PREDICTING TRAJECTORIES OF POST TRAUMATIC STRESS DISORDER FOLLOWING DISCHARGE FROM A LEVEL 1 TRAUMA CENTER

A Dissertation

by

JESSICA CHANG

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Chair of Committee,	Timothy R. Elliott
Committee Members,	Daniel Brossart
	Charles R. Ridley
	Brian H. Stagner
Head of Department,	Victor Willson

August 2016

Major Subject: Counseling Psychology

ABSTRACT

Posttraumatic stress disorder (PTSD) is a mental health disorder impacting an ever-increasing number of Americans every year. There is a lack of information about how physical trauma impacts the development of PTSD. Level 1 trauma centers provide expert care to individuals experiencing physical injuries who are at risk of developing PTSD. Trajectories of PTSD, assessed with the Primary Care PTSD (PC-PTSD) Screen, were examined among individuals admitted to a Level 1 trauma center for severe physical injuries. Hierarchical linear modeling (HLM) was used to investigate whether injury and demographic characteristics, as well as self-reported resilience may predict PTSD trajectories over a 12-month period following discharge.

The average initial score for all individuals on the PC-PTSD was 1.54 points. At 12 months, 17% of the sample had positive screens warranting a possible PTSD diagnosis. Individuals experiencing intentional injuries had significantly higher initial PC-PTSD scores than the unintentional injury group ($p = .044$) but their trajectories decreased at a faster rate than trajectories observed among those with unintentional injuries ($p = .017$), such that by 12 months post-injury, there were no longer significant differences between the two groups. Age of injury was also significant at initial ($p = .019$), but did not impact PTSD trajectories over time. Initial resiliency, measured by the Connor Davidson Resilience Scale 10 (CD-RISC 10), showed a significant inverse relationship in the random intercept model ($p < .001$; $M = 30.69$; $SD = 8.39$) and the random slope model ($p = .035$), indicating individuals with higher initial resiliency

experience a decrease in PC-PTSD scores at a slower rate than individuals with lower initial resiliency. By 12 months, individuals with high initial resiliency scores had significantly lower PC-PTSD scores compared to those with lower resiliency (p = 0.029). No statistically significant differences were seen among traumatic brain injury, injury severity and gender at initial, nor did these variables significantly predict PTSD trajectories. These findings indicate that injury type and psychological resilience play an important role in predicting PTSD outcomes soon after injury. While differences between groups were supported in intentional injury, age of injury, and resiliency group membership, clinical outcomes are limited in that many of the participants met criteria for sub-threshold PTSD and much of these statistically significant differences seen at the initial time point were no longer significant at 12 months post-discharge. Clinical implications involve increased clinician awareness surrounding individuals admitted to trauma centers with pertinent injury characteristics, with aims of helping to decrease patient and clinician burden by helping to further delineate unsupported variables in predicting PTSD trajectories.

DEDICATION

I dedicate this dissertation to my grandfathers, Dr. John Field Lawry and Dr. Winston Chang, and the women who have stood beside them, Eleanor Lawry and Irene Chang.

ACKNOWLEDGEMENTS

I would like to first acknowledge and thank my dissertation committee, Timothy Elliot, Daniel Brossart, Charles Ridley, and Brian Stagner for their investment in my education and being instrumental in my development as a young career professional. Specifically, my committee chair, Timothy Elliott, for whom without I would not be where I am today. Throughout our four years together, you have served as my professor, supervisor, employer, and more importantly, my mentor. As you would say, I have learned the invaluable lesson of "keeping it between the ditches." I would like to thank my graduate program and all the professors who have given me an education to be proud of and promises to prove beneficial in the years to come.

My dissertation would not have been possible without the hard work and endless dedication and partnership of Dr. Anne Marie Warren, Megan Reynolds, and Michael Foreman from Baylor University who were responsible for establishing the Baylor Trauma Outcome Project and database that allowed me to even conduct my research question. I hope one day our paths will cross and I can formally thank you in person.

