. The use of electroencephalography (EEG) as a diagnostic tool for PTSD is generating increased interest given that EEG is less costly, less intrusive, more portable and more feasible for clinical use than other types of imaging (McLoughlin, Makeig, & Tsuang, 2014). EEG auditory event-related potentials (P200; P300; and P50 (i.e., neural responses that occur 50, 200, and 300 milliseconds following a stimulus) and alpha asymmetry (i.e., differences in right and left side prefrontal alpha waves) are promising biomarkers that could shed more light on posttraumatic stress pathology (Lobo et al., 2015). However, reliable neural markers to detect EN are still elusive. EEG biomarkers could possibly pave the way for a reliable PTSD diagnostic test that would yield critical information about the severity of subcluster symptom groups.

In clinical settings, the PCL is typically used for screening suspected cases of PTSD and measuring symptom improvement for treatment-enrolled veterans, while the CAPS is most often used for diagnostic verification of a suspected PTSD case. Specific EN measures, such as the ERNS and GNS, can be used to provide further information about the severity of EN symptoms. Current measures of EN are greatly limited because they rely solely on client self-report.

Studies to date using measures that assess EN have been limited by cross-sectional and retrospective designs that do not allow for the establishment of temporal precedence and causality. Further, most studies to date have relied on categorical self-report methodology using all-male samples of treatment-seeking veterans. Research on the measurement of EN in PTSD with combat veterans could be improved through the use of longitudinal, prospective designs; categorical and dimensional assessments; multiple reporters; and biomarkers (Raab et al., 2015).

In the future, a diagnosis of PTSD and an assessment of the severity of EN is unlikely to be made solely on the basis of self-report and behavioral observations during a clinical interview.

Measurement of PTSD and subcluster symptoms will likely also rely on blood assays, genetic testing, EEG-based neurophysiological testing and neuroimaging, as these diagnostic methods become more affordable and widely available. Currently, EN symptoms are practically assessed for clinical purposes using the PCL-5 (self-report) and the CAPS (self-report and clinical interview), both of which rely on *DSM-5* criteria.

Interventions that Target Emotional Numbing

A substantial minority of troops who served in our nation's wars will require treatment for posttraumatic stress symptoms as a result of their wartime service (Steenkamp & Litz, 2013). Of the PTSD symptom clusters, some experts consider EN symptoms to be the most recalcitrant and difficult to treat (Forbes et al., 2011). Recognition of the role of EN and how it impacts treatment and prognosis in PTSD is growing. Due to the lack of a clear definition, researchers have found EN difficult to isolate and study, resulting in a lack of effective and targeted treatment approaches (Orsillo et al., 2007). The presence of EN is important to the selection of specific treatment modalities (Foa, Cashman, Jaycox, Perry, 1997b; Pietrzak, Goldstein, Malley, Rivers, & Southwick, 2010). Research indicates that EN can impede the effectiveness of evidence-based approaches for treating PTSD (Taylor et al., 2001). Kerig et al. (2016) recommend further consideration of the role of EN because it appears to play a more salient role in PTSD than other symptoms.

Trauma-Focused Therapies

Department of Veterans Affairs & Department of Defense (VA/DOD) Clinical Practice Guidelines for the Management of PTSD (VA/DOD, 2010) endorse the therapies discussed in the following sections as evidence-based approaches.

Prolonged exposure (PE). In essence, PE involves the extinguishing of avoided trauma-related memories and conditioned fear responses by reliving the trauma in a safe environment through imaginal and/or *in vivo* exposure, in 10–12 sessions lasting 90 minutes each (Foa, Hembree, & Rothbaum, 2007).

Cognitive processing therapy (CPT). Rooted in cognitive behavioral therapy, CPT is also a manualized, sequenced PTSD intervention that assists clients in challenging maladaptive beliefs about the trauma and learning healthier ways of thinking. It is usually offered in 12 manualized, sequenced one-hour sessions. Similar to PE, homework is an essential component of the therapy (Monson et al., 2006).

Eye movement desensitization and reprocessing (EMDR). EMDR is a standardized, 8-phase protocol, based on the premise that activated negative emotions related to trauma lessen with alternating bilateral or dual attention stimulation, such as to taps, tones, or the movement of the therapist's finger. For combat-related PTSD, up to 12 sessions of EMDR, 60–90 minutes each, may be required (Shapiro, 2001).

Stress inoculation training (SIT). SIT is a form of cognitive restructuring aimed at changing maladaptive thinking and behavioral responses to stress. Clients apply coping skills they have learned in response to increasing exposure to a stressor (Meichenbaum, 2007).

Psychotherapeutic Approaches

In their review of the evidence for psychotherapeutic approaches in military-related PTSD, Steenkamp and Litz (2013) concluded that randomized controlled trials of trauma-focused therapies for military PTSD were "superior to no treatment and to supportive or psychodynamic therapies, substantiating their use over these interventions (or no intervention) (p. 49). Although trauma-focused treatments, PE and CPT particularly, have shown considerable

empirical support in the treatment of PTSD with military populations (Foa et al., 2005; Monson et al., 2006; Resick et al., 2008), attrition rates are high (Grunert, Weis, Smucker, & Christianson, 2007; Schottenbauer, Glass, Arnkoff, & Gray, 2008) and residual symptoms persist (Hassija et al., 2012). The presence of severe numbing is a critically important consideration in the selection of treatment approach, because it has major prognostic implications (Barglow, 2014). Thus, trauma-focused therapies are not indicated (at least not initially) in cases where EN symptoms are prominent (Grunert, 2007).

Nontrauma Focused Treatment Approaches

The pathophysiology of PTSD is such that symptoms manifest in the cognitive/psychological, behavioral, spiritual, and physiological domains, and a particular therapy may not target all PTSD symptom clusters, suggesting the need for a multi-pronged treatment approach. Evidence-based trauma-focused therapies, such as PE, are not particularly effective at ameliorating EN symptoms (Nishith, Resick, & Griffin, 2002). The persuasive evidence supporting that avoidance and EN are distinct clusters (leading to the separation of these constructs into separate clusters in *DSM-5*), has important implications for treatment. Active avoidance, whereby persons suppress thoughts and eschew environments that are reminiscent of the trauma, is considered by some to be a healthier and more adaptive response than pervasive numbness. As a psychological defense mechanism, avoidance shows trauma control and mastery whereas the numbness represents a more primitive psychophysiological response to overwhelming feelings and helplessness (Barglow, 2014). Given the particularly deleterious impact of EN symptoms, innovative assessment and treatment approaches are needed that specifically identify and target the psychophysiological aspects of EN (Felmingham et al., 2014; Raab et al., 2015).

Heart rate variability refers to the small interbeat variations in heart rate used to measure autonomic responsiveness. An increasing number of nontrauma focused therapies, such a mindfulness meditation, behavioral activation, yoga, acceptance and commitment therapy, and HRVB are being used adjunctively with trauma-focused therapies to assist clients to observe and regulate the strong emotions that often arise during standard PTSD interventions (Bormann, Oman, Walter, & Johnson, 2014; Jakupcak et al., 2010; Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011; Vujanovic, Niles, Pietrefesa, Potter, & Schmertz, 2014).

Consistent with theoretical premises underlying polyvagal theory, the social response system can be bought back online through stimulation of the vagus nerve using HRVB (Porges, 1995; 2007; 2011). Using a somatic therapy, such as HRVB to address EN symptoms pre-emptively, or at least adjunctively, could also reduce attrition and treatment response in gold-standard exposure-based therapies that more effectively target other PTSD symptoms by supporting client's safety needs.

In the absence of more adaptive coping mechanisms, trauma reminders, such as those evoked through trauma narratives characteristic of exposure-based treatment approaches, may also elicit the protective neural changes that occur during an immobilization response. Polyvagal theory can be used to aid clinicians in understanding primitive traumatic reactions and how to develop treatment interventions that "respect the client's quest for safety" without evoking a neuroprotective response (p. Porges, 2011, p. 297). Focused on the interaction of bidirectional and hierarchical neural feedback circuits between peripheral organs and brain structures, polyvagal theory challenges clinicians to "interpret atypical behaviors and physiological reactions as adaptive" (Porges, 2011, p. 298).

Viewing PTSD through a polyvagal perspective characterizes PTSD as a "normal response to an abnormal event" and provides support for the view that the condition we know as PTSD should be viewed as an injury, rather than a disorder. Although challenging the current psychiatric and cultural nomenclature, widespread adoption of PTSD as *posttraumatic stress injury* could normalize service members' and veterans' social-emotional and behavioral responses to war trauma. Such a sea change in our societal view of posttraumatic stress could go a long way toward the destigmatization of help-seeking by military members who suffer from war-related stress injuries (Castro & Adler, 2011; Hoge, 2011).

The first paper will include what is known in the empirical literature about the deleterious impact of EN on the lives of military members struggling with PTSD. It is expected that the first paper will reveal that EN symptoms are associated with greater psychosocial impact, compared to other symptoms subclusters. Using survivor's own words, the second paper will contain a description of common themes derived from the experience of living with PTSD from the perspective of veterans who have published milvlogs on Youtube. The second paper is expected to provide a unique insight into the effects of combat-related PTSD and to also illustrate the particularly devastating impact of EN symptoms.   The subject of the third paper is a pilot study of a single session HRVB intervention using a smart phone app. The third paper is expected to show that EN symptoms, as well as PTSD symptomatology overall, can be effectively reduced using an alternative HRVB approach, and the intervention can be reinforced using mobile health technology.

Co-authorship

  The author of this dissertation is the sole author of the first and second articles, and the

primary author of the third article. Dr. Michael Killian assisted with analyzing and interpreting

data on Article 3.

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CHAPTER 2

DEAD INSIDE: A SYSTEMATIC REVIEW OF THE PSYCHOSOCIAL EFFECTS OF

COMBAT-RELATED EMOTIONAL NUMBING

Abstract

This systematic review examined the published evidence from 2012 to 2017 on the differential psychosocial impact of emotional numbing (EN) in combat veterans with posttraumatic stress disorder. The study aims were to update a previous narrative review by evaluating more recent evidence of the psychosocial effects of EN that are independent and unique compared to other PTSD symptom clusters, and to examine evidence of the differential impact by race/ethnicity and gender. Of the 911 articles retrieved, 19 studies met criteria for inclusion. Based upon criteria from a national quality assessment tool designed for observational and cohort studies, overall study quality was assessed as fair. Evidence continues to support the differential impact of EN and emerging evidence points to racial/ethnic and gender differences. More research is needed to understand how PTSD symptom profile differences are influenced by gender and culture. Findings regarding the differential impact of EN should be incorporated into assessment, treatment planning, and monitoring to improve treatment retention and psychosocial outcomes.

Keywords: posttraumatic stress disorder (PTSD), emotional numbing, veteran, race/ethnicity, women

Posttraumatic stress disorder (PTSD) is a mental health condition characterized by high chronicity and significant disability. Experiencing direct or indirect exposure to actual or threatened death, serious injury, or sexual violence puts people at risk for developing PTSD. According to the *DSM-5* diagnostic schema, persons with PTSD experience symptoms that fall into four main categories: reexperiencing, avoidance, hyperarousal, and numbing (APA, 2013). The highest rates of PTSD result from rape, military combat, and genocide. PTSD is difficult to treat and is often comorbid with other conditions like substance use disorders, depression, and suicidality (Jacobsen, Southwick, & Kosten, 2001; Pietrzak, Russo, Ling, & Southwick, 2011).

Of the PTSD symptoms, numbing symptoms may be the most salient symptom group for combat veterans due to an association with especially poor psychosocial and health-related outcomes. Hassija, Jakupcak, and Gray (2012) conducted a narrative review of the literature on EN and dysphoria in male Iraq/Afghanistan veterans. In this systematic review, I updated the previous review of the quantitative literature published over the last five years describing the psychosocial impact of combat-related posttraumatic EN on veterans. For this article, the acronym PTSD was used as a shortened designation for both the *DSM*-5 diagnosis and subthreshold symptoms.

Prevalence of Combat-Related PTSD and Emotional Numbing

PTSD is the most common mental health diagnosis for combat veterans, and rates of PTSD are higher in veterans than in the general U.S. population (Kessler, Chiu, Demler, Merkangas, & Walters, 2005; Seal et al., 2009). Estimates of PTSD in combat veterans (i.e., persons who have incurred PTSD from military service in a region of hostilities) range from as low as 5% (Hoge, Auchterlonie, & Milliken, 2006; Seal et al., 2009) to as high as 30% in Vietnam veterans (Pyne & Gevirtz, 2009), compared to 3.5 % in the U.S. civilian population.

The prevalence of a positive PTSD screen for veterans who deployed in support of Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) is 13.5% to 15.8% (Dursa, Reinhard, Barth, & Schneiderman, 2014). Far more struggle with partial or subsyndromal PTSD symptoms causing marked degrees of impairment in relationships, employment, and health (Maguen et al., 2013; Pietrzak & Southwick, 2009). One of the PTSD clusters, EN, is experienced as a form of internal hypoarousal manifested in diminished/ detached responses to others and to the environment. This hypoaroused stated is estimated to occur in 18%–30% of persons with PTSD (Hauschildt, Peters, Moritz, & Jellinek, 2011). Given the high rates of PTSD in military populations, it is critical to understand the differential impact of PTSD cluster symptoms to appropriately assess, treat, and monitor interventions.

Defining Emotional Numbing

Since 1980, EN symptoms of posttraumatic stress (narrowly defined as disconnection, disinterest, restricted affect, and foreshortened future) have been included as diagnostic symptoms in the *DSM*. Most persons with PTSD report restrictions in their ability to feel (Amdur, & Liberson, 2001). Experts describe these deficits in feeling as EN and sufferers characterize them as feeling dead inside (Glover, 1992). Symptoms of EN refer to a "diminished responsiveness to the external world," which is hypothesized as an "automatic biological response to an extended state of uncontrollable hyperarousal" (Bensimon et al., 2013, p. 84). Symptoms of EN typically include markedly diminished interest in significant activities, feelings of detachment or estrangement, and restricted range of affect (Feeny, Zoellner, Fitzgibbons, & Foa, 2000). Felmingham, Bryant, Kendall, and Gordon (2002) described EN as involving blunted positive affect and reactivity, and considered numbing to make a large contribution to the functionally impairing effects of PTSD.

Emotional Numbing Theories

In 1985, Van der Kolk proposed a biphasic relationship between EN and avoidance as a mechanism to allow for more gradual, and therefore more tolerable, trauma recall and processing, known as the infrahuman model of inescapable shock. EN was believed to result from learned helplessness, depleted catecholamines (i.e., adrenaline, norepinephrine, and dopamine), and overstimulation of the endogenous opioid system. Horowitz (1986) also characterized EN as a cycling process between reexperiencing and denial, resulting in a reduction of emotional expression. Likewise, Foa, Zinbarg, and Rothbaum (1992) recognized the role of the endogenous opioid system in EN, and supported the separation of EN from avoidance symptoms.

Litz (1992) maintained that the dampening of emotional response experienced by persons with PTSD was a "generalized deficit in emotional responding to positive events, despite the intact ability to access negative emotional states" (p. 418). Litz and Gray (2002) later clarified that persons with PTSD are not emotionally numb per se, but rather exhibit a hyper-response to negatively valenced emotional stimuli. Individual PTSD symptom clusters do not have the same neural and genetic substrates (Liu, Wang, Cao, Qing, & Armour, 2016; Pietrzak, Galea, Southwick, & Gelernter, 2013). Neuroimaging is revealing that deficits in the dopamine reward system linked to mesolimbic changes underlie EN (Enman, Arthur, Ward, Perrine, & Unterwald, 2015; Felmingham et al., 2002). Porges' polyvagal theory (1995; 1997; 2007; 2011) offers a newer, more innovative way to understand EN as an activation of the primitive immobilization system in the face of life threat.

Psychosocial and Health Ramifications of Emotional Numbing

An increasing number of researchers have found that high levels of EN symptoms in persons with PTSD are associated with the greatest degree of functional impairment (Asmundson, Stapleton, & Taylor, 2004). Hassija et al. (2012) examined eight studies describing the influence of EN and dysphoria symptoms on psychosocial functioning in Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans, and reviewed findings and implications for treatment. They presented evidence linking EN to alcohol misuse and craving (Jakupcak et al., 2009), increased smoking behavior (Cook, Jakupcak, Rosenheck, Fontana, & McFall, 2010), impairments in interpersonal and psychosocial functioning (Shea, Vujanovic, Mansfiled, Sevin, & Liu, 2010), diminished sexual functioning (Nunnink, Goldwaser, Afari, Nievergelt, & Baker, 2010), declines in couple relationship quality (Erbes, Meis, Polusny, & Compton, 2011), and increased suicidality (Guerra & Calhoun, 2011).

Additionally, researchers uncovered evidence of the negative psychosocial effects of EN in active duty service members, National Guard/Reserve, and international military populations. In a cross-sectional study of active-duty Special Forces personnel, Bryan, Stephenson, Morrow, Stahl, and Haskell (2014) detected the unique, significant interaction of EN with somatic symptoms and increased number of total medical visits. In a longitudinal study of National Guard and Reservists, Campbell and Renshaw (2013) observed that EN was negatively associated with later relationship satisfaction and both partners' reports of service members' emotional disclosure. Studying the relationship between PTSD and substance use disorders in German soldiers one year post-deployment, Trautmann and colleagues (2015) found current nicotine dependence was related to EN and to the number of reexperiencing symptoms above the contribution of other PTSD symptom clusters and comorbidities.

Factor Analytic Studies

Several studies have used confirmatory factor analytic approaches to investigate the optimal latent factor structure for PTSD (Elhai & Palmieri, 2011; Weathers, Marx, Friedman, & Schnurr, 2014). King, Leskin, King, and Weathers (1998) proposed the first model to separate avoidance from EN. The "numbing" model included the following factors: reexperiencing, avoidance, emotional numbing, and arousal. In the model by King et al. (1998), EN is defined as: inability to recall aspect of trauma; loss of interest; detachment; restricted affect; and sense of foreshortened future. Simms, Watson, and Doebbeling (2002) proposed a "dysphoria" model that contains the following factors: reexperiencing, avoidance, dysphoria, and arousal. It included eight *DSM-IV* symptoms under the dysphoria cluster: (a) inability to recall aspect of trauma; (b) loss of interest; (c) detachment; (d) restricted affect; (e) sense of foreshortened future; (f) sleep disturbance; (g) irritability; and (h) difficulty concentrating. In a meta-analysis, Ufik and Simms (2010) found most studies showed the Simms et al. model to demonstrate better model fit compared to the King et al. (1998) model. However, the dysphoria model does not disaggregate EN from dysphoric symptoms.

Elhai and Palmieri (2011) proposed a five-factor, hybridized numbing and dysphoria model known as the "dysphoric arousal" model, that included intrusion symptoms, avoidance, numbing, dysphoric arousal, and anxious arousal clusters. In this model, EN is defined as an inability to recall aspects of the trauma, and characterized by loss of interest, detachment, restricted affect, and sense of a foreshortened future. Several researchers have demonstrated superior model fit for the five-factor compared to the models by King and colleagues and Simms and colleagues (Wang, Elhai, Dai, & Yao, 2012).

More recent evidence shows even better model fit for a six-factor model (Tsai et al., 2015) based on the *DSM-5* that clusters PTSD symptoms into intrusion, avoidance, negative alterations in cognitions and mood, externalizing behavior, anxious arousal, and dysphoric arousal. Only one study employed the six-factor model. A seven-factor PTSD model that categorizes EN symptoms under anhedonia also demonstrated significantly better model fit with veteran samples in two studies (Armour et al., 2015; Pietrzak et al., 2015). More research is needed to determine which factor structure best accounts for EN.

The conceptualization of PTSD in the *DSM-5* is based on the numbing model proposed by King and colleagues (1998), and includes the following factor structure: reexperiencing, avoidance, negative alterations in cognitions and mood, and hyperarousal. In the *DSM-5*, EN is subsumed under the new category "negative alterations in cognitions and mood" that includes the following Criterion D symptoms: inability to recall important aspects of the trauma (D1); persistent negative beliefs/expectations about self/others/world (D2); distorted cognitions leading to self-blame (D3); persistent negative emotional state (D4); markedly diminished interest/participation (D5); feelings of detachment/estrangement (D6); and inability to experience positive emotions (D7) (*DSM-5,* pp. 271–272). This reconceptualization is a recognition that trauma survivors are not completely numb, but primarily access negative emotions (Weathers et al., 2014). An important criticism of this conceptualization of EN put forth by Weathers and colleagues is that it is no longer possible to capture the experience of an individual who "is shut down to the point of no longer feeling even negative emotions" (p. 99).

Measurement Approaches (EN)

The studies included in this review assess EN by using information from subscale scores taken from the Posttraumatic Stress Disorder Checklist (PCL) and/or the Clinician-Administered

PTSD Scale for DSM-IV (CAPS; Blake et al., 1995). Both reflect either a four-factor or five-factor PTSD model. The CAPS is a structured diagnostic interview that corresponds to the *DSM*. It is the most widely validated and accepted PTSD measure and is considered the diagnostic gold standard, because it is based on clinical interview and not solely self-report (Weathers et al., 2014). The PCL is a self-report measure intended primarily as a measure of PTSD severity, and was previously available in three identical versions (Military, Civilian, and Specific—different only for reference trauma). The major limitations of the PCL are the sole reliance on self-report and the lack of a functional assessment. Both the CAPS and PCL have been updated for the *DSM-5* (CAPS-5 and PCL-5 respectively; Weathers, Blake, et al., 2013; Weathers, Litz, et al., 2013).

This review covers the period from January 2012 to 2017. The study's aim is to update and evaluate the level of evidence in the recent peer-reviewed literature linking combat-related EN with an increased risk of deleterious psychosocial effects. Specifically, this review was undertaken to answer the following questions: what is the psychological and social impact of EN for veterans with combat-related posttraumatic stress compared to other PTSD cluster symptoms, and does EN exert a differential impact by race/ethnicity and gender?

Method

Search and Inclusion Criteria

I undertook a peer-reviewed literature search to identify articles that examined the psychosocial impact of combat-related EN symptoms. Research articles were identified through Medical Literature Analysis and Retrieval System Online, PubMed, PsychINFO, Published International Literature on Traumatic Stress, Clinicaltrials.gov, Web of Knowledge, Cumulative Index to Nursing and Allied Health Literature, Cochrane Reviews, and Google Scholar. I hand

searched reference lists of relevant review articles identified in the electronic search. Key search

terms included: emotional numbing OR numbing OR anhedonia AND posttraumatic stress OR

PTSD AND military OR veteran.*

Studies that examined psychosocial functioning of veterans with posttraumatic stress-

related EN symptoms were eligible for inclusion. Inclusion criteria included: (a) English

language; (b) empirical study; (c) published from January 2012 to January 2017; (d) combat-

related posttraumatic stress symptoms; (e) results for EN disaggregated or separate from other

criteria (e.g., avoidance and dysphoria). See Figure 2 for exclusion reasons. I uploaded

references into Covidence (www.covidence.org), an online systematic review software

management program endorsed by the Cochrane Collaboration. A trained research associate

assisted me in screening and examining the full text of all relevant articles.

Quality Assessment

The National Institutes of Health (NIH) Quality Assessment Tool for Observational

Cohort and Cross-sectional Studies (QAT; NIH, 2014) was used in this review study to assess

the quality of cross-sectional and longitudinal studies. The QAT contains 14 items to assess the

risk of bias for observational studies. The QAT uses an overall rating system of "good," "fair,"

or "poor." Individual items are rated as "yes," "no," "poor," "cannot determine," "not

applicable," or "not reported." The QAT includes a review guide that was used for training

reviewers. Consistent with guidelines for this assessment tool, we considered studies of poor

quality to have a high risk of bias, whereas we determined studies of good quality to have a low

risk. I worked with a trained doctoral student to independently rate each article meeting

inclusion criteria. We resolved disagreement through consensus. We assessed interrater

agreement for overall eligibility for inclusion ($\kappa = 0.81$) and for overall quality rating ($\kappa = 0.80$).

Due to the heterogeneity of outcome measures and psychosocial constructs, as well as differing definitions of EN, meta-analysis was not possible.

Data Extraction and Analysis

I performed a detailed critical appraisal of all included studies to extract the following elements: study aim(s) and design; sample demographics (percent women, age, race/ethnicity); PTSD model (i.e., four-factor, five-factor) that provided an operational/conceptual definition of EN; measures used; psychosocial domains; key results; study strengths; study weaknesses; and a quality assessment rating. A total of 911 articles were retrieved and uploaded into Covidence. After 43 duplicates were removed, a research associate and I performed abstract and title screening for 868 studies, excluding 653 studies that did not meet a priori criteria. We reviewed the full text of 215 articles, and 19 articles were identified for inclusion and rated for quality. See Figure 1 for a flow diagram of the four-phase process.

Results

Quality and Methodological Characteristics

Based on a structured, tiered assessment of the 14 QAT criteria, I assessed the overall quality of the included studies as "fair." A trained doctoral level research associate independently assessed the articles, and also assessed the overall quality of the studies as "fair." Ten studies used self-report to assess PTSD symptoms, and nine used a diagnostic interview. See Table 1 for overall quality ratings for each study and Table 2 for aggregated ratings on individual quality indicators. Table 1 outlines the 19 published studies that focused on outcomes related to mental health service utilization; substance use disorders; relationship functioning; quality of life; racial/ethnic and gender differences; and negative cognitions. Of the 19 included studies, all were observational. Fifteen studies employed a cross-sectional design. Of the

remaining four studies using a longitudinal design, follow up periods ranged from 4 to 48

months. Only three studies used prospective designs. Three studies were dissertations.
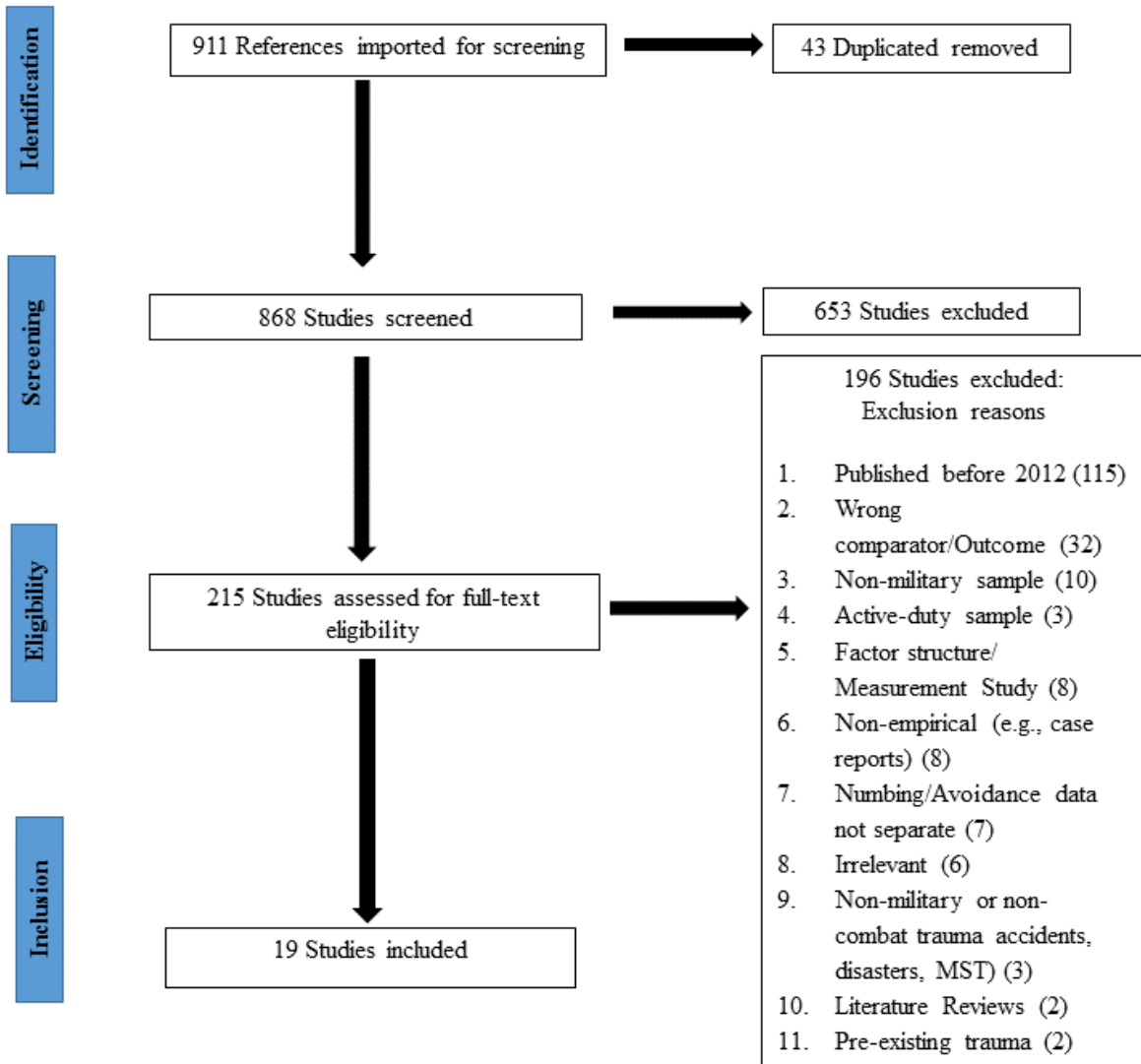
Figure 1. PRISMA 4-Phase Flow Diagram

The total sample for the 19 included studies was 88,824. Sample sizes ranged from 29 to

79,938 with seven studies using a small sample size (<200). Participant ages ranged from 18 to

94 years. Of the total 88,824 veterans in the total sample from 19 included studies, 11.25% ($n =$

9,997) were women and 32.54% were non-White ($n = 28,912$). Ten studies involved mixed war

era cohorts of veterans. Nine studies solely focused on OIF/OEF and Operation New Dawn (OND) veterans. All studies used a VA-enrolled treatment seeking sample. Eighteen studies, used PTSD measures based on *DSM-IV* criteria (either a 17-item version of the PCL or the CAPS for *DSM-IV*). Tsai et al. (2015) was the only study to use the PCL-5, based on *DSM-5* criteria. Thirteen studies operationalized EN using a 4-factor King et al. (1998) model of EN, three studies operationalized EN using a 5-factor model (Elhai & Palmieri, 2011), and one study used a 6-factor model (Tsai et al., 2015). One study used a very narrow definition of EN (i.e., inability to have loving feelings; King, Street, Gradus, Vogt, & Resick, 2013).

Psychosocial Impact of Emotional Numbing

I grouped studies per related domains to address the first research question on the psychological and social impact of EN on combat veteran with PTSD. Compared to the other PTSD cluster symptoms, EN exerts particularly deleterious psychosocial effects. The identified domains included: relationship functioning; mental health and negative cognitions; health service utilization; physical and mental health quality of life; substance use disorders; aggression; and suicidality.

Relationship functioning. Three studies focused on relationship functioning. LaMotte et al. (2015) performed bivariate correlations to examine contributions of each PTSD symptom cluster to partners' desire for changes in three key relationship areas: intimacy, shared activities, and responsibilities. All PTSD clusters were positively correlated with shared activities and responsibilities; however, EN was the only unique predictor for intimacy. In another study, EN was the only cluster independently associated with romantic relationship functioning in a hierarchical multiple regression analysis of family functioning outcomes (Possemato et al., 2015). Rodrigues (2014) found that EN, along with the reexperiencing and avoidance clusters,

Table 1

Summary of Evidence on the Psychosocial Impact of Emotional Numbing in Service Members and Veterans

Author, Date	Design PTSD Model/Measures	Sample. N; % Women; Age Range (Mean, SD); Race Ethnicity (%)	Psychosocial Domains	Key Results	Limitations	QA
Flanagan et al., 2014	Retrospective; Cross-sectional 4-factor/CAPS	Multiple war era veterans with PTSD and SUD (mostly OIF/OEF). N=97; 10.3; (40.46, 11.64); White (53.1%), Black (44.3%), More than one race/other (2.1%)	Aggression	Recent aggression associated with younger age, lower education, greater EN and hyperarousal, suicidal ideation, alcohol and marijuana use	Small sample; Self-report-unable to correlate severities and different types of aggression with PTSD symptom clusters	Good
Harder, 2013	Retrospective; Longitudinal 4-factor/ PCL-M; CAPS	Mixed VA enrolled veteran cohort. N=943; 6; (54, 8.7); White (58%) Black (37%) Hispanic (4%), AI/AP/I (1%)	Health-related quality of life	Reductions in PTSD symptom severity in EN and hyperarousal predicted improvement in the SF-36 Vitality and General Health	Limited generalizability due to sample of large number of Vietnam Era veterans with multiple psychiatric and medical comorbidities	Fair
Harpaz Rotem et al., 2013	Prospective; Cross-sectional 4-factor/ PCL-M	Symptomatic Iraq/Afghanistan veterans. N=137; 3.6; 20-49 (29.61, 7.21); White (67%); Hispanic (21%); Black (12%)	Determinants of mental health service utilization	Reexperiencing more likely to prompt treatment seeking; whereas, EN independently associated with treatment retention	Self-report; Small sample size; Limited generalizability due to predominantly White male sample	Fair
Hellmuth et al., 2012	Retrospective Cross-sectional 4-factor/ PCL-M	Iraq/Afghanistan veterans. N=359; 8; (30.6,8.0); White (65%); Non-White (35%)	Alcohol misuse, anger, and depression as related to suicidality and aggression	EN directly and indirectly related to suicidal ideation through depression—related to suicidal ideation even when depression not present; EN and hyperarousal indirectly related to aggression through trait anger	Self-report; Limited generalizability due to VA-enrolled sample	Fair
Joseph et al., 2012	Retrospective; Cross-sectional 4-factor/CAPS; SCID-*DSM-IV*	Mostly Vietnam era (77%) veterans with PTSD. N=863; 6; 21.83-80.86 (54.47, 8.78); White (59%); Black (35%); Other (6%)	Effect of integrating smoking cessation treatment with mental health care on smoking abstinence	EN independently associated with smoking intensity even after controlling for depression	Self-report; Limited generalizability due to mostly Vietnam veteran sample	Poor

Table 1 (Contd.)

Author, Date	Design PTSD Model/Measures	Sample. N; % Women; Age Range (Mean, SD); Race Ethnicity (%)	Psychosocial Domains	Key Results	Limitations	QA
King et al., 2013	Retrospective; Cross-sectional 4-factor/ PCL-M	OEF/OIF veterans. N= 2,341; 51; men (37.0, 10.0); women: (34.4 8.9); women: 68.4% White, 28.0% non-White; men: 80.8% White, 15.6% non-White	Gender differences in PTSD symptom severity	Women less likely to report EN than men	Self-report; Non-response bias (48.6% response rate); Small effect size	Fair
Koo et al., 2016	Retrospective; Cross-sectional 4-factor/ PC-PTSD; PCL	OEF/OIF/OND veterans. N=79,938; 9.4; 22-38; (30.5, 8.16); AI/AN (1.1%) A/PI (2.6%); Black (15%); Hispanic (12%); Multiracial (0.7%); White (67.2%)	Racial/ethnic and gender differences	AI/AN and Hispanic women and Black men were significantly more likely to endorse EN	Self-report; VA-mental health care sample	Good
LaMotte & Taft, 2015	Retrospective; Cross-sectional 4-factor/CAPS	Male veterans of different service eras and their female partners. N=249; (51.9, 11.2) Caucasian (82.9%), Black (9.8%) AI/AN (8.1%). Asian (1.6%), PI (0.6%), and unknown racial origin (6.5%).	Relationship domains of Intimacy, shared activities, and responsibilities	Of PTSD symptom clusters, only EN emerged as significant unique predictor associated with partners' desire for changes in intimacy	Limited generalizability due to majority Caucasian, heterosexual male-female couples, and predominantly Vietnam era veteran sample; Small effect size	Good
LaMotte et al., 2016	Retrospective; Cross-sectional 4-factor/CAPS	Veterans from Boston area. N=92; 0; (40.37, 9.63) Non-Hispanic Caucasian (77.4%), African American (9.7%), Asian (2.2%), Hispanic or Latino (2.2%), AI/AN (3.2%), Other (5.3%).	Social Skills deficits and Intimate Partner Aggression	Social skills deficits significantly correlated with use of psychological IPA; only EN emerged as significant, unique predictor of social skills deficits	Limited generalizability due to majority Caucasian, heterosexual male-female couples, and predominantly Vietnam era veteran sample	Good
Langdon et al., 2016	Prospective; Longitudinal 4-factor/ PCL-M	Combat-exposed recently-deployed OEF/OIF veterans. N=478; 55; (24.09, 8.09); White (66%), African-American/Black (14%), Hispanic (12%), AI/AN (4%), A/PI (4%)	Alcohol misuse	Intrusion and EN symptom severity predicted greater alcohol misuse at subsequent time intervals	Self-report data; limited generalizability due to combat-exposed sample	Good

Table 1 (Contd.)

Author, Date	Design PTSD Model/Measures	Sample. N; % Women; Age Range (Mean, SD); Race Ethnicity (%)	Psychosocial Domains	Key Results	Limitations	QA
Lowrey, 2014	Retrospective; Cross-sectional 4-factor/ CAPS	Mixed war era veterans with PTSD. N=318; 23; 22-84; (49.5, 13.8); White (67%); Black/African American (16%); Asian (4%); AI/AN, Hawaiian/PI or other (>3%)	Physical and mental health quality of life; treatment goals	EN had the greatest impact on mental health quality of life	Limited generalizability due to sample of mostly older, predominantly Vietnam era veterans	Fair
Possemato et al., 2015	Prospective; Longitudinal 4-factor/ CAPS	OEF/OIF veterans with PTSD and alcohol misuse. N=137; 12; (30, 7.2); White (81.8%)	Family functioning	EN uniquely and independently associated with functioning in romantic relationships	Limited generalizability due to low participation of women and nonwhite veterans	Fair
Raab, 2015	Retrospective; Cross-sectional 4-factor/ CAPS; PCL	Male combat veterans of multiple war eras with PTSD. N=150; 0; (54.9, 13.3); Caucasian (45.6%), A/PI (35.9%)	Comorbid depressive symptoms and Posttraumatic cognitions	EN had significant unique positive association with negative cognitions about self and self-blame	Limited generalizability due to male only sample; Post hoc exploratory analyses	Fair
Rodrigues, 2015	Retrospective; Cross-sectional 5-factor/PCL	Utah National Guard/Army Reserve male veterans of Iraq/Afghanistan/Middle East and partners. N=219 (N=213; 6 veterans participated without partners); 26-44 (35.20, 8.35), Caucasian (92.8%)	Dyadic partner relationship functioning	Veterans with high EN at greatest risk for poor relationship functioning; EN did not exert unique effects on partners' functioning	Self-report; Limited generalizability due to mostly White, religious, male veteran with female partner only sample	Fair
Scott et al., 2013	Retrospective; Cross-sectional 5-factor/PCL-M	Community sample of OIF/OEF/OND veterans. N=634; 54; (37.8, 10.3); White (84.4%), Hispanic (6.9%), Black (6.3%); A/PI (2.1%)	Hazardous drinking and gender differences	EN uniquely associated with hazardous drinking in women	Self-report; Limited generalizability	Fair

Table 1 (Contd.)