To the family I have cultivated during my "transplant" to Texas, thank you for giving me endless encouragement, laughs, and love: C.E.M., M.D., M.T.G., R.A.M. And of course to my California family: P.F.J., M.C.L., and M.L.L.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

FIGURE Page

CHAPTER I

INTRODUCTION

Although Post Traumatic Stress Disorder (PTSD) did not make its debut until the *Diagnostic and Statistical Manual-Third Edition (DSM-III)* in 1980, the nature and effects of trauma have long been documented (Jones & Wessley, 2005; Scott, 1990). An estimated $406 billion in direct medical care and lost wages are attributable to traumatic injury (Finklestein, Corso, & Miller, 2006). More recently, there has been a dramatic increase in combat Veterans requiring psychological attention, with more than 200,000 Veterans receiving compensation for combat-related PTSD at an estimated cost of $4.3 billion dollars in 2005 (Tanielian et.al, 2008). Because of the mass numbers of soldiers returning from the Iraq and Afghanistan wars, understanding and predicting trajectories of trauma is an increasingly "hot topic." Veterans with PTSD are more likely than other Veterans to be unemployed, homeless, and abuse substances (National Center for PTSD, 2004). Additionally, Veterans with PTSD have increased health care costs, with one study finding Veterans with PTSD having 60% higher medical costs for both mental and physical care (Marshall, Jorm, Grayson, & O'Toole, 2008).

Previous diagnostic criteria for PTSD in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; text rev.; *DSM-IV-TR;* American Psychiatric Association, 2000) were as follows: An individual has to have experienced, witnessed, or be confronted with an event(s) that involved actual or perceived threat of death, serious injury, or sexual violation. In response to the trauma, the individual must have responded with intense fear, helplessness, or horror and must be currently experiencing symptoms

in each of the three clusters: re-experiencing, avoiding, and hyperarousal. Additionally, these symptoms have to have persisted for a minimum of 1 month after the initial trauma and cause clinically significant distress or impairment in social, occupational, or other important areas of functioning (American Psychiatric Association, 2000).

In the most recent edition of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (5th ed.; *DSM-5*; American Psychiatric Association, 2013), the diagnostic criteria for PTSD has changed. The disorder is no longer categorized as an Anxiety Disorder; it is categorized as a Trauma-and/or-Stress Related Disorder. Additionally, the DSM-V has included an additional cluster (Cluster C), cognition and mood symptoms. These symptoms include the inability to remember important details surrounding the traumatic event, distorted thoughts, persistent negative emotional states, and numbing. The criterion that the individual reacted with horror or helplessness is no longer a necessary condition as it has been found not to be predictive of developing PTSD (American Psychiatric Association, 2013).

It is estimated that roughly 81% of individuals in the United States will experience some form of trauma in their lives. However, the lifetime prevalence of developing PTSD is approximately 8.7% (Bahraini, Breshears, Hernandez, Schneider, Forster, & Brenner, 2014). Therefore, a large majority of American citizens will experience a trauma at some point in their lives, but the risk of meeting criteria for PTSD is relatively low. Understanding how trauma impacts people in general can inform interventions and prevention methods. In the civilian sector, trauma centers are one of

the most common places where mental health professionals can conceivably encounter individuals at risk of developing PTSD.

Each year approximately 2.5 million Americans sustain traumatic physical injuries and many are treated at medical centers that specialize in trauma treatment, prevention, and research. These centers are ranked by Levels 1 through 4, with Level 1 providing the highest standard of care (Bonnie, Fulco, & Liverman, 1999). Trauma centers can serve as a point of intervention for PTSD in which physicians and nurses can more effectively screen for PTSD and filter referrals to the appropriate professionals as needed. However, one of the most common barriers identified by physicians who fail to screen for posttraumatic stress disorder (PTSD) in trauma patients is time constraint (Powers et al., 2014). Brief screening devices are needed for use in Level 1 trauma centers.

There are several factors that may be associated with the development of PTSD among civilians who experience a traumatic event or injury. For example, individuals may incur a traumatic brain injury (TBI) as a secondary injury resulting from their primary physical injury. TBI is described by the Centers for Disease Control and Prevention (CDC; 2014) as "…caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain." There are varying degrees of severity, ranging from mild to severe. A concussion is typically described as a mild TBI (mTBI) and often does not include a loss of consciousness (LOC). Severe TBIs can include extended periods of LOC, amnesia, and/or death (Center for Disease Control, 2014). There have been upper limits designated to operationalize the definition

of mTBI: 1) LOC does not exceed 30 minutes and 2) Posttraumatic amnesia (PTA) does not exceed 24 hours (American Congress of Rehabilitation Medicine, 1993). While mTBIs are usually not life threatening, symptoms may go undiagnosed or untreated because there is a more serious health concern resulting from the trauma or the individual doesn't believe their symptoms warrant the services of a physician (Vasterling, Bryant, & Keane, 2012). Evidence from combat Veterans now indicates TBI is associated with PTSD (Bryant, & Harvey, 1999; Vanderploeg, Belanger, & Curtiss, 2009) and there is evidence from at least one follow-up study suggesting a significant minority of individuals who incur a mTBI may be at risk for PTSD at 6 months post-injury (Hoffman, Dikman, Temkin, & Bell, 2012).

Premorbid psychological functioning has also been investigated to see what role it plays in whether an individual will develop PTSD. Resiliency may be a protective factor against the development of PTSD. Resiliency and PTSD have been conceptualized as opposing reactions in the face of trauma: one cannot be resilient and have PTSD (Bonanno, 2004). However, this position is open to empirical scrutiny as it is uncertain if self-report measures of resiliency predict lower PTSD symptomology over time.

Purpose of the Study

The purpose of this exploratory study was to examine factors that influence the trajectory of PTSD in civilians after a significant trauma. Much of the relevant research concerning PTSD following trauma is cross-sectional, providing a "snap shot" of one's reactions to a traumatic event. However, PTSD may have different trajectories of

development over time, and individuals may not exhibit symptomology until months or years after the initial traumatic event (DSM-IV, 2000). In one study using a brief screening measure of PTSD at a Level 1 trauma center (Reese et al., 2012), patients were followed over the course of 23 weeks. This study found that 42% of their respondents endorsed meeting criteria for PTSD, and those with gunshot wounds had the highest likelihood of having PTSD (13 times higher than observed among those injured in falls and twice as high as motor vehicle collision). The current study followed individuals for a year post-injury. Additionally, the respondents in the Reese et al. study self-administered the Primary Care PTSD Screen (PC-PTSD; Prins et al., 2003). In the current study, health professionals or research assistants administered the PC-PTSD.

Level 1 trauma centers are expected to conduct research that informs their clinical practice (Warren, Stucky, & Sherman, 2012). Identifying factors that predict the development of PTSD can inform clinical practice and advance our theoretical understanding of PTSD. This study examined the impact of multiple variables on initial PTSD scores and the trajectories of PTSD symptoms over time in individuals admitted to a Level 1 trauma center. Specifically, this study evaluated the influence of mild TBI, age of injury, gender, injury severity, intentionality of the injury, and self-reported resilience.