Author, Date	Design PTSD Model/Measures	Sample. N; % Women; Age Range (Mean, SD); Race Ethnicity (%)	Psychosocial Domains	Key Results	Limitations	QA
Simpson et al., 2012	Retrospective; Longitudinal 4-factor/ PCL-Civilian; SCID for *DSM-IV*	VA-enrolled veterans; N=24; 7; (48, 7); African American (41%); Native American (45%); Non-Hispanic White (45%); Other (4%)	Current and lifetime alcohol use, severity, and craving	Higher distress from nightmares, more EN, and higher hypervigilance predicted greater next day alcohol craving	Limited generalizability; Small sample size; veteran status of 7 participants recruited from community unclear	Good
Tsai et al., 2012	Retrospective; Cross-sectional 5-factor/PCL-C	OIF/OEF/OND veterans. N=233; A/PI (85%); Other (15%)	Combat-related concussion and physical and mental health-related quality of life	EN showed strongest independent association with social functioning, role emotional, and mental health subscales, controlling for concussion	Self-report	Fair
Tsai et al., 2015	Retrospective; Cross-sectional 6-factor/PCL-5	Nationally representative sample of US veterans. N=1,484; 10.3; 20-94; (60.4, 15.3); White (75.4 %)	Depression, anxiety, suicidal ideation, hostility, physical & mental health-related functioning, & quality of life	EN more strongly related to suicidal ideation. EN more strongly related to depression and worse mental health–related functioning	Self-report;	Fair
Yang, 2014	Retrospective; Cross-sectional 4-factor/PCL-M	VA-enrolled veterans. N=128; 5.5; 18-65; White Non-Hispanic (50%); Hispanic (50%)	Culture and dyadic relationship functioning	EN consistently predicted dyadic relationship functioning for non-Hispanic White Americans; Only related to lower constructive communication among Hispanics	Self-report; Definition of EN narrow and unclear; Limited generalizability— over half of sample above age 55	Fair

Table 2

NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies

Criteria	Yes (# of Studies)	No (# of Studies)	CD, NR, NA (# of Studies)
1. Was the research question or objective in this paper clearly stated?	19	0	0
2. Was the study population clearly specified and defined?	16	2	1
3. Was the participation rate of eligible persons at least 50%?	6	2	11
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	15	1	3
5. Was a sample size justification, power description, or variance and effect estimates provided?	1	18	0
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	16	3	0
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	2	0	17
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	18	1	0
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	19	0	0
10. Was the exposure(s) assessed more than once over time?	3	16	0
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	19	0	0
12. Were the outcome assessors blinded to the exposure status of participants?	3	0	16
13. Was loss to follow-up after baseline 20% or less?	1	0	18
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	15	4	0

exerted significant direct effects for partners' relationship functioning; whereas, only the EN

cluster showed significant negative direct effects for veterans' relationship functioning.

Mental health and negative cognitions. Using a newly proposed six-factor model, Tsai

et al. (2015) found that EN was more strongly related to depression and worse mental health-

related functioning, compared to the other clusters. Raab and colleagues (2015) explored the

relationships between posttraumatic cognitions and individual PTSD clusters. In simultaneous

regressions, EN had a unique positive association with negative cognitions about the self and

self-blame compared to other PTSD clusters. Also, post hoc analyses showed the relationship

between negative self-cognitions remained significant, even after accounting for the mediating

effects of depressive symptoms.

Health and mental health service utilization. One study explored the determinants of

health and mental health service utilization. Harpaz-Rotem Rosenheck, Pietrzak, and Southwick

(2014) reported only the EN cluster was significant with completion of 12 or more mental health

visits.

Quality of life. Three studies investigated the contribution of individual PTSD clusters

to quality of life in veterans with PTSD. Harder (2013) found reductions in EN severity

predicted improvement in physical health quality of life. EN was the strongest predictor of

mental health-related quality of life in comparison to the other PTSD clusters (Tsai, Whealin,

Scott, Harpaz-Rotem, & Pietrzak, 2012). Lowrey (2014) demonstrated that increases in EN and

hyperarousal symptoms were predictive of impairments in mental health quality of life.

Substance use disorders. Four studies focused on PTSD symptoms and substance use

disorders. Langdon et al. (2016) found EN symptoms, as well as intrusion symptoms, predicted

greater alcohol misuse at subsequent time intervals. In another study, EN was associated with

hazardous drinking, but only in females (Scott et al., 2013). Simpson, Stappenbeck, Varra, Moore, and Kaysen (2012) found associations between upsetting dreams, EN, and hypervigilance and next-day craving for alcohol. In another study, EN was uniquely related to smoking intensity (Joseph et al., 2012).

  Aggression. Three studies looked at EN and aggression. In a study of social skills deficits and the use of intimate partner aggression in combat veterans with PTSD, LaMotte, Taft, Weatherill, and Eckhardt (2016) found EN uniquely predicted social skills deficits; moreover, social skills deficits were a significant mediating factor for the enactment of psychological intimate partner aggression. In another study, recent aggression was correlated with EN (Flanagan et al., 2014) in veterans diagnosed with substance use disorders and PTSD, whereas lifetime aggression was correlated with the reexperiencing cluster. Hellmuth et al. (2012) found both EN and hyperarousal were associated with aggression when veterans identified higher trait anger.

  Suicidal ideation. One study of the correlates of PTSD in a sample of Iraq/Afghanistan veterans found that EN exerts direct and indirect effects on suicidal ideation through depression, and EN was directly associated with suicidal ideation, even in the absence of depression (Hellmuth, Stappenbeck, Hoerster, & Jakupcak, 2012). Tsai et al. (2015) also found a greater association for EN and suicidal ideation in veterans compared to other individual PTSD clusters.

Diversity

  To answer the second question, we looked at the quality of evidence on the differential impact of EN by gender, ethnicity, and race. Two studies looked at gender differences in PTSD symptom clusters. King et al. (2013) found men were more likely to report EN, nightmares, and hypervigilance and women were more likely to report greater problems with concentration and

distress reminders. Yang (2014) found EN was negatively correlated with constructive

communication, dyadic adjustment, and intimacy in persons of non-White Hispanic ethnicity.

For persons of Hispanic ethnicity, EN was not correlated with dyadic adjustment or intimacy; it

showed a significant negative association with constructive communication. Post hoc regression

analyses revealed that for non-Hispanic White persons, EN significantly and independently

predicted dyadic adjustment and intimacy. EN also significantly predicted constructive

communication. However, EN did not significantly account for variance in relationship

variables in persons of Hispanic ethnicity.

In an investigation of racial, ethnic, and gender differences in PTSD symptom

presentation, Koo, Hebenstreit, Madden, and Maguen (2016) found that Asia/Pacific Islander

women and Black men were significantly more likely to report EN symptoms as compared to

their White counterparts. Compared to White women, Hispanic women were also more likely to

acknowledge EN.

Discussion

This systematic review of studies published between January 2012 and January 2017

examined the differential psychosocial impact of EN on combat veterans compared to other

PTSD symptom clusters. Findings from this review showed EN to have a particularly

deleterious and wide-ranging association with relationship functioning, health- and mental

health-related quality of life, depression, aggression, mental health functioning, mental health

service utilization, substance use disorders, social skills deficits, negative cognitions, and

suicidality. These findings are consistent with Hassija and colleague's (2012) previous review of

studies published between 2009 to 2011 on the relationship between numbing/dysphoria

symptoms of PTSD in male OIF/OEF veterans and a wide range of problematic outcomes.

In contrast to the previous review, three studies used five-factor PTSD models to conceptualize EN, and one study used a six-factor model. Another disparity was that 84% included women in their samples, and several ($n = 3$) showed evidence for cultural and gender differences in EN profiles. The strongest evidence for the differential impact of EN compared to other PTSD clusters was found for aggression, relationship functioning, social skills deficits, medical service utilization, alcohol misuse and craving, and health-related quality of life. The upper end of the range (79,938) was not representative of the mean sample size.

A total of 19 studies were included in the review, and the overall study quality was deemed as fair. Of these 19 studies, 78.9% ($n = 4$) utilized cross-sectional designs, precluding the determination of directionality for variables. A significant number of studies relied solely on self-report to assess PTSD. Most of the studies were plagued by limited generalizability due to largely male VA-enrolled samples. Fifteen of the studies (78.9%) operationalized EN using the King et al. (1998) four-cluster PTSD model; however, more recent factor analytic studies support 5-, 6-, and 7-factor models (e.g., Armour et al., 2015; Pietrzak et al., 2015; Tsai et al., 2015).

Growing evidence supports the prominent role EN plays in relationship functioning for service members and veterans with posttraumatic stress symptoms, most particularly in intimate relationships (Erbes et al., 2011). Intimate partner problems were the most commonly found factor preceding deaths of male service members (Logan, Skopp, Karch, Reger, & Gahm, 2012). Depression and alcohol use have also been associated with military suicide (LeardMann et al., 2013). Guerra and Calhoun (2011) related EN symptoms to increased suicide risk in military members. Military members with prominent EN and comorbid depression, alcohol use disorders, and relationship problems may be at particularly heightened risk for suicide.

The recommended treatment for PTSD ranges from 9 to 15 sessions (Harpaz-Rotem et al., 2014; Monson et al., 2006). However, the presence of EN negatively impacts treatment outcomes for persons with PTSD (Taylor et al., 2001), possibly because EN has been associated with perceived stigma and barriers to care (Menke & Flynn, 2009). Jaycox, Foa, & Morral (1998) determined that PTSD treatment with exposure therapy, considered by many to be the gold standard for treating combat trauma, is less successful if EN symptoms are present. Foa (1997) hypothesized that emotional deficits characteristic of EN interfere with treatment and recovery by limiting a person's ability to emotionally engage the treatment process. Service members and veterans with prominent EN are at higher risk of prematurely terminating PTSD treatment due to failure to emotionally engage with treatment providers.

Compared to previous research (Hassija et al., 2012), more efforts are being made to include women and non-White veterans in research on the differential impact of PTSD symptom clusters. King et al. (2013) found similar gender profiles for PTSD, but only used one self-report measure for PTSD. Women and minorities are rapidly growing populations in the US military (Murphy & Hans, 2014). Evidence suggests that important cultural and gender differences exist regarding EN (Joseph et al., 2012; Rodrigues, 2014; Scott, 2013) that require further exploration to fully understand.

Limitations

First, our search strategy may not have included all relevant terms. Another issue with this review is publication bias leading to a skew toward studies favoring positive findings. Also, our findings must be interpreted cautiously given the over-reliance on self-report measures for PTSD symptoms and other outcome variables, which can increase over- and under-reporting of

symptom distress. Finally, the studies in the review did not use a uniform conceptual definition for EN.

It is likely that future diagnostic criteria for PTSD will reflect changes in categorization of EN symptoms; although the items reflecting EN will remain part of the diagnostic criteria, as has been the case since 1980 when PTSD first appeared in the *DSM-III*. The association of EN to severe deleterious psychosocial outcomes, such as suicide and substance use disorders, highlights the criticality of developing targeted assessment and treatment interventions. Behavioral health staff must be trained to assess the severity and functional impact of EN using diagnostic measures, and to monitor EN throughout the treatment process. Targeting and effectively monitoring EN symptoms could reduce mental health and medical service utilization, improve quality of life indicators, and reduce suicide risk. Periodically assessing the quality of the treatment relationship is important to prevent premature dropout.

Limitations notwithstanding, this review was strengthened using an explicit search strategy with clear inclusion and exclusion criteria, in conjunction with the use of systematic review software and established quality assessment criteria. The body of research showing the differential impact of the psychosocial effects of EN compared to other PTSD clusters continues to mount. Understanding the differential psychosocial impact of EN compared to other PTSD clusters, is important to planning appropriate assessment, intervention, and treatment retention strategies. Future studies should prospectively focus on the association between EN and psychosocial outcomes and operationalize EN using models that show superior fit with nationally representative samples of veterans. Also, studies should use a combination of diagnostic measures and collateral data, in addition to self-report. More research is needed to

better understand the factors underlying EN and adverse psychosocial outcomes, particularly

regarding the differential impact on women and non-White service members and veterans.

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CHAPTER 3

IRAQ AND AFGHANISTAN VETERANS' PTSD MILVLOGS ON YOUTUBE:

A PHENOMENOLOGICAL INQUIRY

Abstract

Studies have shown the benefit of self-published video blogs (vlogs) as mechanisms for education and social support to manage chronic physical and psychological illness. The purpose of this study was to explore the lived experience of veterans and service members who self-published their PTSD stories to YouTube. An analysis of transcribed text from 17 military video web blogs (milvlogs) and interviews with seven vloggers yielded the following ten themes: loss, stigma, guilt and shame, not getting help, alienation, suicide, motivation, living with it, honoring the fallen, and meaning and transformation. The medium serves as a way for combat veterans to tell their stories, voice their concerns, and engage in advocacy. In doing so, vloggers helped themselves as well as interested others.

Keywords: posttraumatic stress; qualitative; vlog; service members; military; veterans

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Posttraumatic stress disorder (PTSD) is the most common mental health diagnosis for men who served in Operation Iraqi Freedom (OIF), Operation Enduring Freedom (OEF), and Operation New Dawn (OND), and the second most common for women (Koo, Hebenstreit, Madden, Seal, & Maguen, 2015). Many more combat veterans suffer from subsyndromal, or partial PTSD (Maguen et al., 2013; Pietrzak & Southwick, 2009; Pietrzak et al., 2011). Of the PTSD symptoms, emotional numbing symptoms (i.e., feeling disconnected and detached from others, losing interest in significant activities, and having great difficulty accessing positive emotional states) are linked to greater psychosocial impairment compared to other PTSD subcluster symptoms (Hassija, Jakupcak, & Gray, 2012). In this article, the acronym PTSD will be used to refer to the categorical diagnostic designation as well as subthreshold symptoms.

Recounting war experiences in a safe, supportive environment is vital for veterans' readjustment and recovery (Usbeck, 2014). According to Usbeck (2012), "Soldiers and warriors have always related their combat experience to an audience; be it in songs, memoirs, or letters from the front" (p. 271). Traditional treatment settings that use evidence-based therapies for PTSD, such as exposure therapy or cognitive processing therapy, facilitate the sharing of trauma stories and provide social support. However, dropout rates are high, ranging from 28 to 30% (Chard, Schum, Owens, & Cottingham, 2010; Eftekhari et al., 2013). Due to the socially impairing nature of symptoms, service members and veterans, particularly those with significant emotional numbing, may especially struggle with telling their stories. Some service members and veterans who served in combat are seeking out the Internet as a vehicle for self-healing and social support through discussion forums, blogs (web logs), and vlogs. A vlog is a portmanteau for video web log and can be used as a noun or a verb (i.e., "the act of creating a vlog"; Holtgrave, 2015, p. 190).

Although researchers have focused on text-based blogs as a form of social support in chronic disease management, vlogging is only beginning to be explored (Huh, Liu, Neogi, Inpen, & Pratt, 2014). Military video web blogs, or simply "milvlogs," are emerging as a form of self-healing, education, social expression, and social support for war veterans with PTSD. In these ways, milvlogging transcends barriers to healing experienced in more traditional PTSD therapy settings. Unlike text-based blogs, milvlogs merge live journaling with a form of journalistic reporting. As in text-based military web logs (milblogs), posttraumatic stress is one of the most popular topics found in milvlogs (Wireman, 2013). In milvlogs, combat veterans post their trauma stories on YouTube, often entitled "My PTSD Story," and they freely share their experiences in the hopes their videos are beneficial to others, themselves, or both. The purpose of this study was to explore the lived experience of combat veterans who self-publish their PTSD stories to YouTube. Because no research currently exists on the use of YouTube to self-publish PTSD stories, I chose a qualitative phenomenological approach.

Using the Internet to help manage mental health symptoms is not a new phenomenon. Due to avoidance, marked physiological discomfort, and the socially impairing nature of symptoms, engaging combat veterans with PTSD in treatment poses significantly greater difficulty than for those without PTSD. For those veterans with PTSD who are reluctant to engage in therapy, Internet-based treatment is an emerging boon (Parish, Apperson, & Yellowlees, 2014). Since the outset of the global war on terror and the development of Web 2.0, a number of online support forums for war veterans with military-related PTSD have appeared, such as mycombatptsd.com, militarysos.com, and militaryspot.com, among others. Wireman (2013) analyzed blogs of veterans and found their symptom portrayals accurately represented in the *DSM-IV-TR*. Konolaev, Scotch, Post, and Brandt (2010) examined Operation Iraqi

Freedom/Operation Enduring Freedom (OIF/OEF) combat veterans' blogs using natural language processing and automation retrieval techniques and concluded that combat blogs provide valuable insight into veterans' emotions and experiences.

YouTube

Web 2.0 technologies (i.e., YouTube) that allow for sharing user-generated content through social media are giving rise to a new form of war narratives delivered via computer-mediated communication (CMC). Though YouTube is not the only video sharing platform, it is the largest. YouTube boasts over a billion users, or close to one-third of the universe of Internet users. According to the site, "Everyday people watch hundreds of millions of hours on YouTube and generate billions of views" (YouTube, n.d.).

Officially launched in 2005 and bought by Google a year later (Burgess & Green, 2009), YouTube is a free online digital technology streaming platform that allows registered amateur videographers to upload short videos of themselves taken with a cell phone or small camera and unregistered users to view them. In YouTube videos, the speaker delivers an unscripted monologue or "quasi-soliloquy that comes from addressing an imagined audience" (Holtgrave, 2015, p. 176).

YouTube tracks how often a video is viewed; features a box for comments; offers "thumbs up" and "thumbs down" buttons; and provides a continuously updated tally of viewer votes shown below the video. Videos self-published to YouTube can provide a rich source of information on lived experiences of phenomena that is often otherwise difficult to access (Anthony, Kim, & Findlater, 2013). The power of YouTube may lie in a concept termed *participatory culture*, defined by Jenkins (2007) from his research on fan communities. The attributes that characterize a participatory culture are: decreased barriers to artistic expression

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and civic engagement; support for creating and sharing intellectual property; informal mentorship; a belief that one's contributions matter; and, a sense of social connection embedded within the culture (Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009). For some, the participatory culture of YouTube creates an environment in which they can tell stories that might not otherwise be told.

Vlogging

Holtgrave (2015) described vlogging as "an Internet folk film tradition that is characterized by people talking about their personal experience in a verbal diary-like form" (p. 177). Extant literature on vlogging comes from research on computer-mediated communication (CMC). There is some literature on the use of vlogging as a form of self-presentation (Griffith & Pappacharissi, 2009), social communication (Christian, 2009; Harley & Fitzpatrick, 2009; Warmbrodt, Sheng, & Hall, 2008), and social support for persons struggling with stigmatized conditions (Huh et al., 2014).

In a qualitative study, Huh et al. (2014) explored the unique advantages health vlogs offer in providing support to chronically ill persons with human immunodeficiency virus (HIV), diabetes, and cancer—health conditions that carry some degree of stigma. Compared to health bloggers, they found vloggers revealed far more personal details about their real identities. One particularly noteworthy finding was that men were more likely to participate, possibly because they found the medium easier to convey their messages than text-based blogging. Importantly, health vloggers intentionally disclosed their stigmatized status, showed their faces, and used their real names, even going so far as to provide email addresses and phone numbers. In this way, the act of vlogging functioned as an empowering and healing "coming out" process.

In comparison to bloggers who wrote mostly for themselves but welcomed audience feedback, vloggers were more likely to have mixed motivations. For example, some vlogged to bring awareness and provide education to fellow survivors and to self-reflect. In contrast to health blogs, vlogs promoted intense self-disclosure that led to greater intimacy and connection with viewers, suggesting unique opportunities for social support through visual venues. The ability to see faces provides credibility and relatability not found in text-based blogs, resulting in intense community building that is reflected in the intimacy level of viewer comments.

In a phenomenological study, Foster (2013) explored how YouTube vloggers made sense of their identities and negotiated their online and offline experiences. She found information and connection with others who share their experiences to be the chief reasons for participation. However, vloggers also identified fears of stigma around admitting to having a mental illness and loss of privacy as significant concerns. Harley and Fitzpatrick (2009) showed how YouTube vlogs could provide opportunities for social contact and create a sense of conversational context that could potentially address social isolation issues between persons of different generations.

Exploring the ways members of the mental health community use YouTube to increase awareness, provide information, and express themselves, folklorist Darcy Holtgrave (2015) explored functions of narrative positioning (i.e., interactions in which speakers co-negotiate parts of their identities) in YouTube vlogs on bipolar disorder. For these vloggers, she identified four common functions of vlogging: information sharing, community formation, promoting self-efficacy and health, and mitigating stigma. Holtgrave concluded that the asynchronous nature of the medium was particularly appealing to vloggers with stigmatized mental health conditions because they could choose what aspects of their identities they wished to disclose and when. However, Naslund, Grande, Aschbrenner, and Elwyn (2014) examined the peer support features

of YouTube for persons with severe mental illness and concluded that users often overlooked the risks to users with severe mental illnesses who reveal their offline identities online.

Additionally, the ability of YouTube vloggers to enable or disable the comments function and edit comments helped them maintain some sense of control over how much and what kind of audience interaction they preferred (Holtgrave, 2015).

When sharing information, vloggers may read or refer to material from expert sources. According to Holtgrave (2015), their authority is grounded in personal experience, and they own their experience with phrases such as "my story" or "my personal experience." Positive community formation also comes from the provision of information and advice on dealing with the issue. Vloggers promote self-efficacy and healing through learning more about the condition, passing that information off to others, and leading community activity. By doing so, they empower others and themselves and take control of their disorder. Anecdotal evidence suggests vloggers feel better for having shared their stories, and users feel better for having heard them. In narrating their experiences, they position themselves as "agents of their own healing" (p. 185). The empowering mantra, "you are not alone," combined with encouragements to comment or contact the vlogger, serve to build the sense of community. Stigma is challenged by vloggers who demystify the condition by talking about their own experiences, dispelling stereotypes, and correcting misconceptions (Holtgrave, 2015).

Tradition and Lens

The phenomenological process focuses on the meaning of lived experiences and was chosen for this study dueto its use of rich and thick descriptions of a profound phenomenon, such as milvlogging about combat-related PTSD. Phenomenology is characterized by descriptions of the meanings of lived experiences of persons who have experienced a phenomenon and involves

the synthesis of common themes into a unifying universal essence. Phenomenology arose from writings of the German mathematician Husserl (1931) and was expanded by Heidegger, Sartre, and Merleau-Ponty (Creswell, 2013). Husserl (1931), the acknowledged father of phenomenology, asserted that we can only know what we experience—there are no absolute facts; therefore, scientific inquiry can only examine the essence of knowledge, or shared meanings. Thus, the essence is the central meaning within the lived of experience of individuals. Rejecting hermeneutical phenomenology which involved a study of the "texts" of life, Moustakas (1994) advocated for transcendental phenomenology which emphasized the perceptions of the participant over the interpretation of the researcher, and involved a less interpretive approach. In phenomenology, researchers examine common statements, extract meanings, and develop themes which are then distilled into a common universal essence, or essential invariant structure.

According to Moustakas (1994), an underlying assumption of phenomenology is intentionality of consciousness in which experiences contain outward appearance and inward consciousness based on memory, image, and meaning. When conducting a phenomenology, researchers must be aware of personal biases, misconceptions, and prejudices. Moustakas (1994) believed the researcher must set aside his or her experiences and biases through the process of *epoché* to approach the research with a fresh perspective, bracketing out personal experiences by first acknowledging them. Based on that description, I make the following statement: I am a Licensed Clinical Social Worker and the spouse of a retired combat veteran. I have worked with PTSD survivors in military treatment facilities. Though I have never self-published a video to YouTube, I have viewed many vlogs, commented on a few, and have assigned the viewing of some vlogs for educational purposes in graduate social work classes I have taught.

Moustakas (1994) maintained that researchers must develop two descriptions: a textural one (what the participant experiences), and a structural one (how they experience it). From these descriptions, the researcher develops an overall essence of the experience (Creswell, 2013). Horizonalization involves assigning equal value to each developing meaning segments that yield way to related clusters of meaning, from which experiential themes and an essential essence are ultimately derived (Moustakas, 1994). Throughout the research process, I adopted a narrative constructionist lens, as described by Sparkes and Smith (2008), that focuses on how narratives are the vehicle through which we express our lives and selves, and narratives are viewed as a form of social action.

In this study, I specifically questioned: What is the lived experienced of OIF/OEF veterans as portrayed in their self-initiated PTSD stories on YouTube? I had three subquestions: What motivated them to post their milvlogs?; What previous experiences did they have with emotional numbing symptoms of PTSD?; and, how were they impacted by publishing their PTSD stories?

<center>**Method**</center>

Using the transcendental phenomenological style of Moustakas (1994), I examined the visual elements and the corpus of the transcribed text of milvlogs posted on YouTube by U.S. military members about their personal experiences with posttraumatic stress injury arising from deployment to Iraq and/or Afghanistan. I used an inductive approach as the focus was on looking at the lived experiences of military members with PTSD with a fresh perspective. To arrive at the "essential invariant essence," significant statements were clustered into units of meanings and synthesized into themes to create an integrative textural-structural description portrayed in all the milvlogs. The unit of analysis was single milvlogs referring to posttraumatic

stress symptoms. A "combat veteran" was defined as anyone who deployed (active duty, National Guard, Reserves) to Iraq and/or Afghanistan from 2001 to the present. The University of Texas at Arlington Institutional Review Board approved this study.

Sample

I sought a purposive heterogeneous sample (i.e., age, race, gender, branch of service) of Iraq/Afghanistan veterans' self-reported posttraumatic stress stories published on YouTube. I used critical case sampling, a type of purposive sampling that involves choosing a small number of the most illustrative cases to "yield the most information and have the greatest impact on the development of knowledge" (Patton, 2002, p. 276). Thus, I chose a sample of vloggers who featured elements of emotional numbing in their milvlogs, specifically those struggling with relationship difficulties, feelings of isolation and alienation, and having difficulty identifying positive emotions. Creswell (2013) recommends collecting 5 to 25 samples for a phenomenological study to reach saturation. I identified 17 milvlogs published by 17 unique vloggers.

Even though the study retrospectively examined previously published milvlogs and relied mostly on observation of publicly available data, I sent emails to 12 of 17 vloggers who provided email addresses on the About page of their YouTube channel informing them of the study and inviting them to complete an interview through Qualtrics Survey Software (2014) (See Table 1 for demographic characteristics of interview participants). Prior to the written interview, potential participants viewed the consent form and consented by clicking "I voluntarily agree to participate" or "I decline to participate." Several communicated with me by email regarding questions they had about the study prior to giving consent.

Procedure

To locate potential milvlogs, I used YouTube's relevance based search mechanism and the advanced features of Google search, inputting keywords to retrieve results. The search terms were: PTSD, post-traumatic stress, posttraumatic stress, post-traumatic stress, soldier, veteran, Marine, military, combat, National Guard, Reserves, Airman, Navy, Army, and Air Force. I also performed a hand search of relevant results. Inclusion criteria included: (a) audible quality; (b) English language; (c) military; and (d) description of posttraumatic stress symptoms related to OIF/OEF deployment. Exclusion criteria were: (a) videos uploaded by government, professional, educational, veteran groups, or news organizations; (b) stories about someone else with posttraumatic stress; (c) product or commercial endorsements.

Using the advanced search features of Google, I received 12,800 total results. I scanned through the results until PTSD or "posttraumatic stress" was no longer included in the title (after 600 results). From these 600 results, I eliminated 401 irrelevant results and excluded another 125 milvlogs that did not meet inclusion criteria. From the remaining 74, I selected a diverse sample of 17 milvlogs that best answered the research questions (i.e., milvlogs with the richest, thickest description of the PTSD experience and elements of EN). Quotes from transcripts were used only with the permission of the vlogger, or if the quote did not appear in the first 20 results of the YouTube search engine.

Participants

See Table 1 for characteristics of the vloggers featured in the milvlogs and the subset of vloggers who participated in interviews. The seven vloggers who participated in the interviews were enlisted, and four were Non-Commissioned Officers (NCO). The sample was heterogeneous in terms of roles, mission, and era, although all shared a common core of PTSD

experiences. Of the seven interview participants, four were veterans, one was in the Reserves, and three were still serving on active duty. Participants served in the following career fields or combinations of fields: Motor Transport Operator, Radio Operator, Scout, Sniper, Aerospace Control Operator, Military Police, Infantry, Ranger/Green Beret, and Combat Medic (Health Care Specialist). For the purposes of confidentiality, military occupations were not reported alongside other demographic data listed in Table 1. All participants interacted with commenters using various forms of social media.

Table 1
Demographic Variables

Characteristics	Vloggers (Milvlogs) (*n* = 17)	Vloggers (Interviews) (*n* = 7)
Age: range	–	29-48
(*M*, *SD*)		(36.85, 13.43)
Race (*n*, %)		
White	11 (64.70%)	4 (57.14%)
Nonwhite	6 (35.29%)	3 (42.86%)
Gender (*n*, %)		
Women	3 (17.65%)	
Men	14 (82.35%)	7 (100%)
Marital status (*n*, %)		
Single	–	1 (14.29%)
Married	–	5 (71.42%)
Divorced	–	1 (14.29%)
Service Branch (*n*, %)		
Army*	11 (64.70%)	5 (71.43%)
Marines	3 (17.65%)	1 (14.29%)
Air Force*		1 (14.29%)
Unknown	3 (17.65%)	
OIF/OEF Deployment (*n*, %)		
Iraq	3 (17.67%)	6 (85.71%)
Afghanistan	2 (11.80%)	1 (14.29%)
Unknown	12 (70.6%)	

Note. The milvlogs did not provide enough information to report age and marital status.
*One Army vlogger and one Air Force vlogger were members of Non-US forces who served with the US military.

As part of the written interview, I asked vloggers to provide basic demographic and service information (i.e., age, race/ethnicity, service branch, places of deployment) and to respond to the following open-ended questions:

1. Please describe your reasons for publishing your posttraumatic stress story to YouTube.

2. Please describe the impact of any viewer comments received on YouTube or other forms of social media.

3. Please describe your experiences, if any, with feeling disconnected from others, losing interest in previously enjoyed activities, and/or inability to experience positive emotions.

4. If you could go back and do it over, would you still publish your posttraumatic stress story on YouTube? For this item, participants were given the following answer choices: (a) Definitely yes; (b) Probably yes; (c) Might or might not; (d) Probably not; and, (e) Definitely not.

In several cases, I corresponded with participants by email to clarify responses to the interview questions.

Data Analysis

I obtained verbatim transcriptions of the milvlogs from Rev.com. Two research associates assisted with coding the text of the milvlogs and the seven interviews. One is a PhD-prepared Licensed Clinical Social Worker and combat veteran. The second is a PhD Candidate, social worker, and a military family member. We used QDA Miner 4.1.29, a mixed methods qualitative software program, to analyze the corpus of milvlog texts and interview responses and

generate descriptive statistics of sampling characteristics. We used an open-coding process to develop the code book and identify common statements.

Through the process of horizonalization, equal meaning was assigned to each coded segment. The coding scheme iteratively evolved as we continuously revised, refined, and merged codes to generate a subset of themes. Initially, I identified 555 significant statements. Both research associates and I collapsed these into 31 clusters of meaning, and distilled these meaning clusters into 18 themes. After recombining some categories and subthemes, ten overarching themes remained.

Ten of the 12 vloggers who were contacted and invited to participate in an interview responded to my email explaining the purpose of the study and requesting participation. One vlogger gave permission for quotes to be used from his vlog but indicated he did not wish to participate in an interview. One vlogger was unwilling to give consent before the study closed. Another indicated willingness to participate, but did not complete the survey by the cutoff date. Seven vloggers completed written interviews (71.58% response rate).

Credibility and Validation

Lincoln and Guba (1985) maintain that qualitative study can ensure rigor through credibility, confirmability, dependability, and transferability. To ensure credibility and confirmability of the results, I maintained field notes during the data collection and analysis processes. I also obtained and verified the quality of verbatim transcripts. An expert on PTSD in combat veterans assessed that the study's conclusions were supported by the data. To enhance transferability, I sought a sample of milvlogs reflecting racial/ethnic and gender diversity.

In qualitative research, thick and rich descriptions of a phenomenon allow readers to determine the transferability of study results (Creswell, 2013). I included quotes that provided

thick, rich descriptions to augment transferability. By maintaining an audit trail that included

transcriptions, field notes, and expert validation, I enhanced the dependability of the findings. I

also invited 6 of the 7 vloggers who participated in interviews to perform member checks. Two

responded that the study accurately reflected their experiences, and a sentence was added in

response to the request of a third. Another important aspect of ensuring the integrity of the

research process is reflexivity, which is accomplished by retrospective reflection on the part of

the researchers to guard against data being influenced by the researchers' personal values and life

experiences. Epoché occurred before and during all phases of this study.

Patton (2002) recommended the use of triangulation (i.e. sources, methods, analysts,

theories) to add to confirmability and improve validity of findings. I achieved analyst

triangulation by working with two research associates to code the data. Triangulation of

methods involves the use of more than one method. In this study, I triangulated methods by

examining some of the audiovisual and textual elements of milvlogs, along with interviews with

vloggers.

Results

Analysis of Milvlogs

Milvlog features. Milvlog characteristics are featured in Table 2. The 17 milvlogs

included in the study were published between 2008 and 2017. Milvlog lengths ranged from just

over one minute to almost 26 minutes (*M*=10:21). The research associate and I analyzed a total

of 2 hours, 54 minutes, and 13 seconds of video. Ten milvlogs included social media links, with

Google Plus, Facebook, and Twitter being the most popular. Other included social media sites

were: Instagram, Pinterest, Reddit, Tumblr, Twitch, and Vine. Two milvlog sites included links

to the National Suicide Hotline and the Veterans Crisis Line. One of these also included links to

PTSDchat.org and Military OneSource. Three milvlogs included donation buttons to support

these vloggers' YouTube sites. Seven vloggers interacted with commenters on the vlog site.

(See Table 2 for number of comments.) It is unknown how many communicated using other

forms of social media.

Table 2
Milvlog Characteristics

Median length in minutes/seconds (Min/Max)	10:21 (1:40/25:56)
Median # of views* (Min/Max)	9,073 (12/379,862)
Median # of subscribers** (Min/Max)	3,079 (0/31,514)
Median numbers of comments* (Min/Max)	90.67 (0/4,816)
Median # of social media links*** (Min/Max)	2.12 (0/6)

Note. Number of views, number of comments, interaction, and links are current as of the date the website was last viewed: 2/01/2017.
* Due to extreme outliers, a 10% trimmed mean was used.
** The median was computed based on totals from 14 vloggers who enabled subscriber features on their YouTube sites.
*** Social media links included Facebook; Twitter; Google Plus; Instagram; Pinterest; Tumblr; Twitch; Reddit; YouTube Chat; Vine; Line; Personal blog or website, and podcasts.

It was interesting to see that some of the milvlogs contained military symbolism such as

division flags, combat medals, and maps of Iraq/Afghanistan. Also noteworthy, two milvlogs

were filmed without narration, instead communicating a typical life in the day of a PTSD

sufferer through selected scenes, sound effects, and music.

Milvlog Themes

Theme 1: Loss. "One of the hardest things." Veterans want others to understand the

significance of their losses. Upon entering a war zone, they lost their sense that the world was a

safe and good place, and any illusions about the glamour of war. One shared, "I wanted to kill

monsters . . . but I didn't see monsters; I saw people." Veterans were devastated by losing friends

and battle buddies in combat. One described witnessing the death of a friend as, "the hardest

thing I experienced overseas." A grieving vlogger described the sudden loss of a friend who

died in an improvised explosive device (IED) attack: "His vehicle got blown up and he died before I even got overseas." Another mournfully reflected: "I returned from my year-long tour in Afghanistan . . . By that time in my life, I had already lost seven close friends."

More losses occurred when they returned home to loved ones and a country that did not understand them, and one they no longer understood. Some were alienated from friends and family due to symptoms. One vlogger, alone in a hotel room and anguished over not having seen his infant son for months, stated: "He was my hope for the future, he was my support. . . Now my ex wants to gain full custody or have me waive my rights. She's using my PTSD, my TBI against me.

Theme 2: Stigma. "I ain't no John Rambo, I ain't no psychopath." Veterans with PTSD are concerned about the "psycho vet" stereotype popularized by Hollywood and the media following Vietnam. One vlogger referred to the movie, *First Blood* (1985, Kotcheff), in which a troubled Vietnam veteran with PTSD engages in combat with law enforcement in a small US town. Stereotypes about PTSD contribute to stigma, as depicted in the words of this vlogger:

> I believe there is a stigma towards PTSD in the army . . . I'm sure the majority view it as a weakness, not a problem which you can help. It's frustrating because they'll sit there and they'll make fun of you, they'll laugh, they'll joke around about stuff that they don't even understand and they've never experienced. It definitely sucks.

Another vlogger shared how stigma interfered with his seeking help: "PTSD had a very bad stigma. It was like something was wrong with you, so I waited a good four years before I finally asked for help."

Theme 3: Guilt and Shame. "Don't thank me for my service." Some veterans were wracked with feelings of guilt and shame because they survived and their friends did not. One

noted, "Samurais used to kill themselves over shame." He went on to describe the connection between guilt and shame as: "Soul cancer. This is the one where people kill themselves over all the time. It's where you have to do something that conflicts directly with your ethics, morals, or values." Reflecting on his own survival, one was perplexed as to why five others were killed instantaneously by an IED, yet he was spared. Another struggled with guilt over the death of a friend who shot himself using the vlogger's gun. One vlogger captured the moral complexities of combat that cause not only physical but psychological wounds in the form of moral injury. "There were kids that were used as bombs by terrorists and we couldn't save them."

Theme 4: Not getting the help they need. "Help ME!" Veterans with PTSD are desperate to find help for their distressing symptoms. Vloggers discussed their frustration with accessing the help they needed for PTSD, including through the Department of Veterans Affairs (VA) or the Department of Defense. They must wait for care; there is a lack of providers who can prescribe medication; there are inexperienced care providers; providers who had never been to combat themselves; and providers who were not properly credentialed to provide specialized care. Expressing frustration at counselors who did not understand, a vlogger stated:

> The counselor doesn't know what you've been through so they can't really help you. They talk about you should go to the beach or you should read this or you should be calm, you should do yoga, but yet . . . yeah, they've never done what infantry people, marines, navy seals [have done], they don't know what the real insight is so . . ."

Even though they are not getting the help they need, veterans believe that treatment is important and can be helpful. In rare instances, providers did understand, as expressed by this vlogger:

I never felt like anybody understood me (psychologist, social worker, psychiatrist, military doctor, etc.. . .) until I met a military doctor that was suffering from PTSD. At that moment, I started trusting her more, she was listening to me, and did everything she could to provide me the support that I needed. I didn't have to explain everything in details, she already knew what I was talking about.