CHAPTER II

LITERATURE REVIEW

Predictors of PTSD

Understanding what makes individuals at risk for developing PTSD is still relatively unknown, with many inconsistent findings in the literature (Bremner, Southwick & Charney, 1995; Brewin, Andrews, & Valentine, 2000; Frans, Rimmo, Aberg, & Fredrikson, 2005). Interestingly, a consistent finding is that the trauma severity does not predict post-injury psychological consequences (Richmond, Ruzek, Ackerson, Wiebe, Winston, & Kassam-Adams, 2011), with even minor traumatic events eliciting PTSD symptoms. Several other variables have consistently been found to account for the variance seen in the risk of developing PTSD. These include age, gender, previous injury/trauma exposure, substance abuse, pre-injury functioning and mood, and type of trauma (Ditlevsen & Elklit, 2011; Frans et al, 2005; McCauley et al, 2013). While these variables have consistently been seen to be associated with increased risk of developing PTSD, there are still many unanswered questions about others variables that may be associated with the development and course of PTSD. It is important to examine stable variables such as age, gender, trauma type, and fluid variables, such as current physical and psychological functioning and symptomology. As Hetzel-Riggen and Roby (2011) noted, "Those in the trauma field have sought to develop a consensus on the definition of trauma and its effects on victims, but this has proved extremely difficult as traumatic events vary along many lines, such as level of life threat, duration, predictability, and controllability" (p. 41). Stable variables may assist in identifying at-risk individuals, and

flexible variables may indicate points of intervention.

Age

The relation of age and the development of PTSD has not been well studied and the results have been inconsistent (Contractor, Layne, Steinberg, Ostrowski, Ford, & Elhai, 2013). Russo, Katon, and Zatzick (2013) found that in general, younger individuals were more likely to develop PTSD in their study of 878 patients. However, it is unclear as to how age functions as a predictor. A handful of studies have found that pre-adolescents report more PTSD symptoms than adolescents (Anthony, Lonigan, & Hecht, 1999; Giannopoulou, Strouthos, Smith, Dikaiakou, Galanopoulou, & Yule, 2006; Kar, Mohapatra, Nayak, Pattanaik, Swain, & Kar, 2007). In particular, Giannopoulou et al. (2006) found that younger adolescents are more likely to engage in the avoidance symptoms of PTSD. Younger individuals may be less able to cognitively and emotionally process traumatic experiences and may rely more on parental reactions as guidance. Other studies find adolescents reporting more PTSD symptoms than pre-adolescents, possibly due to experiencing multiple traumatic events as they mature to adulthood (Copeland, Keeler, Angold, & Costello, 2007; Kaplow, Dodge, Amaya-Jackson, & Saxe, 2005). Other studies have found no age-related differences associated with PTSD (Agustini, Asniar, & Matsuo, 2011; Bal & Jensen, 2007). The contradictory and inconclusive nature of these findings highlights the need for more information on how age may be associated with PTSD.

Gender

A consistent finding in the trauma literature is that men experience more traumatic events in their lives, but women are at higher risk of developing PTSD than men. Specifically, women are twice as likely to develop PTSD and experience PTSD-symptoms for up to four times longer than men (Breslau, Chilcoat, Kessler, & Davis, 1999; Norris, Foster, & Weisshaar, 2002). Some attribute this gender difference to the fact that interpersonal traumas are more common in women than men (Kessler, 2000), leading to an increased sense of betrayal (Freyd, 1994). However, even when assaultive violence is statistically accounted for, females still were at higher risk of developing PTSD than males (Breslau, 2009). From a conditioning standpoint, it has been hypothesized that the traumatic event serves as the unconditioned stimulus (UCS), while the emotional response is the unconditioned response (UCR). Conditioned stimuli, or trauma triggers, elicit the conditioned response, being PTSD. Gender differences come into play in that PTSD has been shown to enhance conditionability among women, rendering them more susceptible to develop PTSD, even when men experience more potentially traumatic events (UCS) (Orr, Metzger, Lasko, Macklin, Peri, & Pitman, 2000).