One milvlog ended by showing a vlogger getting support from a group of veterans of different war eras. One vlogger brought up the importance of seeking treatment: "A person with PTSD that wants to be better will seek treatment. He will do what he can to keep his demons at bay." The very nature of the symptoms of PTSD prevents many veterans from getting the care they so desperately need. This vlogger explained his difficulty accessing VA care due to his symptoms:

The difficult part with PTSD when it gets bad enough is that you don't have the motivation to get out of bed to go see somebody. They make an appointment for me and, obviously, I miss it. I don't show up because I can't coordinate that well. My brain sometimes just does not work and then I miss it. Then I don't call to reschedule.

Veterans who are able to seek help are often troubled about medications and treatment. A vlogger expressed confusion around his treatment plan: "My current treatment plan right now is to just take my meds . . . They haven't even told me if there's an overall goal for my treatment or not." One maintained his doctor prescribed medication without ever having seen him. Vloggers were apprehensive about the quantities of medication they were prescribed; One stated, "I take about 12 pills a day, I don't want to take 12 pills a day," and another said, "they just loaded me up with meds." Veterans do not always accept or comply with prescribed medications or treatments. One vlogger explained her rationale for declining antidepressant medication:

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"You're not really facing it. You're just prolonging the healing." In contrast, another vlogger encouraged fellow PTSD survivors to comply with prescribed medication, saying, "Please take your prescribed medication because it will help you."

Veterans have a complicated relationship with their VAs. Though they complain about inadequacies in care, they rely heavily on VA care and do not wish it to go away. One vlogger sent out a call to action to veterans to spearhead needed changes in the VA: "Just because the VA is not what you want it to be, it doesn't mean that you can't make it what you want it to be . . . We have to make our VA better."

Theme 5: Alienation. "What could I tell you to help you understand?" Veterans with PTSD do not feel understood. Some veterans with PTSD experience a profound sense of alienation from themselves and others. Struggling with feelings of disconnection and estrangement, vloggers seek understanding from a faceless audience because they do not feel understood by the people closest to them. They are overwhelmed by loss, stigma, guilt and shame, and dealing with social systems and communities that lack understanding of their lived experience. As a result, many veterans shut themselves off from the world around them.

The following quote illustrates the social isolation experienced by veterans with PTSD: "You can't really relate to anyone else in the world anymore because of what you've done." Still, they long to be understood and by putting their stories out on the Internet, they believe there are people out there, somewhere, who will understand. For many, elusive understanding will come from other veterans with PTSD. This sentiment is demonstrated in the words of these vloggers: "Other vets can talk to other vets because they've been through it"; and, "Some things should be bottled up for a reason and never be shared with anyone . . . or only with people as messed up as you are."

Theme 6: Suicide. "PTSD won't take my life." Veterans are deeply impacted by the suicide deaths of fellow veterans. They are now passionately concerned about the problem of military suicide and are pleading with the VA to do more. Several vloggers referred to oft-quoted and disturbing suicide statistics from a previous VA report on suicide (Kemp & Bossarte, 2013), as illustrated in the words of this vlogger: "Recent years have shown us that there's more veterans that are committing suicide than the 22 that was reported earlier by the Department of Veterans Affairs." Veterans with PTSD think about suicide. Some of the vloggers struggled with times when they wanted to end their own lives, or knew others who did. One vlogger asserted, "People with PTSD are probably trying to find a reason to live . . . They go through this downward spiral and its rapid, it's pretty bad. I know because I went through that many, many times. The overall result of PTSD is death, suicide."

Another vlogger recollected times when he thought, "I'm like this isn't worth it. I don't want to live the rest of my life with this burden . . . I just want to end it all." A vlogger observed that not everyone with PTSD survives it: "During my four years of intensive treatment, I met countless people who were going through the same thing I was. Some of those people are no longer here due to suicide." One vlogger recalled, "I didn't felt like I deserved my wife, my family, that they would be better without me." Several vloggers connected their feelings of emotional numbing (i.e., disconnection, detachment, and inability to experience loving feelings) to suicide. The association between numbing and suicide was best captured by the words of one vlogger: "Since I couldn't love, I really thought that there was no point in the future, and especially if that was the way I was going to live for the rest of my life. I really didn't want to live."

Others believe that if veterans with PTSD reached out, suicide could be averted— "There are a lot of people unfortunately who end their lives in the fight against PTSD, and that is unfortunate and unnecessary, because there's so many of us going through the same thing." For suicidal veterans with PTSD, getting needed help can be lifesaving. The importance of seeking help to survive PTSD was illustrated in the words of this vlogger, "I would go in and out of wanting to kill myself. Luckily, I went and got help. Now, I'm slowly learning to cope."

Theme 7: Motivations. "I make these videos because…" Similar in some ways to the confessional, some veterans with PTSD pour out their deepest struggles in their vlogs. Unlike the safe space of a confessional where secrets remain private, vloggers choose to make their struggles public. Why do they do this? What motivates them? In almost every milvlog analyzed, vloggers explicitly stated their motivation for self-publishing their PTSD story. They shared their stories via YouTube for a variety of reasons—most notably, to help themselves and to help others, but most importantly to break through feelings of alienation by reaching out. Connecting to others and comments received by viewers were important subthemes of motivation for vlogging.

Connecting to others. One participant emphasized how important vlogging was in helping him to connect to others who shared his interests. One vlogger shared, "I've made friends both only online and in person. Also, it gives me something to look forward to. A vlogger noted the importance of connecting with others, stating, "I realized I wasn't by myself. I met people who suffer from PTSD just like I did . . . This is not something to try to deal with on your own." One participant described how he began vlogging to tell his story and connect to others:

After posting a suicide note on Myspace my family forced me to seek treatment. While in treatment at the [deleted] VA I came up with the idea . . . After losing so many friends for simply being too negative I decided to post my videos for anybody who was interested in listening to me.

Another participant's words illustrated how a person with PTSD has a very limited positive emotional range, despite an intact ability to access negative affective states: "Emotional numbness was my biggest symptom . . . I believe the numbness played a role in me forming a unhealthy sex addiction because sex was the only way I would form some kind of a connection with women." He found vlogging to be a much more positive way to connect to others.

One indicated how he had helped other veterans who were struggling with suicidal and/or addiction issues: "I had [a] tremendous amount of veterans who have reached out to me. Some who have said I saved them from their own hand and others with staying sober." Other participants identified how they were not only helping themselves and other veterans with PTSD, but family members as well.

Vloggers want to help others, with the dual motivation of reaping self-therapeutic benefits. "I'm doing these to help my treatment and shed some insight on what PTSD is." Many expressed specific concern about the numbers of military suicides. Others wished to change the stigmatized perception of veterans with PTSD. Some included links on their vlogs to suicide prevention services. Reassuring others who were suffering that they were not alone was very important to vloggers.

Vloggers who struggled with expressing themselves in traditional therapeutic settings derived benefit from this form of self-expression. One vlogger illustrated how the solitary

aspects of the medium helped him communicate what he could not say in a traditional therapeutic setting: "I can talk what I think to myself and alone."

Comments received by viewers. Viewer feedback in the form of comments on the vlog site was very important to them, and some participated in interactive conversations through the viewer comments section on YouTube. Although one participant acknowledged that commenters can be "really cruel," all participants indicated the comments they received from viewers were overwhelmingly positive. "The pinnacle was having other vets asking for MY help and inspiration," one vlogger proudly shared.

Theme 8: Learning to live with it. "It never goes away" but "it can get better." Veterans experience persistent life changes resulting from combat. One vlogger stated, "There have been several events in my life, over this past tour, that I feel have changed me forever." He went on to describe events including killing insurgents, witnessing the deaths of friends, and being injured in a rocket attack. Another addressed this statement to loved ones of veterans with PTSD: "They notice there's something very different about them. Of course, everybody changes, especially after deployment. They're in survival mode . . .in reality, they're not the same . . . it's never going to go away."

Veterans with PTSD compare their experiences to veterans of previous war eras. One vlogger stated: "I talk to World War II vets that they still have Normandy in their mind or they may have North Africa in their mind. I've talked to Vietnam vets who Vietnam is still fresh in their mind." Similarly, a vlogger recounted his conversation about PTSD with a Vietnam veteran:

I talked to some old Vietnam vets . . . and they told me that's it's [PTSD] never going to go away. They were like, "Hey, I'm 60 years old. I served in Vietnam. I had a very

similar . . . experience to you . . . It never goes away" . . . so I guess for the rest of my life, whatever . . . It's always going to be something that's there.

Even though they saw PTSD as a lifelong struggle, vloggers overwhelmingly emphasized hope that their symptoms and lives could significantly improve: "You can fight this. If you're dealing with PTSD . . . it can get better." Another elaborated, "things can get better. Anybody that has PTSD, just know you can learn to cope…It might not ever get 100%, but… when …is anything 100%?"

Theme 9: Honoring the fallen. "Rest in Peace . . ." Memories of friends and colleagues who died in war can be unhealed wounds to the psyche, deeply painful and enduring. Sharing memories helps veterans to process grief, as well as honor fallen friends. Vloggers also shared specific and personal ways they memorialized and honored their fallen friends. Gesturing to his arm, one shared, "I lost a very good friend who was a neighbor . . . I have a memorial tattoo right here." Another shared a tribute he was planning: "There's a song I want to make for some of my friends that died over there."

Theme 10: Meaning and transformation. "I turned the page . . ." For these vloggers, the experience of milvlogging their PTSD stories was transformative in terms of recovery and posttraumatic growth because they derived meaning from their experiences. As vloggers accepted a new normal; they transitioned to embracing a renewed vigor for life. One commented: "Once the video was released on YouTube I felt like I took off 100 lbs. off my shoulders…and now it was time to live again." Another indicated: "Vlogging has been a major reason for why my life is as great as it is today." Several participants shared how their milvlogs created opportunities for them to speak publicly about PTSD at local, state, and national levels; one was studying to work as a behavioral health provider for the VA. All seven of the

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participants responded "definitely yes" to the question if they would self-publish their PTSD story to YouTube if they had the chance to do it over again, suggesting the benefits received were far greater than any negative experiences.

I uncovered ten overarching themes in the study. In essence, vloggers struggled with coping and self-management in a challenging social environment that offered little understanding, leaving them feeling alienated. As a positive response, they turned to forging new communities by self-publishing their PTSD stories on YouTube. The experience of vlogging was transformative because they derived meaning from their suffering, leading to substantial growth.

Discussion

This study is the first of its kind on OIF/OEF veterans who self-published their PTSD stories to YouTube. The lived experience of these war veterans included the following themes: loss, stigma, guilt and shame, not getting help, alienation, suicide, motivation, living with it, honoring the fallen, and meaning and transformation. For these vloggers, the essence of their experience was that milvlogging empowered them and aided in their recovery by allowing them to connect and engage with interested others. It also gave them a platform to express their deepest concerns and to reject the stigma of living with an isolating illness.

Because vlogging is a medium that can allow individuals whose illnesses keep them socially isolated to connect with others, particularly those who experience symptoms of PTSD that contribute to social distancing, it can be a vehicle for telling stories that might not otherwise be told—even those stories for which there are no words, as was demonstrated in the two milvlogs without narration. Vlogging is also a medium for weaving disparate narratives into a cohesive, and healing community.

Regarding the impact of milvlogging, vloggers reported they gained many benefits from self-publishing their stories. The feedback they received in the form of viewer comments on the YouTube site and through other forms of social media was overwhelmingly positive. Insofar as what motivated the vloggers to publish their stories, most had mixed motivations that included some combination of the four functions of vlogging theorized by Holtgrave (2015): providing information; forming community; promoting self-efficacy and healing; and mitigating stigma. Previous research shows that receiving online support by persons with a stigmatized condition can challenge stigma and provide a sense of empowerment (van Uden-Kraan et al., 2008). Many vloggers were motivated by a desire to receive support from others, but almost all emphasized that helping others was crucial to their own recoveries. By helping themselves, they also helped others. Renowned holocaust survivor, Viktor Frankl famously said, "…suffering, ceases to be suffering as soon as we form a clear and precise picture of it" (p. 73). By finding meaning in their lives through altruistically helping fellow sufferers, the vloggers reinforced their own recovery processes.

A survey conducted by Foster (2013) of YouTube users who used the site for mental health reasons found that providing support to others was ranked higher than any other motivation. Foster (2013) also found that an important part of information-seeking on YouTube involved reading others' comments. In this study, interactions with viewers helped participants connect with interested others and feel less alone. Far more people viewed the milvlogs than commented on them; in this form of CMC, viewers far outnumber commenters (Holtgrave, 2015). There was evidence that viewers were contacting the vloggers and responding to the milvlogs through other forms of social media. Social media websites by their very nature are

conducive to developing networks and communities; they serve as an antidote to the isolation borne of living with PTSD.

Implications

Viewing milvlogs can help behavioral health providers gain insight into service members and veterans' lived experiences with PTSD, and increase understanding into the many forms PTSD can take. Vlogs that feature individual PTSD stories can also serve as a resource and educational tool for learning about vloggers' struggles with the professional treatment system and may help providers identify issues that hinder care. For some PTSD survivors, recording a video with a cell phone, narrated or unnarrated, may be an easier way to relate a trauma narrative. Using other forms of media may also allow for tapping into deeper emotions that cannot be conveyed with words, suggesting the need for providers to become more familiar with the nontraditional ways service members and veterans tell their PTSD stories. For example, in lieu of a written or recorded trauma narrative, they may better express their PTSD stories through still or moving images, or other media or art forms.

Milvlogs provide insight into combat veterans' perceptions of existing service gaps. One perceived gap was a lack of behavioral health providers who can treat combat-related PTSD. Another was a concern that military suicide is not being adequately addressed. It is also important for policymakers concerned with PTSD and military suicide to recognize and find ways to harness the influence of veterans using popular social media such as YouTube. Some of the milvlogs in this study garnered thousands of views and hundreds of comments, and made use of a broad range of social media. In this way, the vloggers developed a new collective narrative about PTSD that superseded their individual experiences, and became a new lens for all.

Not only did vloggers create informal support communities, but by including links to professional treatment and military suicide prevention resources on their milvlogs, some vloggers engaged in grassroots efforts to improve outreach, education, and support to service members and veterans struggling with PTSD and suicidality. By doing so, they bridged service gaps. Encouraging more vloggers to add PTSD treatment and suicide prevention links on their video sites could aid existing treatment and military suicide prevention efforts by reaching vulnerable service members, veterans and military family members who were motivated to seek out PTSD milvlogs because of their own struggles coping with personal or loved ones' symptoms.

Limitations

YouTube is the most popular video sharing medium; however, there are others. For example, I did not look at milvlogs published using other video sharing platforms such as Vimeo. The experience of the vloggers who chose to participate in interviews was very positive—the vloggers who did not participate may have been more likely to have had a negative experience. Also, vloggers who had negative experiences may have been more likely to remove their vlogs from YouTube altogether. This study did not look at the content of commenter responses or how viewers are affected. Future research efforts should focus on how viewing another's PTSD story impacts viewers with PTSD, and if messages about suicide and suicide prevention resources provided through this medium are effective. Finally, though efforts were made to include military women vloggers in the study, none consented to participate in an interview.

Conclusion

For some current and former military members, vlogging is a way to tell their PTSD stories. By fostering greater community involvement through online social interaction combined with providing vehicles for catharsis and destigmatization, vlogging can reduce social isolation and promote self and other-healing. The medium can also serve as a way for service members and veterans to speak out on issues of paramount concern to the greater military community, such as military suicide, and problems accessing help through the VA.

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CHAPTER 4

PILOT STUDY OF A SINGLE SESSION HEART RATE VARIABILITY BIOFEEDBACK

INTERVENTION ON VETERANS' POSTTRAUMATIC STRESS SYMPTOMS

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Abstract

Veterans with traumatic stress symptoms exhibit reduced heart rate variability characteristic of autonomic nervous system dysregulation. Studies show heart rate variability biofeedback is effective in reducing combat-related posttraumatic stress symptoms by improving autonomic functioning. In this quasi-experimental pilot study that featured a switching replication design, a comparison group was used to determine if participation in a single-session heart rate variability biofeedback intervention, reinforced by twice daily practice for four weeks, could: (a) reduce posttraumatic stress symptoms in combat veterans (N=12), and (b) yield an intervention that the veterans would find acceptable. Heart rate variability biofeedback significantly reduced global posttraumatic stress symptoms, whereas diaphragmatic breathing did not. Effect sizes were greatest for emotional numbing symptoms. Further, veterans found the approach acceptable, as demonstrated by a high degree of compliance with prescribed practice, low study attrition, and continued use over time. Results contributed cautious evidence that a single-session heart rate variability biofeedback intervention, followed by brief twice-daily mobile app-enabled practice sessions over a four-week period could reduce posttraumatic stress symptoms.

Keywords: heart rate variability; posttraumatic stress disorder; veterans

Posttraumatic Stress Disorder (PTSD) is a chronic, disabling condition resulting from exposure to a traumatic event; it is characterized by sleep disturbances, mood problems, hypervigilance, avoidance, emotional numbing, anxiety, unwanted thoughts, and altered perceptions (APA, 2013). PTSD is the most common mental health diagnosis for combat veterans (Seal et al., 2009). A minority of troops who served in our nation's wars require treatment for posttraumatic stress symptoms resulting from wartime service (Steenkamp & Litz, 2013). In this article, the acronym PTSD will serve as an abbreviation for both the categorical diagnosis and the dimensional continua of symptoms.

Increasing evidence suggests that veterans with combat-related PTSD have autonomic nervous system (ANS) dysfunction, resulting in significantly lower heart rate variability (HRV) (Ginsberg, Berry, & Powell, 2010; Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011). HRV, the small interbeat variations in heart rate used to measure autonomic responsiveness, has been shown to be effective as a form of biofeedback used in treating ANS dysregulation in veterans with combat-related PTSD (Ginsberg et al., 2010; Tan et al., 2011; Tan, Wang, & Ginsberg, 2013; Zucker, Samuelson, Muench, Greenberg, & Gevirtz, 2009). A pilot study by Polak, Witteveen, Denys, and Olff (2015) demonstrated that heart rate variability biofeedback (HRVB) was an effective adjunct to trauma-focused cognitive behavioral therapy for PTSD.

Previous HRV studies of veterans with combat-related PTSD delivered training across 8 to 10 sessions in clinical settings (Lehrer, Vashillo, & Vashillo, 2000; Tan et al., 2011; Tan et al., 2013). At least three studies have demonstrated the effectiveness of fewer sessions (Eddie, Kim, Lehrer, Deneke, & Bates, 2014; Gross et al., 2016; Lehrer et al., 2013). The use of mobile health, or mHealth, could further shorten the time required to deliver the intervention by allowing for self-monitoring of practice outside clinical sessions.

The purpose of this switching replication pilot study was to explore the impact of a single-session HRVB intervention, reinforced by practice using a mobile phone app. Although longer protocols have resulted in reductions in posttraumatic stress symptoms, it was unknown if a single training session would be effective in reducing posttraumatic stress symptoms arising from a traumatic event experienced during combat-related military service or while in a combat training environment. A secondary study aim was to determine the acceptability of using mHealth to reinforce HRVB training. A tertiary study aim was to examine if there were any differences between HRVB and diaphragmatic breathing.

Mobile Health

Mobile health, or mHealth, involves the use of smart phones or other mobile technologies and software applications to improve health either as stand-alone or adjunctive interventions (Erbes et al., 2014). Personal training devices and apps that can measure and modify HRV are rapidly increasing (Pyne et al., 2016). Moreover, the rapid growth of smart phone use is significantly expanding capabilities for behavioral health care treatment (Luxton, McCann, Bush, Mishkind, & Reger, 2011).

In a Department of Veterans Affairs (VA) study of veterans' access and use of mHealth-capable devices (Erbes et al., 2014), most participants (76%) had access to an mHealth-capable device, such as a smart phone or tablet, but few indicated they had ever used mHealth applications for PTSD. Although younger participants were more likely to own mHealth-capable devices, age was not predictive of willingness to use the technology and 56% to 76% indicated a willingness to try such programs for PTSD symptoms. Though the use of mobile apps that allow self-monitoring of HRVB, could expand access to greater numbers of veterans struggling with PTSD symptoms, with reduced training time, it is unclear if veterans could

sufficiently to benefit. Further testing is needed to properly examine the effects of the

technology and monitoring protocols.

Heart Rate Variability Biofeedback (HRVB)

Heart rate variability is a known all-cause mortality marker (Thayer & Lane, 2007). In

essence, HRV is a critically important health metric that reflects a person's ability to adjust

physiological arousal on a momentary basis in response to environmental demands, and naturally

declines with age (Hauschildt, Peters, Moritz, & Jelinek, 2011). Accumulating evidence points

to reduced HRV in combat veterans with PTSD (Ginsberg et al., 2010; Tan et al., 2011). A twin

study of male veterans revealed that veterans with PTSD have lower HRV than do their twins

who do not have the disorder, providing further evidence of the relationship between PTSD and

reduced HRV (Shah et al., 2013).

Porges' (1995; 2007; 2011) polyvagal theory provides a neurophysiological framework

through which to understand PTSD by proposing a hierarchical phylogenic relationship between

the tripartite subsystems of the ANS: safety (social engagement), danger (mobilization of fight or

flight responses), and life threat (immobilization or "freeze" responses). Referring to the

defensive functions of a primitive vagal circuit and the actions of an evolutionarily newer

mammalian vagal circuit related to safety and social behavior, polyvagal theory emphasizes the

weakened influence of the parasympathetic nervous system (PNS) and the component vagal

circuits as underlying autonomic dysfunction (Williamson, Porges, Lamb, & Porges, 2015).

Heart rate variability biofeedback refers to a technique for using slow diaphragmatic

breathing to increase time and frequency domain parameters in HRV. Multiple findings support

the notion that perceptions of both threat and safety may be linked to HRV via shared brain

regions (Schiller, Levy, Niv, Ledoux, & Phelps, 2008; Thayer, Åhs, Fredrickson, Sollers, &

Wager, 2012) providing logical evidence for the use of HRVB in the treatment of PTSD. Studies have demonstrated the efficacy of HRVB used with paced breathing at a rate of 0.1 Hz in the treatment of psychological disorders involving ANS dysfunction (Karavidas et al., 2007; Zucker et al., 2009). In a healthy heart, there is a dynamic balance between the sympathetic nerve system (SNS) and parasympathetic nerve system (PNS) branches of the ANS. Upon inhalation, the SNS is dominant, stimulating the baroreceptors. Increases in baroreceptor firing cause heart rate to quicken, followed by an increase in blood pressure five seconds later. Upon exhalation, the PNS becomes dominant, causing a slowing in heart rate and a subsequent decline in blood pressure approximately five seconds afterward. Individuals can produce very large increases in HRV through biofeedback because of resonance characteristics in the cardiovascular system (Shaffer & Venner, 2013).

Baroreceptors, blood pressure sensors located in the aortic arch and internal carotid arteries, contribute to HRV. According to Porges (2007), respiratory sinus arrhythmia (RSA) occurs at a fast frequency associated with spontaneous breathing, while the baroreflex is stimulated at the low frequency (LF) range, which is assumed to be related to the endogenous rhythm of blood pressure regulation via the baroreceptors and spontaneous vasomotor activity. HRVB can be used to train RSA in the high frequency (HF) range or to strengthen the baroreflex in the LF range. Thus, when blood pressure goes up, the baroreflex causes heart rate to slow, and when blood pressure decreases, heart rate goes up, causing a rhythm in heart rate fluctuations.

When a person breathes at this exact rhythm, somewhere between 4.5 and 6.5 breaths per minute, the system resonates. A person's resonance frequency is the frequency that produces the largest fluctuation in heart rate between inhalation and exhalation. Breathing at the resonance

frequency stimulates and strengthens the baroreflex system, and can produce beneficial effects through projections to other systems in the body, such as the limbic system (Lehrer et al., 2000; Lehrer et al., 2013; Shaffer & Venner, 2013). Through HRVB, the PNS can be strengthened by stimulating vagal functioning through paced, slow breathing at the resonance frequency, thereby resetting the ANS.

Although HRV is often reported to be depressed in people with PTSD, and HRVB studies appear to improve HRV indices, some studies did not find measurable improvements in PTSD in combat veterans using HRVB (Lande, Williams, Francis, Gragnani, & Morin, 2010; Wahbeh & Oken, 2013). However, an increasing number of studies have found a significant correlation between PTSD and low HRV; findings have indicated that increases in HRV have been shown to significantly reduce PTSD symptoms (Dennis et al., 2014; Tan et al., 2011; Zucker et al., 2009).

In a critical review of the effectiveness of HRV and related biofeedback across 14 studies, Wheat and Larkin (2010) found ample evidence supporting the efficacy of HRVB in clinical outcomes, but emphasized a lack of clarity in short-term and long-term carryover effects. In a meta-analytic review, Chalmers, Quintana, Abbott, and Kemp (2014) showed that PTSD and anxiety disorders were associated with reduced HRV, even after controlling for confounds such as smoking, medical conditions, socioeconomic status, and lifestyle factors. In a pilot study, Tan et al. (2011) found greater depression of HRV in veterans with PTSD. Tan et al. (2011) also found emotional numbing/arousal symptoms particularly responsive to HRVB. Further, the researchers determined that HRVB was an acceptable, feasible, and efficacious form of treatment for combat-related PTSD.

No previous research studies on the use of HRVB for combat-related PTSD have used a single session protocol or utilized a smart phone app to reinforce practice. Undertaking a pilot study will help determine if the research protocol is realistic and identify potential logistic problems. Because emotional numbing symptoms (Criterion D symptoms) can exert adverse psychosocial effects beyond those of other subclusters and may be more treatment resistant (Hassija, Jakupcak, & Gray, 2012), we were especially interested in whether these symptoms would respond to a brief intervention.

This pilot study aimed to demonstrate that participation in a single session of HRVB is an effective way to reduce posttraumatic stress symptoms, particularly emotional numbing symptoms. We hypothesized that participation in a single, self-monitored HRV biofeedback intervention using a phone app would affect posttraumatic stress disorder (PTSD) symptoms from baseline (Time 1; T_1) to follow-ups at 4-weeks (Time 2; T_2) and 16-weeks (Time 3; T_3) postintervention, as indicated by participant scores on the Posttraumatic Stress Disorder Checklist-5 (PCL-5) and ERNS. We also hypothesized that participants would show a difference in HRV indices after HRVB, compared to diaphragmatic breathing. Further, we examined whether or not the use of mHealth, consisting of a smart phone and breath pacing app, would be an acceptable way for veterans to reinforce biofeedback training.

Method

Participants

The first author recruited participants through flyers posted in the Office of Veterans Services and public bulletin boards on the campus of a large university in the southern US, and at four counseling agencies in the community that treat veterans with trauma. Participants who responded were emailed information about the study, including inclusion and exclusion criteria

and risks and benefits to participation. I obtained written informed consent prior to participation. Participants were informed of treatment services available at local veteran centers/VA Hospital and were advised to continue any treatment if already enrolled. I applied the following inclusion criteria: English-speaking; ages 18 to 65; military-related posttraumatic stress symptoms confirmed by a score of at least 15 on the PCL-5 (Weathers, Litz, et al., 2013); good general health; agreement to abstain from alcohol, tobacco, and caffeine for 24 hours prior to HRV measurement; and enrollment in the VA.

Exclusion criteria included: persons outside the specified age range; non-English speaking veterans; nonmilitary PTSD; current or prior psychosis, panic, obsessive compulsive or bipolar disorder; excessive substance use within the past six months (any use of illegal drugs, or consuming more than two alcoholic drinks per day or typically drinking more than three days in a week); significant cognitive deficits as evidenced by inability to recall three items at the end of the screening interview ("dog, apple, ball"); history or diagnosis of seizure disorder, diabetes, or cardiovascular disease including the use of pacemakers, bypass surgery, or heart transplant; current prescription for beta-blocker, antipsychotic, acetylcholine esterase inhibitor, serotonin-norepinephrine reuptake inhibitor; or previous participation in an HRV study. The Institutional Review Board at the University of Texas at Arlington approved this study.

Measures

Demographic and health questionnaire. I used a demographic questionnaire to gather information on gender, age, education, marital status, race/ethnicity, use of tobacco, caffeine, and alcohol and drug use, medications, and health and mental health history. Military information collected included rank/pay grade, service component and branch, military occupational specialty (MOS), and deployment history.

Posttraumatic stress symptoms. I assessed posttraumatic stress symptoms using the 20-item PCL-5 (Weathers, Litz, et al., 2013). Items on the PCL-5 are rated as: 0 = Not at all; 1 = A little bit; 2 = Moderately; 3 = Quite a bit; and 4 = Extremely. The PCL-5 corresponds to the 20 *DSM-5* symptoms of PTSD and is often used to monitor symptom change. The PCL-5 consists of five reexperiencing symptoms corresponding to *DSM-5* Criterion B; two avoidance symptoms corresponding to Criterion C; seven emotional numbing symptoms, named "negative alterations in cognitions and mood," corresponding to Criterion D; and six hyperarousal symptoms referred to as "alterations in arousal and reactivity" corresponding to Criterion E. Items Scores can range from 0 to 80, and a suggested clinical cut point is 33 pending further psychometric research (Weathers, Blake, et al., 2013; Weathers, Litz, et al., 2013). This study used the PCL-5 with extended Criterion A component to assess trauma. The PCL-5 has shown high reliability and validity in military populations (Wortman et al., 2016).

Combat intensity. I measured combat intensity using the Combat Exposure Scale (CES; Keane et al., 1989). The CES consists of seven self-report items and is used to subjectively assess combat stressors experienced by combatants, as rated on a 5-point scale, light to heavy. Sums of weighted scores of combat exposure can range from 0 to 41. The CES is regarded to have acceptable reliability and validity.

Emotional numbing. I measured emotional numbing using the Emotional Reactivity and Numbing Scale (ERNS) developed by Orsillo, Theodore-Oklota, Luterek, and Plumb (2007). I analyzed the psychometric properties of the 62-item scale using a traumatized veteran sample. The following scales were included: Positive (26 items), Sadness (11 items), Anger (11 items), Fear (six items), and General (eight items). Participants rate items on a 5-point Likert scale from 1 ("not at all typical of me") to 5 ("entirely typical of me"). Higher scores indicate greater

emotional reactivity and lower scores denote greater emotional numbing. There are no

established cut-off scores for the ERNS; however, Orsillo and colleagues (2007) found that

veterans with PTSD (n = 39) scored lower on the Positive subscale and higher on the Sad and

Anger subscales compared to scores for those who did not have PTSD (n = 40). The scale has

demonstrated acceptable test-retest reliability and convergent and discriminate validity with a

veteran population.

Acceptability of mHealth. I determined acceptability by attrition, self-reported

compliance with prescribed practice sessions, and continued use over time. A high degree of

acceptability was operationally defined as a rate of at least 70% compliance prescribed practice

as reported on daily logs, at least 1 to 2 times monthly use of the technique at T_3 per self-report at

the final follow-up session, and an attrition rate of less than 20% during the study.

Heart Rate Variability. The primary researcher and a research associate obtained

psychophysiological measurements using Nexus 10 Mark II (mindmedia.com) with Biotrace

Software (Version 2014). The Nexus 10 Mark II is an FDA approved multichannel biofeedback

device available from MindMedia that offers data acquisition at up to 8,192 samples per second.

Measurements were collected as recommended by the manufacturer and according to industry

standards. The electrocardiogram (ECG) signal was measured from the wrists using pre-gelled

electrodes. Rate of respiration was measured using a respiration strain gauge placed horizontally

around the abdomen. Visual inspection was used along with automatic artifact rejection to clean

the data, and a Boolean rejection algorithm automatically rejected interbeat intervals more than

20% above or below previous values. HRV was measured using power spectral analysis, which

measures the quantitative contribution to the total variance of heart rate of the different

frequency bands. Power spectral analysis has illustrated the significant reductions in HRV in

patients with PTSD (Omerbegovic, 2009). Heart rate data included heart rate, time, and frequency domain measures.

HRV was measured based on interbeat intervals, time intervals between successive R waves in the QRS complex, or electrical manifestations of ventricular polarization, sampled at a time resolution of approximately 2048 samples per second. HRV was analyzed by measuring the distance from the peak of one R wave to the next. The measures of interest were the SDANN, and the RMSSD, two time-domain measures of HRV. The HRV indices were the standard deviation of normal-to-normal R-R intervals averaged over a five-minute interval (SDANN) and the Root Mean Square of the Standard Deviation (RMSSD). The SDANN provides information about overall HRV, while RMSSD is a measure of sympathovagal influences on the heart. In a previous study, healthy volunteers (n = 10) showed markedly higher SDANN scores (M = 138.70, SD = 47.87) compared to veterans with PTSD ($n = 20$; $M = 48.10$, $SD = 47.87$; Tan et al., 2011).

Procedure

This pilot study used a quasi-experimental switching replication design wherein one group was provided an HRVB intervention (Group A) and the other group (Group B) was provided with a diaphragmatic breathing intervention. After a 4-week period of practicing diaphragmatic breathing, Group B participated in the HRVB intervention. Full randomization was not possible because two participants needed to be placed in Group A due to transportation barriers. A Licensed Clinical Social Worker (LCSW), board certified in biofeedback (BCB) by the Biofeedback International Certification Alliance (BCIA) with a specialty certificate in Heart Rate Variability (HRV) biofeedback from the same certifying body, conducted the interventions.

Two trained research assistants (Licensed Professional Counselors) assisted with data collection (administering measures, applying sensors).

During the first session, study participants completed basic demographic and health information and psychometric measures including the PCL-5 and ERNS. Data were obtained in a quiet, temperature-controlled room in a clinic, office, or in the participants' own home in a quiet room. HRV data were obtained from sensors attached to the wrists and left forearm (electrocardiogram) while participants were in a seated position. After a stabilization period of five minutes, we recorded a baseline measure of seven minutes of heart rate variation for participants in both groups.

We used a training protocol following the steps in Figure 1. Group A participated in an intervention consisting of a resonance frequency assessment that tested different rates of paced breathing (6.5, 6.0, 5.5, 5.0, 4.5, and 4.0 breaths per minute) for two minutes each (with 1 to 2 minutes' pause between each respiratory frequency) to determine optimal breath rate based on the greatest density of power spectral measures and participant comfort. The optimal breath rate for training was the rate of breathing showing the greatest density of HRV measures.

Upon conclusion of the training, we assisted participants in downloading a free phone app. MyCalmBeat (MyBrainSolutions, 2016) available at no cost from MyBrainSolutions, can be used as a breath pacer for diaphragmatic breathing and was designed to assist in learning the skill of diaphragmatic breathing to reduce stress and anxiety.

Next, we instructed participants both verbally and in writing to use the phone app twice daily to pace their breathing at their individual resonance frequency rate—the rate determined to be optimal for HRV biofeedback training—10 to 15 minutes each, for a total of four weeks. Participants were further instructed that they could increase or decrease the rate in 0.5 second

increments, or lengthen exhalation relative to inhalation, based on individual comfort. One participant did not own a smart phone and we provided one for temporary use.

HRB Assessment and Biofeedback Training Protocol

1. Diaphragmatic breathing education/practice (10 minutes)

2. Heart rate variability (HRV) education (5 minutes)

3. Sensor hook up (5 minutes)

4. Resonance Frequency Assessment (15 min)

5. Respiratory Sinus Arrhythmia (RSA) practice session in Nexus Biotrace (MindMedia), using a cardiotachometer (5 minutes)

6. Sensor removal and re-attachment (5 minutes)

7. Orientation and practice in Alive Clinical software training games and environments (Breath Spirals; Dream House; Four Seasons; and Dual Drive Pro) using a photoplethysmograph sensor attached to the earlobe (15 minutes)

8. Coaching on the use of MyCalmBeat (MyBrainSolutions) mobile app (5-10 minutes)

Figure 1. Heart Rate Variability Biofeedback (HRVB) Assessment and Training Protocol.

After the initial session, we gave Group B participants written and verbal instructions to practice diaphragmatic breathing twice daily, 10 to 15 minutes each, for a period of four weeks. After four weeks, Group B participants underwent the HRV assessment and biofeedback training protocol. We provided both groups with logs to use for recording assigned practice, and both received a weekly encouraging text message to continue twice daily practice. Participants received a $20 gift card for each face to face session (3 to 4 for each group).

Data Analysis

The second author assisted with data analysis and interpretation. We conducted our analysis using SPSS (Version 24.0). All tests were two-tailed. Missing data were excluded test-by-test. We used Rosenthal's (1994) alternative for calculating effect sizes that violated the general assumptions of Cohen's (1988) formula. We interpreted effect sizes using Cohen's (1988) criteria for r: .1 to .3 (small effect); .3 to .5 (medium effect); .5 and above (large effect). Heart rate variability data were analyzed using a 5-minute sequential interbeat interval averages (SDANN) because this measure is the most commonly used HRV index (Task Force, 1996). The Wilcoxon signed-rank test was used in lieu of dependent samples t tests to test median within-group differences on repeated measures. Given the non-normal distribution of the data, we used the Wilcoxon rank-sum test to test differences between Group A and Group B scores on the primary measures, and the two HRV indices (SDANN and RMSSD). We compared T_2 to T_3 to determine the persistence of treatment effects across time.

Results

Characteristics of the Samples

The participants ($N = 12$) consisted of nine men (75%) and three women (25%) veterans from the north central Texas area who self-reported military-related posttraumatic stress symptoms (i.e., incurred because of combat or military service and a PCL-5 score $>/= 15$). See Table 1 for sample characteristics. Participants ranged in age from 26 to 50 ($M = 36.16$, $SD = 10.45$). Racial composition consisted of 66.7% White ($n = 8$); 25% Black ($n = 3$); and 8.3% Asian/Pacific Islander ($n = 1$). Eleven (91.6%) served during Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) and one (8.3%) served in the period between the Vietnam and Persian Gulf War eras. Six served in the Army (50%); four served in the

Marines (33.3%); and two served in the Navy (16.7%). One continued to serve in the National

Guard. Four were enrolled as students at the university and eight were recruited from local

counseling agencies.

Table 1
Demographic Variables

Characteristic	Group A (*n* = 6)	Group B (*n* = 6)	*p*-Value
Age *M* (*SD*)	40.7 (16.9)	44.3 (19.0)	
Race (White vs. Nonwhite)			1.0
White	4 (66.7%)	4 (66.7%)	
Black	2 (33.3%)	1 (16.65%)	
Asian Pacific/Islander		1 (16.65%)	
Gender			.09
Women	3 (50%)	6	
Men	3 (50%)	(100%)	
Marital status (married/living as married vs. not partnered)			
Single	2 (33.3%)		1.0
Married	1 (16.7%)	5 (83.3%)	
Divorced	2 (33.3%)	1 (16.7%)	
Living as married	1 (16.7%)		
Military trauma type (combat vs. noncombat)			1.0
Combat	4 (66.7%)	4 (66.7%)	
Military sexual trauma	2 (33.3%)		
Training		1 (16.7%)	
Natural Disaster		1 (16.7%)	

Note. Fisher's exact test calculated for significance testing.