Kessler, Sonnega, Bromet, Hughes, and Nelson (1995) found in their National Comorbidity Survey that men were two times more likely than women to report being violently attacked or assaulted (11.1% vs. 6.9%), but women were 15 times more likely to meet criteria for PTSD after experiencing a violent physical attack. A more recent study by Frans, Rimmo, Aberg and Fredrickson (2005) found that although the

differences in the risk for PTSD between men and women are significant ($p < .001$), gender only explained 2% of the variability in PTSD prevalence, whereas type of trauma accounted for 16.7% variance and perceived distress and trauma frequency explained roughly 10 times more variance than gender or ethnicity (Frans et al., 2005). Similar results were found in a study by Hetzel-Riggin and Roby (2013) in which both gender and trauma type were significant predictors of PTSD, yet trauma type yielded a stronger effect than gender. Additionally, no interaction effects were found leading the authors to conclude that gender and trauma type contribute to PTSD independently. Together, these studies confirm gender as a statistically significant predictor of PTSD prevalence rates, but given the small amount of variance explained by gender, its practical utility remains uncertain and research must continue to investigate other predictors, such as trauma type, that explain more variability.

Trauma Type

The type of trauma experienced by the individual may contribute to the discrepancy in the rates of PTSD observed among men and women (Breslau et al., 1999). The causes of trauma can be generally categorized as natural causes (e.g., flood, earthquake, fire), interpersonal (physical and sexual assault and violence), and accidental (motor vehicle accidents, car vs. pedestrian, falls) (Hetzel-Riggen et al., 2013). Combat experience is the common trauma type experience associated with PTSD in men and sexual assault is the most common in women (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995).

The type of traumatic experience has been hypothesized to explain some of the between and within gender differences seen in PTSD development. A national study of current and lifetime prevalence rates of PTSD development among women in the United States found that women experiencing criminal events (rape, sexual assault, and physical assault) were almost three times more likely to have lifetime prevalence rates of PTSD (25.8% vs. 9.4%) as well as current PTSD (9.7% vs. 3.4%) when compared to women experiencing noncriminal events (Resnick, Kilpatrick, Dansky, Saunders, & Best, 1993). In another study investigating prevalence of PTSD among women in the United States, female victims experiencing violent traumas were four times more likely to develop PTSD than females with a history of nonviolent trauma (Rothbaum, Foa, Murdock, Riggs, & Walsh, 1992). These studies highlight the intersection between gender and the type of trauma contributing to development of PTSD.

Another prospective study of women in the United States investigated the implications of assault on PTSD development. In this study, 17.8% of women who experienced aggravated assault and 12.4% of rape victims experienced chronic PTSD symptom reports, compared to only 3.4% of women who experienced non-interpersonal traumas (Rothbaum et al., 1992). A longitudinal study of sexual and non-sexual assault victims over a 12-week period found 94% of the rape victims met criteria for PTSD at the first assessment (two weeks after the incident; Rothbaum et al., 1992). The sexual assault group's PTSD trajectory gradually decreased over time; however, at the final assessment 47% of rape victims still meet criteria for PTSD.

A frequently cited paper presented by Foa (1995) at a conference addressing treatment of PTSD, investigated PTSD rates among 96 rape victims and 100 nonsexual assault victims and found 92% of rape victims and 74% of nonsexual assault victims met criteria for PTSD two weeks post trauma. However, PTSD cannot be formally diagnosed until 1-month post trauma. Three months later, 47% of rape victims and 27% of nonsexual victims met criteria for PTSD. Six months later, 38% of rape victims and 13% of nonsexual victims still met criteria for PTSD. Taken together, these two studies show that a large majority of women may recover and regain functionality. Nevertheless, a significant percentage of women do not return to their pre-trauma level of adjustment, and differences between sexual and nonsexual assault trajectories are seen.

Intentional Injuries

Women are more likely to experience interpersonal events, such as rape or sexual assault, and men are more likely to experience physical violence (Breslau et al., 1999). Specifically, one study found that the type of trauma with the highest conditional risk of developing PTSD was rape, but the trauma type associated with the highest gender difference in developing PTSD was nonsexual assault (Ditlevsen & Elklit, 2011). Frans et al. (2005) summarized the gender controversy by saying, "Thus, gender differences, may in part, reflect exposure to different trauma types or, different exposure rates, or alternatively, differential effects of the perceived impact of the event" (p. 292).

In the present study, the type of trauma was categorized as either an intentional injury or unintentional injury. This was based on previous studies showing that trauma victims from intentional injuries were more likely to develop PTSD. Intentional injuries

might disrupt an individual's sense of security and ability to make sense of the world, leading to a sense of betrayal and mistrust; unintentional injuries (e.g., accidents) do not precipitate the same level or rate of psychological distress associated with assault (Freyd, 1994; Janoff-Bulman, 1992).

Traumatic Brain Injury

A relatively new and controversial issue concerns the potential relationship of traumatic brain injury (TBI) to PTSD. Vasterling and Dikmen (2012) state, "TBI is precipitated by a physical event (i.e., external force to the brain) and PTSD is precipitated by a psychological event (i.e., psychological trauma), a growing body of evidence suggests that biological and psychosocial factors are relevant to both mTBI recovery and PTSD course" (p. 390). There is some debate as to whether TBI and PTSD can even co-occur, given the amnestic effects of posttraumatic amnesia (PTA) and impaired recollection reported in all severities of TBI (Mayou, Black, & Bryant, 2000; Sbordone & Liter, 1995). Previous research has also shown that PTSD has been found to co-occur with TBI at all severity levels; however, mild TBIs (mTBI) may be more likely associated with PTSD than other more severe TBIs (King, 2008; Zatzick, Rivara, Jurkovich, Hoge, Wang, Fan, et al., 2010). Many believe this is because of the lack or limited duration of LOC seen in mTBI compared to more severe brain injuries (Greenspan, Stringer, Phillips, Hammond, & Goldstein, 2006; King, 2008; Mayou, Bryant, & Duthie, 1993). Since one of the key criteria in PTSD is re-experiencing, if the individual loses consciousness in more severe TBIs, they may be protected from

developing PTSD as they cannot remember much, if any, of the traumatic event (Vasterling & Dikmen, 2012).

The rate of developing PTSD after a TBI appears to vary across studies. One study found 10% of participants meeting criteria for PTSD after 1 month (Bombardier et al., 2006), while Bryant and Harvey (1999) found rates of 20% among motor vehicle accidents (MVA) participants 6 months post-injury. An alternative study found 40% of MVA participants, with severe enough head injuries to cause LOC, meeting criteria for PTSD 1-4 months after injury (Hickling, Gillen, Blanchard, Buckley, & Taylor, 1998).

Mild TBIs (mTBIs) are often considered to be the least understood in the TBI literature, as the diagnosis is often based on subjective reports and many individuals do not seek immediate or any medical attention, making it difficult for physical and mental health care providers to monitor and treat post-concussive symptoms (PCS). Post-concussive symptoms are self-reported symptoms resulting from TBIs that persist long after the residual effects of the initial TBI are believed to have resolved. Typically, most individuals recover from a single mTBI without lingering post-concussive symptoms within days, if not hours. However, there appears to be a small, yet meaningful, subset of individual in which this is not the case (Yeates, 2010). In fact, 44% of individuals in one study with uncomplicated mTBI were found to report at least three PCS as long as one year post injury (Dikmen, Machamer, Fann, & Temkin, 2010).

Differentiating PTSD from PCS has proven difficult given the symptom overlap between the two (Vasterling et al., 2012). Common complaints for both PTSD and TBI-related PCS include irritability, neurocognitive complaints, such as memory difficulties,

insomnia, depression and anxiety. The two most common PCS reported are sleep and irritability, which are commonly seen in PTSD as well (Morissette et al., 2011). Additionally, further complication is added by the recent finding that new PCS symptoms have been found to spontaneously emerge as PTSD develops (Mears et al., 2011).

There is emerging evidence that the relationship between PTSD and PCS symptomology strengthens over time. For example, in a study that followed civilians admitted to a trauma center found that 21% of participants with mTBI had developed PCS at the 3 month follow up that had not reported PCS at Time 1 (within 14 days post-injury; Mears et al., 2011). Additionally, 30.8% of participants reporting irritability and 86.2% of participants with concentration problems during hospitalization were reporting either new PCS or more frequent symptoms during 3 month follow up. This indicates that while individuals may return to initial quickly after mTBI, PCS may continue to persist as PTSD develops (Meares et al., 2011), further highlighting the need for routine follow-ups and targeted interventions.