All six participants in Group A completed T_2 and T_3 follow-up assessments. One of the

six participants in Group B dropped out of the study after the baseline assessment at T_1. One

Group B participant dropped out after the intervention at T_2. Four (66.7%) of the Group B

participants completed the T_2 and T_3 follow-up assessments. Postintervention data were

available for 10 of the 12 participants who initially enrolled in the study. The combined postintervention follow-up rate at T_3 was 83.3%.

Group Equivalence

Fisher's Exact tests (FET) were used, given the small sample size. No significant pre-intervention differences were found between Group A ($n = 6$) and Group B ($n = 6$) on demographic variables. Table 1 includes descriptive statistics for the two groups. None of the participants in either group were tobacco users. We also found no differences between the groups on alcohol use (use vs. no use; FET, $p = 1.0$), caffeine use (>1 cup daily vs. 1 cup or less; FET, $p = 1.0$), exercise (at least 90 minutes or more per week vs. not; FET, $p = 1.0$), or treatment participation (participation vs. not; FET, $p = .56$). There were no significant differences between the groups for age (*Mdn*=38.5) $W_s = 31.0$, $z = -1.28$, p=.59, r=.37, combat intensity (CES scores; *Mdn*=16.0) $W_s = 35.5$, $z = -.56$, p=.59, r=.16), or levels of depression (BDI-II scores; *Mdn*=16.5) $W_s = 35.0$, $z = -.64$, p=.24, r=.18, or levels of PTSD (PCL-5 Global scores; *Mdn*=41.0) $W_s = 36.0$, $z = -.48$, p=.70, r=.14.

At the time of initial assessment, 8 of 12 participants (66.66%) met *DSM-5* diagnostic criteria for PTSD, and all had some symptoms (minimum score >/=15 on the PCL-5). See Table 2. Results on the PCL-5 Global score at initial assessment for Group A ($M = 42.50$, $SD = 21.28$) and Group B ($M = 45.50$, $SD = 13.30$) were in the moderate range of severity, with 75% ($n = 9$) meeting *DSM-5* criteria for PTSD. Results were significantly different at T_3 for participants in both Group A ($M = 30.50$, $SD = 13.39$) and Group B ($M = 18.50$, $SD = 14.88$), with only three

Table 2

Evolution of PCL-5 Scores, ERNS Scores, and HRV Indices

| | | T_1 | | T_1 | | $T_{1.5}$ | | T_2 | | | | T_3 | | | |
| | | Group A (n=6) | | Group B (n=6) | | Group B (n=5) | | Group A (n=6) | | Group B (n=4) | | Group A (n=6) | | Group B (n=4) | |
Var		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
PCL															
	Global	45.50	13.30	42.50	21.28	40.60	21.34	21.50	14.52	21.50	1.73	30.50	13.39	18.50	14.88
	B	13.50	2.25	10.83	7.08	9.60	5.41	6.33	1.50	5.75	4.57	7.83	2.78	5.00	5.03
	C	5.83	1.47	5.33	2.33	3.80	1.48	7.66	11.05	2.50	1.73	4.33	3.01	3.25	2.75
	D	12.66	5.60	12.16	8.03	14.00	11.46	8.00	5.83	5.00	3.91	8.16	5.63	3.75	2.62
	E	13.50	5.31	14.16	8.18	13.60	7.36	4.83	2.92	8.25	7.67	9.00	5.72	8.25	7.67
ERNS*															
	Positive	92.00	20.37	95.16	12.73	105.40	13.48	83.83	33.54	101.50	6.95	100.16	16.12	114.25	5.37
	Sad	38.66	9.99	36.33	8.95	39.80	4.60	40.00	10.23	44.75	3.59	40.00	8.62	50.25	10.04
	General	28.66	7.20	27.66	4.84	28.20	7.62	30.66	5.60	26.75	5.31	32.66	5.20	32.75	2.87
	Angry	43.16	6.85	43.66	2.25	44.40	4.15	43.33	8.95	45.25	5.43	41.00	9.91	42.50	3.10
	Fear	24.00	6.89	17.66	5.53	17.40	3.43	20.66	7.31	18.25	5.37	19.16	4.70	21.75	4.11
HRV															
	SDANN	53.10	24.88	49.26	16.37	54.08	32.69	59.95	19.13	64.55	41.29	59.15	12.40	70.20	39.51
	RMSSD	32.43	12.55	27.64	7.83	36.84	27.48	37.79	6.89	50.72	40.22	38.89	12.73	42.33	19.56

Note. In the PCL-5, Criterion B consists of five reexperiencing symptoms; Criterion C consists of two avoidance symptoms; Criterion D consists of seven emotional numbing symptoms, named "negative alterations in cognitions and mood"; Criterion E consists of six hyperarousal symptoms referred to as "alterations in arousal and reactivity."

* denotes lower score represents greater numbing

(30%) meeting *DSM-5* criteria for PTSD, and 30% ($n = 3$) reporting scores above the

recommended cut point. Overall, all participants ($N = 10$) saw improved PCL-5 global scores by

T_3.

Switching Comparisons

We tested the groups at baseline and for the effects of repeated measures. See Figure 2

for study design and planned group comparisons. There were no significant differences between

the groups at T_1, denoting a stable baseline across the sample. Wilcoxon rank-sum tests showed

a significant decrease in PCL Criterion E scores for Group A at T_2 (*Mdn*=5.5) compared to

Group B at T_1 (*Mdn*=13.50), $W_s = 31.0$, $z = -1.28$, p<.05, *r*=.38. Compared to the baseline of

Group A at T_1, scores on the PCL-5 B (*Mdn*=13.5) and D (*Mdn*=12.5) clusters for Group B

showed a significant decrease at T_3 (*Mdn*=4.0) $W_s = 12.0$, $z = -2.15$, p<.05, *r*=.57, and (*Mdn*=4.5)

$W_s = 12.5$, $z = -2.03$, p<.05, *r*=.54, respectively. There was also a significant decrease in ERNS

Positive Scores at T_3 (*Mdn* = 104.0) for Group B compared to the baseline of Group A at T_1 (*Mdn*

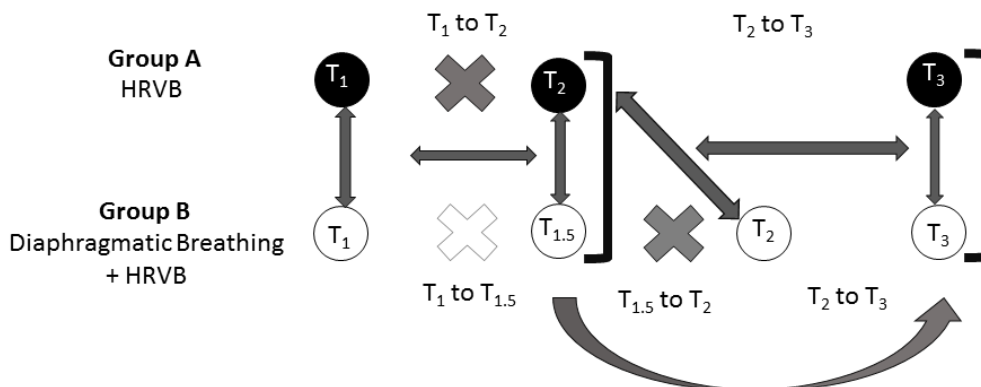$= 93.0$) $W_s = 23.50$, $z = -2.03$, p<.05, $r = .61$.

Figure 2. Group Comparisons

HRVB vs Relaxation Breathing

We examined repeated measurements across time within each group, as shown in Table 2. We compared HRVB only (Group A) to relaxation breathing (Group B) at four weeks. Group A showed a significant reduction in the PCL-5 Global scores from baseline (Mdn = 41.0) to four weeks post-intervention (*Mdn* = 24.0), $z = -2.2$, $p = .02$, $r = -.64$); Group B did not show a significant reduction from baseline (*Mdn* = 38.5) to four weeks (*Mdn* = 28.0), $z = .41$, p=.41, *r* =.24).

Combined Groups Comparisons

For all subsequent analyses, we combined the data and compared changes across time for the primary measures. For the combined groups, posttraumatic stress symptoms improved from T_1 to T_2 (see Table 3), the period when participants practiced the twice daily resonance frequency breathing practice using the mobile app. For the PCL-5, there was a significant decrease in global scores (large effect). PCL-5 Criterion B (large effect), Criterion E (large effect), and ERNS Fear (medium effect) also significantly decreased. See Figure 3 for changes in the primary measures from $T_{1/1.5}$ to T_3.

After participants were no longer being instructed to engage in regular twice-daily practice (but continued to intermittently use the resonance frequency breathing technique to manage symptoms), there were no significant decreases in PCL-5 Global and subscale scores. Posttraumatic stress symptoms did not change from T_2 to T_3 suggesting that participants in both groups did not lose the benefits of the intervention. From T_2 to T_3 (see Table 3), ERNS Positive scores significantly increased (medium effect), denoting less numbing of positive emotions. The ERNS General scores significantly increased (medium effect), signifying less numbing overall.

Table 3

Combined Group A and B Repeated Measures Comparisons

Dep VAR	$T_{1/1.5}$ (N=11)	T_2 (N=10)	T_3 (N=10)	$T_{1/1.5}$ to T_2 (N=10)			T_2 to T_3 (N = 10)			$T_{1/1.5}$ to T_3 (N=10)		
	Median			Z-Value	p-Value	r	Z-Value	p-Value	r	Z-Value	p-Value	r
PCL-5												
Global	36.0	24.0	23.0	-0.24	.01*	.54	-0.83	.407	.18	-2.65	.008**	.59
Criterion B	11.0	7.0	7.0	-0.24	.01*	.53	-0.59	.549	.13	-2.46	.014**	.55
Criterion C	5.0	3.0	4.5	-0.98	.32	.21	-0.50	.612	.11	-1.19	.232	.26
Criterion D	11.0	7.0	6.0	-1.93	.052	.42	-0.210	.833	.04	-2.68	.007**	.60
Criterion E	5.50	5.5	5.0	-0.26	.009**	.56	-0.98	.32	.21	-2.54	.011*	.57
ERNS												
Positive	108.0	98.50	107.0	-2.04	.041*	.46	-2.04	.041*	.45	-1.42	.153	.31
Sad	39.0	43.0	42.0	-1.43	.151	.31	-0.59	.553	.13	-1.83	.066	.40
General	29.0	32.0	32.0	-2.03	.042*	.45	-2.52	.012*	.56	-2.80	.005**	.63
Anger	44.0	42.0	40.50	-0.08	.933	.01	-1.36	.171	.30	-.842	.40	.18
Fear	22.0	20.0	20.50	-2.03	.042*	.44	-0.20	.837	.04	-.892	.373	.19
HRV												
SDANN‡	47.51	52.24	62.27	-1.07	.314	.23	-0.153	.878	.03	-1.481	.139	.33
RMSSD‡	33.68	36.75	44.17	-1.40	.161	.30	-0.153	.878	.03	-1.956	.050*	.44

Note. Combined measures were based on Wilcoxon Signed-Rank Tests. Baseline data was collected prior to HRVB intervention (Group A at T_1 and Group B at $T_{1.5}$). * denotes p<.05; ** denotes P<.01; ‡ denotes missing data on one case due to experimenter error. We used Rosenthal's (1994) formula for calculating effect sizes (*r*) that violated the general assumptions of Cohen's (1988) formula.
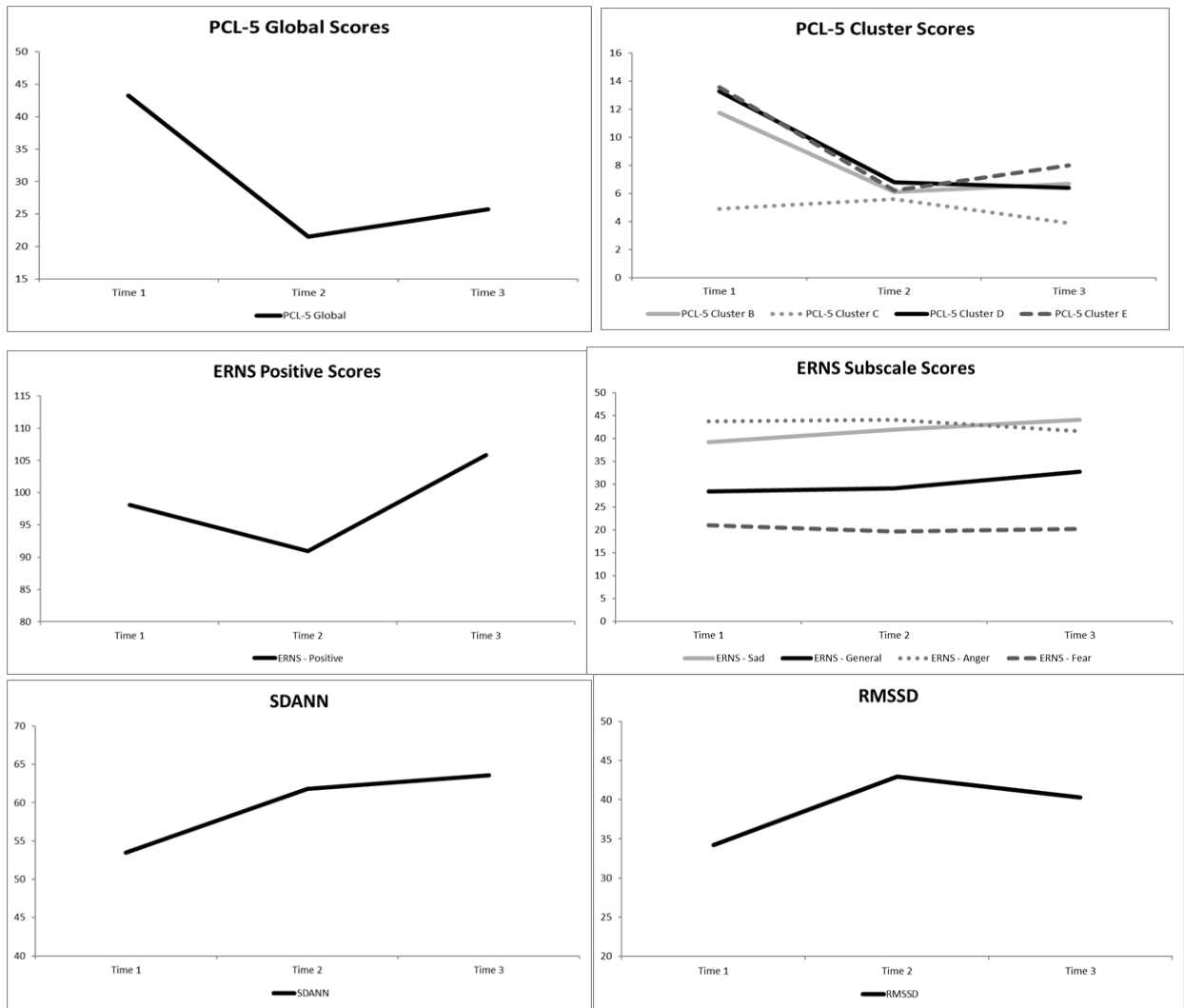
Figure 3. Changes in the primary measures for combined groups from $T_{1/1.5}$ to T_3

The PCL-5 Global score, and Criterion B, D, and E scores significantly decreased from T_1 to T_3, as indicated in Table 3. From $T_{1/1.5 \text{ to}} T_3$, EN also significantly improved. Criterion D (emotional numbing) showed the largest effect size ($r = .60$). Generalized numbing (defined narrowly as disinterest, disconnection, and detachment), significantly improved at four-weeks, and showed the largest effect sizes at T_3 ($r = .63$). Only Criterion C (avoidance) symptoms showed no improvement at 16 weeks postintervention. The ERNS General scores significantly increased overall. For the HRV indices, the RMSSD significantly increased during this time frame,

indicating improvement. The rate of practice for HRVB was determined from the logs available from 10 participants ($M = .86$, $SD = .09$). At T_3, half of participants ($n = 5$) reported continuing to use the resonance frequency breathing technique (either assisted by the app or from memory) twice per week, and the other half ($n = 5$) reported using the technique once per week. Continued use was most commonly reported to reduce symptoms of anger ($n = 5$), followed by anxiety (n = 3), and sleep disturbances ($n = 2$).

Discussion

We found that participation in a single, self-monitored HRV biofeedback intervention using a phone app was significantly associated with decreasing posttraumatic stress disorder (PTSD) symptoms at 4- and 16-weeks postintervention, particularly EN symptoms, as indicated by PCL-5 and ERNS scores. In the *DSM-5*, EN was reconceptualized based on the notion that trauma survivors are not completely numb, but rather, predominantly access negative emotions (Weathers, Marx, Friedman, & Schnurr, 2014). Veterans' Positive scale scores increased even though they displayed marked negative emotionality as evidenced by heightened Anger, Sad, and Fear scale scores. Scores on the Global PCL-5 and on Criteria B and E decreased denoting significant improvement after the HRVB intervention. Both groups saw a significant reduction in posttraumatic stress symptoms. Group B experienced a greater reduction, possibly due to the two dropouts in this group having much more severe symptomatology.

There were no significant postintervention differences between the groups four weeks after both received the HRVB intervention, suggesting stability in gains. There were no significant declines in ERNS and PCL-5 from T_2 to T_3, indicating the persistence of treatment effects across time after the intervention was withdrawn. Participants saw significant improvement in emotional numbing (Criterion D) symptoms at 16 weeks compared to four

weeks, suggesting that this symptom cluster took longer to respond. In a previous study that combined EN with avoidance symptoms, Tan et al. (2011) found that this combined cluster had the strongest response to an HRVB intervention when compared to other PTSD symptoms.

Participants also reported significantly less fearful symptoms on the ERNS at four weeks and there was no significant degradation in effect at 16 weeks. Global PTSD, and Criteria B, D, and E subscale scores improved from four to 16 weeks showing the distal effects of the intervention over time. The ability to access more positive emotions took longer to respond, but continued improvement was reported.

Group A showed a significant improvement in PCL-5 Global scores when measured four weeks after the HRVB intervention; however, Group B did not show a significant improvement four weeks after the diaphragmatic breathing intervention. Neither group showed a significant increase for SDANN or RMSSD at 4-weeks postintervention; however, for the combined group, RMSSD did significantly improve from baseline to 16 weeks. Though not significantly different, the combined groups showed a 29% improvement in SDANN scores by 16 weeks, compared to the baseline scores for the Group B. Given the small sample size, the failure to detect differences was likely due to Type II error.

We also questioned if the use of mHealth, using a smart phone and a breath pacing app, would be an acceptable way to practice resonance frequency training and reinforce biofeedback training. The combined group (N=10) reported completing 86% of twice-daily recommended resonance frequency breathing practice sessions. Group B ($n = 4$) participants completed 93% of twice-daily recommended diaphragmatic breathing practice sessions. All participants reported continued use of the technique for posttraumatic stress symptom management over time. For the two groups, the combined dropout rate was less than 17% ($n = 2$). Weekly motivating text

messages encouraging continued practice likely increased the rate of compliance with prescribed practice for both groups.

Trauma-focused therapies are effective in treating PTSD in military populations (Foa et al., 2005; Monson et al., 2006; Resick et al., 2008). Even so, many service members and veterans leave treatment prematurely (Grunert, Weis, Smucker, & Christianson, 2007; Schottenbauer, Glass, Arnkoff, Tendick, & Gray, 2008). Moreover, not all symptoms are fully addressed (Hassija et al., 2012). Adding HRVB to cognitive and exposure-based therapy protocols could enhance participants' treatment response.