The research is mixed concerning the possible causal relations between mTBI and PTSD. The rate among combat Veterans identified as having probable PTSD with individuals identified as having probable mTBI is 33 to 39% (Carlson et al., 2011). Vanderploeg et al., (2009) found that mTBI was significantly related to PTSD, with 11.5% of Veterans sustaining mTBI meeting criteria for PTSD compared to 5.8% of motor vehicle collision (MVC) injury controls. Additionally, MVC injury control and Veterans with mTBI were found to have similar rates of PTSD 1 year post discharge, yet

follow ups over the next 16 years revealed almost 70% of the control group no longer met PTSD criteria, whereas almost 50% of individuals in mTBI group continued to report PTSD symptoms. These results are similar to the Bryant, Creamer, O'Donnell, Silove, Clark, and McFarlane (2009) study, which found that individuals with mTBI were more likely to develop PTSD 3 months post injury compared to those with non-brain related injuries, even after accounting for general injury severity.

Belanger, Kretzmer, Vanderploeg, and French (2010) studied the relationship between PCS and TBI severity and investigated the influence of PTSD symptoms on PCS reports. OEF/OIF Veterans were given self-report assessments, such as the PTSD Checklist (PCL; Weathers, Litz, Herman, Huska, & Keane, 1993), and Neurobehavioral Symptom Inventory (NSI; Cicerone & Kalmar, 1995) to measure PCS. TBI severity was determined by either self-report and/or documentation by medical records. Veterans with mild TBI versus moderate or severe TBI were significantly more likely to report PCS, even after controlling for age, time since injury, and mechanism of injury (i.e., motor vehicle accident, blast injury). However, once PTSD was controlled for (using the PCL total score) the statistically significant relationship between PCS and mTBI disappeared. Alternatively, a similar study found that even after controlling for PTSD, mTBI was still associated with PCS, suggesting that PTSD and mTBI independently contribute to self-reported PCS (Vanderploeg et al., 2009). LOC appears to be associated with PTSD development even after controlling for combat severity, mechanism of injury, and demographic factors (Hoge, Castro, Messer, McGurk, Cotting, & Koffman, 2008).

Collectively, these studies suggest that the experience of a brain injury has a unique influence in the development of PTSD.

Mild TBIs are frequent and poorly understood, and they may be associated with the development of PTSD. It seems as though the field is moving towards accepting that mTBI and PTSD can and do co-occur, yet the sequelae of brain injury and whether it uniquely predicts one's development of PTSD over time is still unclear. These relationships may be best examined with "…longitudinal work examining the trajectory of PTSD symptoms when index trauma events involve TBI" (Vasterling, Verfaelli, & Sullivan, 2009, p. 674).

Resiliency

Although the field still lacks an operational definition of resiliency (Davydov, Stewart, Ritchie, & Chaudieu, 2010) it can generally be defined as the "…ability to maintain sufficient psychological balance to maintain mental and physical functioning following exposures to aversive stress and or trauma" (McCauley et al., 2013, p. 647). Resiliency research initially was born out of grief and bereavement research and studies of child development that found children who reacted with little distress to potentially traumatic life events or adults who lost a family member but had little disruption in their daily life (Bonanno, 2004; Garmezy, 1991; Werner, 1995). At first, clinicians pathologized these types of responses and what is now termed as "resiliency" was considered to be the exception, not the norm (Bonanno, 2004). Contemporary research implies that resiliency and positive adjustment following life challenges may be much more common and normative than previously assumed (Bonanno, 2004).