Limitations

The most significant limitation was the small sample size which precluded generalization of the results to a larger population of veterans. Factors associated with differences in trauma type may have affected results. The gender difference between the groups may have impacted the results. One group included women, but the other did not. Women tend to have slightly lower HRV than men, but this difference decreases with age (Sztajzel, Jung, & Bayes de Luna, 2012). Participant changes during the study period affected internal validity and decreased HRV indices – one participant had a serious injury between the four and 16-week measurement periods, resulting in markedly decreased HRV measures. A quiet, temperature-controlled room in the participant's own home was used as an alternative study site for two veterans (once for one and twice for another) with transportation barriers and differences in settings may have impacted study results. The higher attrition observed in Group B could have resulted to some degree from participants in this group waiting longer before beginning the intervention. Because data was collected by the researcher providing the intervention to participants, social desirability bias could explain the success of the intervention.

Implications

The integration of somatic-focused approaches, such as HRVB, either as stand-alone or adjunctive therapies, could more effectively target posttraumatic stress symptoms. Limitations notwithstanding, this pilot study provided cautious evidence that a single-session heart rate variability biofeedback intervention, followed by brief twice-daily practice sessions over a four-week period using a mobile phone app, could reduce posttraumatic stress symptoms, most particularly numbing symptoms. For the veterans, HRVB was superior in reducing posttraumatic stress symptoms compared to diaphragmatic breathing. Further, veterans found the approach acceptable, as demonstrated by a high degree of compliance with prescribed practice, low study attrition, and continued use over time. Modifying the protocol to include a HIPAA compliant app that provides real-time HRV biofeedback and tracks participant practice could improve results. A randomized controlled trial with a larger sample is warranted. Future research should focus on further refinement of an HRVB protocol that utilizes mHealth to treat PTSD in military populations.

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CHAPTER 5

GENERAL CONCLUSIONS

The construct of emotional numbing (EN) in military populations with posttraumatic stress disorder (PTSD) was explored in the three articles in this dissertation, each using a different methodological approach:

1. A systematic review study (SRS)

2. A qualitative phenomenological study of milvlogs

3. A quasi-experimental comparison study of a single-session heart rate variability biofeedback (HRVB) intervention

As in the first chapter, PTSD will be the acronym used for both the categorical diagnosis and subthreshold symptoms. This final chapter discusses each article in terms of related themes, polyvagal theory, and contributions to the field. This chapter concludes with an exploration of the broader implications for practice, policy, and research.

Related Themes

The SRS established the impact of EN on veterans compared to other *DSM* subcluster symptoms, suggesting the need for specialized interventions or approaches. The second (milvlog) and third (HRVB) articles had several commonalities that bound them together. First, they featured methods to manage the social destruction wrought by PTSD—one was therapist-guided, but involved self-monitoring (HRVB intervention), and the other was a form of self-healing using an Internet folk film tradition (i.e., vlogging on YouTube). Second, the milvlog and HRVB studies focused on the therapeutic use of technological innovations as ways to ameliorate EN symptoms in military populations by promoting social engagement. Finally, both involved forms of feedback that positively impact EN. Vloggers received social feedback in the form of viewer comments, and participants in the HRVB study received psychophysiological feedback as well as motivating text messages.

Polyvagal Theory

Porges' polyvagal theory (1995; 1997; 2007; 2011), which provides a biological

explanation for social behavior, was the guiding theoretical framework underpinning this

dissertation research. Polyvagal theory emphasizes that the hierarchically organized tripartite

systems of the Autonomic Nervous System (ANS) adaptively evolved in response to safety,

threat, and mortal danger. According to Williamson, Porges, Lamb, and Porges (2015),

"activating a sense of safety is greatly challenged in PTSD" (p. 4). Persons with PTSD may be

able to intellectually appraise a situation as safe, but may be responding defensively due to

perceptions of threat outside of conscious awareness at the level of the limbic system (i.e.,

neuroception). A key takeaway from polyvagal theory is that restoring of a sense of safety is

essential for persons to socially engage.

Polyvagal theory can be used to explain the findings from the SRS that showed that EN

symptoms exerted greater psychosocial devastation compared to other PTSD symptoms. In the

model, the most extreme state of social withdrawal (EN) occurs in response to life threat

(Williamson et al., 2015). According to Williamson et al. (2015), "autonomic functioning is

related to central and peripheral inflammatory factors, immunologic functions, and psychosocial

impairments (e.g., hostility and loneliness) in mediating and often exacerbating deleterious

health outcomes" (p. 2). Chronic overstimulation of the threat response system, such as that seen

in PTSD, is linked to adverse health outcomes and deterioration in social relationships.

The second article explored milvlogging by combat veterans as a means to address EN by

connecting with interested others via a medium that introduces mechanisms of narrative control.

YouTube features that increased user control reduced some of the sensory overload that could be

invoked by recounting trauma narratives face-to-face. This research emphasized the importance

of safety in being able to tell one's trauma story, as well as the importance of altruism and

finding meaning in one's suffering as a path to recovery. According to polyvagal theory, social communication occurs in the context of safety when defensive strategies are offline. Thus, the veterans who milvlogged their PTSD stories could socially engage with others through YouTube milvlogs because the medium features a vehicle for social interaction with user-controlled features that do not trigger more primitive defensive responses. Because their defensive strategies were inhibited, the vloggers felt safe. Feeling safe made social communication easier.

Combat veterans with PTSD show lower heart rate variability (HRV) compared to controls, suggesting the use of psychophysiological interventions such as HRVB (Tan, Dao, Farmer, Sutherland, & Gevirtz, 2011). In the HRVB study, EN symptoms significantly improved as did the Positive scores on the ERNS. When they feel safe, people are perceptually biased toward positive states (Williamson et al., 2015). According to polyvagal theory, autonomic interventions such as HRVB can work to restore autonomic harmony and facilitate greater access to emotions through vagal stimulation. Strengthening of the parasympathetic nervous system through HRVB is associated with emotional recovery and resilience. By resetting the ANS through HRVB, the limbic structures that mobilize defensive reactions when triggered were inhibited, resulting in reductions in EN and an improved ability to access positive affective states.

Contributions

This dissertation research made several key contributions to the study of military-related posttraumatic EN. First, the SRS updated the extant literature on military-related posttraumatic EN. This study also established the psychosocial severity of EN symptoms above those of the other PTSD symptom clusters. In particular, EN uniquely predicts poorer relationship functioning, health- and mental health-related quality of life, comorbid depression, mental health

functioning and service utilization, aggressive behavior, substance use disorders, deficits in

social skills, negative cognitions, and suicidality (Hassija Jakupcak, & Gray, 2012). Moreover,

the symptoms of disconnection, detachment, loss of interest, and negative emotionality that

characterize EN can be devastating.

Second, the study of military-related posttraumatic EN is especially important because

the impact of PTSD is most keenly experienced in the form of impaired relationships with others

(Williamson et al., 2015). Humans are social creatures. The need to connect with others is

fundamental. Relationship functioning is particularly impacted by EN, leaving many service

members and veterans isolated. Eradicating social isolation is one of the American Academy of

Social Work and Social Welfare's *12 Grand Challenges for Social Work*, a call to action for

social workers. One of the goals of this program is to educate the public on the deadly impact of

social isolation, and to identify and promote ways to strengthen social connectedness (American

Academy of Social Work and Social Welfare [AASWSW], 2017). The severity of EN suggests

the need for better assessment and monitoring and specialized treatment approaches that promote

social engagement.

Third, the milvlog and HRVB studies explored approaches that utilized technology and

reduced social isolation. The HRVB study aimed to pilot a protocol that could increase access to

greater numbers of military members by reducing resources through a no-cost phone app and

reducing clinician time by delivering a biofeedback protocol in a single session. The Grand

Challenges initiative also calls for harnessing technology in the form of innovative applications

of digital technology to speed up the development of effective treatment strategies and programs

and to increase access to wider numbers of individuals and communities (AASWSW, 2017).

Fourth, no previous studies have examined military PTSD stories told through milvlogs on YouTube. The milvlog study highlighted a technological medium that offers an alternative way for some veterans and service members to tell their PTSD stories, socially engage with interested others, and make meaning of their struggles through altruistically helping fellow sufferers. The study also pointed to how vloggers are drawing attention to the serious public health concern of military suicide.

Finally, the HRVB study employed the use of biomarkers consistent with recommendations from the National Institute of Mental Health (NIMH; n.d.-a) Research Domain Criteria (RDoC). The RDoC project is part of the NIMH Strategic Plan that calls for researchers to use neurobiological measures as well as observable behavior dimensions to classify mental health disorders. Currently, PTSD is diagnosed, treated, and monitored based on self-report measures and clinical observation. The HRVB study utilized HRV, a paradigm in the Arousal/Regulatory Systems domain of the RDoC (NIMH. n.d.-b). Results from the pilot suggest the need to conduct a larger, randomized, controlled trial.

Limitations

Though the limitations of the studies were addressed in the individual articles, a couple of limitations emerged as themes across the studies related to the conceptualization of EN and diversity. The SRS study identified the different ways included studies measured EN. For the milvlog and HRVB studies, I chose to use the broad definition from the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association [APA], 2013) that reflects Litz's (1992) conceptualization of EN as having limited access to positive emotions despite an intact ability to access negative affective states. However, despite the popularity of this model, it does not show the best fit. Another key limitation was the lack of

diversity in the study samples. It is critically important that women and minorities be included in research on military populations. The studies upon which the results for the SRS were based were largely male, VA-enrolled samples. Also, despite attempts to include persons of color and women in the interview phase of the milvlog study, I was unsuccessful.

Implications

Practice and Policy

Several points of key importance emerged over the course of this research for practice and policy. First, PTSD subcluster symptoms do not wield equal impact, reinforcing the need to tailor individualized treatment approaches. Milvlogs could be used to help educate providers about service members' and veterans' lived experiences with PTSD and their experiences with EN. Emotional numbing symptoms, even in veterans and service members with subthreshold PTSD, are related to the most adverse psychosocial outcomes, up to and including suicide (Guerra & Calhoun, 2011). Behavioral health therapists must pay close attention to levels of EN at assessment and throughout the treatment process. Higher levels of EN should prompt closer screening for suicidality.

Second, PTSD is a noncategorical, but rather dimensional, multisystem disorder experienced differently according to individual genetics, neurobiology, developmental influences, environment, and experiences (Williamson et al., 2015). PTSD is not a standalone disorder; it affects multiple systems and should be treated as such. In addition to the PTSD assessment information recommended by Weathers, Marx, Friedman, and Schnurr (2014)—the use of multiple sources, collateral information, diagnostic interview, psychometric testing, and reviews of medical and military records—psychophysiological assessment should be included as part of a comprehensive PTSD evaluation. Effective PTSD treatment must be holistic,

addressing the psychophysiological as well as the spiritual, psychological, cognitive, and behavioral domains.

Autonomic Nervous System dysfunction is a core feature of PTSD. "One size fits most" trauma-focused treatment paradigms that do not address ANS dysfunction must be updated to a holistic focus that includes psychophysiological diagnostic techniques and treatments. For persons with PTSD, direct human interaction may evoke intense psychophysiological reactions that interfere with the healing aspects of traditional therapies. Though it may be well beyond the scope of many social workers who treat trauma to acquire biofeedback skills, they should become more knowledgeable about psychophysiological approaches and be willing to refer to therapists who specialize in these areas. Further, psychophysiological approaches should be integrated into all PTSD treatment programs serving military populations.

Hassija and colleagues (2012) maintained that "true broad based emotional numbing does not seem to be characteristic of PTSD" (p. 840); however, findings related to complex PTSD and polyvagal theory do not bear this out, and other trauma experts believe the lack of a way to conceputalize generalized numbing is a deficit in the *DSM-5* (Weathers et al., 2014). There is evidence showing EN occurs along a continuum—trauma triggers may re-initiate a flood of endogenous opioids (Foa, Zinbarg, & Rothbaum, 1992; Pitman, Orr, van der Kolk, & Greenberg, 1990; van der Kolk, 1987). For some, this opioid flood could result in more pervasive numbing.

Recovery may entail greater access to negative emotions before access to positive emotions is restored. This may be uncomfortable initially in persons who are accustomed to feeling pervasive numbing. More profound, or rather, generalized emotional numbing symptoms appear to be a manifestation of a primitive vagal response to threat, while fight or flight responses involve negative states such as fear and anger and are related to increased sympathetic

nervous system activation. The negative behaviors involved in a fight or flight response would be a second-order, more evolved defensive response than generalized numbing. Individuals with PTSD need more education about the recovery process, particularly regarding generalized EN (i.e., global numbing of both positive and negative emotional responsiveness). Persons with generalized EN may not readily see regaining access to negative emotions as improvement and could drop out of therapy. Increased support from behavioral health therapists could prevent dropout.

Consistent with polyvagal theory, exposure to the most severe trauma, or perhaps to repeated trauma, activates the most primitive vagal circuit associated with defense, and results in physiological hyporeactivity (Williamson et al., 2015; D'Andrea, Pole, DePierro, Freed, & Wallace, 2013). Although the behavioral health field is still far from the standard use of diagnostic neuroimaging to detect and monitor PTSD, there are some psychophysiological measures that could more easily be implemented alongside standard PTSD assessment and treatment protocols, such as peripheral temperature, heart rate, heart rate variability, respiration rate, muscle tension, and skin conductance measures.

Evidence is emerging to support the use of biomarkers in PTSD diagnosis and treatment. For example, using magnetoencephalography, Dunkley and colleagues (2016) correlated resting state hippocampal connectivity to PTSD symptom severity, suggesting potential uses as a biomarker for diagnosis and treatment monitoring. Studies have also shown higher levels of corticotrophin in the cerebrospinal fluid of persons with PTSD (Bremner, Elzinga, Schmahl, & Vermetten, 2007). Biomarkers are also being identified that correlate with EN, such as reduced cortisol levels. In adult civilians with PTSD, low cortisol levels were independently linked to EN and not to any other PTSD clusters or depressive symptoms (Horn, Pietrzak, Corsi-Travali,

& Neumeister, 2014), Genetic factors may also predict EN. Though not predictive of global PTSD, the rs2267735 *CC* genotype was found to significantly predict EN in female Chinese earthquake survivors (Wang et al., 2013).

Even if blood assay, genetic, salivary, or neuroimaging information is available to the clinician, psychophysiological measurements are far less expensive, more easily accessible, and could be harnessed to support assessment, as well as monitor and inform treatment. For example, along with dissociation, EN has been associated with reduced skin conductance responses to emotionally salient stimuli in response to a novel implied body-threat illusion task (Dewe, Watson, & Braithwaite, 2016). Thus, persons with PTSD who show reduced skin conductance responses during the repetition of a trauma narrative may be high in EN and could benefit from vagal stimulation therapies (i.e., interventions that manipulate breath).

The vloggers in the milvlog study perceived a lack of well-trained behavioral health providers to address war-related PTSD. YouTube milvlogs yield a rich source of important information and point to gaps in the system of care. Some of the milvlogs had garnered hundreds and even thousands of views far outnumbering viewer comments, suggesting a wider-reaching impact. Also, a couple of vloggers were posting links to national military suicide prevention resources on their milvlog sites and several vloggers had been contacted by veterans and family members concerned about suicide. In one case, a vlogger was actively directing veterans and family members to VA treatment and suicide prevention resources.

For some veterans, the vlogger may be their first point of contact because nonprofessional vloggers with personal experience of PTSD may be less daunting, and perceived as more knowledgeable, than professional providers. Some professional sites which feature vlogs by military members with PTSD include links to VA and DoD treatment and military

suicide prevention resources. Encouraging independently affiliated vloggers to voluntarily post

Department of Defense and VA suicide prevention resources on their vlog sites would not

necessarily constitute an endorsement of the vlogger or the milvlog, but could be helpful in

promoting help-seeking in viewers. Also, national efforts to provide military vloggers who self-

publish PTSD stories with information on how to respond to suicidal persons over social media

could be a worthwhile effort.

Future Research

Several potential areas for future research efforts emerged from this dissertation research.

Growing evidence from factor analytic studies show that the current 4-factor *DSM-5* PTSD

model does not have superior fit compared to 5-, 6-, and 7-factor models (Armour et al., 2015;

Armour, Műllerová, & Elhai 2016; Liu et al., 2016; Pietrzak et al., 2015; Tsai et al., 2014; Tsai et

al., 2015). Likely, future revisions to diagnostic criteria will entail a reconceptualizion of EN.

The overlap between anhedonic features of depression and EN must be resolved. Is EN just a

manifestation of depression? Some studies say not, but evidence conflicts and questions remain.

Studying viewer comments on milvlogs could provide important information about this

population. The milvlog study focused on the lived experience of the vloggers, but the impact of

the milvlogs extended to the many interested viewers. Future research should focus on studying

viewer responses to milvlogs, particularly those who may be exhibiting red flags for mental

health concerns and suicidality.

Treatment retention is another important area for research. Service members and

veterans with EN are at higher risk to dropout of treatment (Taylor et al., 2001). Research is

needed to understand the course of recovery for those individuals who experience generalized

numbing and regain access to negative affective states over the course of recovery before they experience more positive emotions.

Research is lacking on the neural correlates of interventions to treat EN (Frewen et al., 2012). Individualized treatment necessitates the consideration of PTSD cluster phenotypes. Targeted treatments for PTSD and subcluster symptoms should be informed by neuropsychophysiological biomarkers, but no reliable indicators currently exist. The behavioral health field needs translational research to identify and develop treatment strategies for different PTSD phenotypes and reliable biomarkers to guide PTSD diagnosis and treatment planning.

It is critical to consider diversity in PTSD research with military populations. Ethnic minority veterans have higher rates of PTSD than do White veterans, possibly due to higher exposure to war zone stressors or negative race-related events in veterans who look like the enemy (Loo, 2017). Women are the fastest growing segment of the US military and are now serving in combat roles (Murphy & Hans, 2014). For these reasons, rates of PTSD in women can be expected to rise. Emerging evidence supports that EN is manifested differently in women and in ethnic minority veterans (Joseph et al., 2012; Rodrigues, 2014; Scott, 2013; Yang, 2014). There is a dearth of knowledge regarding PTSD phenotypes for all military populations, but particularly for ethnic minority veterans and women (who have been underrepresented in military research studies). Stronger efforts must be made to include ethnic minority and women veterans in PTSD research.

The study of links between PTSD and cardiovascular disease in military populations is emerging as an important area of focus. Heart disease is the worldwide leading cause of death (Mozaffarian, 2016). Findings from studies linking PTSD to cardiovascular disease in service members and veterans are of great concern (Boscarino, 2008; Crum-Cianflone et al., 2014;

Kubzansky, Koenen, Spiro, Vokonas, & Sparrow, 2007). The potential mechanisms being

investigated include alterations in ANS function (Brudey et al., 2015; Wentworth et al., 2013).

Studies have demonstrated that HRVB improves ANS function and increases HRV in military

populations (Reyes, 2014; Tan et al., 2011). As a treatment modality for military-related PTSD,

HRVB may also be effective with reducing rates of cardiovascular disease (CVD), which has

been linked to PTSD in military populations. Research is needed to see if HRVB is helpful in

reducing PTSD-related CVD, and if higher rates of EN are related to CVD in military

populations beyond the effects of the other PTSD subcluster symptoms. Finally, research is

needed to determine which vagal stimulation therapies are most effective and acceptable to

military populations (invasive vagal stimulation may be more effective, but least acceptable).

Conclusion

Collectively, the three articles comprising this dissertation examined the construct of military-

related posttraumatic EN. The studies that are the subject of the articles add to the literature

linking EN to particularly adverse psychosocial outcomes in service members and veterans with

PTSD, and suggest the role of technology in delivering interventions that promote social

engagement. YouTube milvlogs are one way service members and veterans are overcoming

social barriers imposed by PTSD and reengaging. The pilot study demonstrated that HRVB can

reduce military-related EN symptoms, as well as overall PTSD symptoms.

<div align="center">**References**</div>

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