Bonanno (2004), one of the contemporary scholars in resiliency research, defines resiliency as one's ability to maintain emotional homeostasis throughout the course of difficult life events. Using latent growth modeling, four trajectories of depression are observed over time in reaction to loss and trauma. These four trajectories are labeled as *chronic*, *recovery*, *delayed*, and *resilient* (Bonanno, 2004). Individuals exhibiting a *chronic* trajectory consistently report symptoms of depression without significant improvements of symptomology over time. Individuals exhibiting a *recovery* trajectory show higher levels of depression following a traumatic event or loss that steadily decrease over time and eventually return to initial levels. *Delayed* trajectories show relatively mild levels of depression that steadily increase over time. *Resilient* trajectories show almost no fluctuation in depression scores over time, indicating no significant change from premorbid levels of functioning. Bonanno (2004) distinctly distinguishes recovery from resilient trajectories in that recovering individuals experience a spike in their reports of depression and dysfunction. Resilient individuals do not exhibit a noticeable difference in depression levels at any time point. More recently, Bonanno and Diminich (2013) have further defined resiliency trajectories, *emergent resilience* and *minimal impact resilience*. Emergent resiliency is seen individuals that exhibit positive adjustment after chronic adversity (Garmezy, 1993), and exhibit more of a "gradual sweep toward positive outcome" (p. 380), whereas minimal impact resilience represents more isolated and acute stressors and "allow for more focused and relatively more proscribed coping efforts" (p. 380).

The Bonanno process model conceptualizes resiliency only in the context of a stressful event and it does not take into account traits or characteristics, both positive and negative, an individual possesses before a traumatic event is experienced. According to Mancini and Bonanno (2009), "…resiliency can *only* be defined in terms of their level of adjustment after the stressor event. *Resilience* cannot be defined in the abstract or applied to individuals in the absence of an extremely aversive experience, such as loss" (p. 1806-1807).

However, the Bonanno model is not without criticism. First, it is possible that individuals who are distressed after a traumatic event had problems with distress prior to the event. For example, Hoffman et al. (2012) followed individuals for 6 months after a mTBI and found those who developed PTSD were more likely to report worry and unhappiness on initial measures prior to their injury. Similarly, soldiers who report high resiliency post-deployment were also categorized as resilience pre-deployment as well (Bonanno et al., 2012). Another shortcoming of the Bonanno model concerns the way individuals are categorized. Individuals are not categorized based on self-report measures of depression but instead categorized *post hoc* as resilient or not using complex statistical procedures. The assumption of this model is that the presence of depression by default indicates a lack of resiliency. But the model does not provide an *a priori*, "clinician-friendly" method to determine resiliency (e.g., with a self-report instrument).

An alternative conceptualization of resiliency conceives resiliency as a more stable personality trait (Block & Kremen, 1996; Waugh, Fredrickson, & Taylor, 2008). In Block and Block's model, ego control and ego resiliency are two central

constructions. Ego control relates to impulse inhibition/expression and ego resilience refers to one's ability to respond and adapt to one's environmental demands. From this, three specific personality prototypes can be identified: overcontrolled, undercontrolled, and ego-resilient. Overcontrolled individuals exhibit impulse and emotional restraint across situations and tend to shut down as a mechanism of coping. Undercontrolled individuals lack impulse and emotional regulation. In contrast to their overcontrolled counterparts, undercontrolled individuals have a proclivity to explore their environment and be impulsive as opposed to shutting down. High ego-resilient individuals are able to adjust their level of control as the situation requires; individuals low in ego-resilience tend to exhibit the same level of control and emotional expression in every situation and are seen as inflexible. The Block model has been used to determine what differentiates individuals with high ego-resilience from others in their abilities to rebound and recover from potentially threatening events. Specifically, high ego-resilient individuals have been found to have less negative emotion (Waugh, Wager, Fredrickson, Noll, & Taylor, 2008), faster cardiovascular recovery times (Tugade & Fredrickson, 2004), and recover quicker from anticipated threats (Waugh et al., 2008) than low ego-resilient individuals.

One way of evaluating and measuring one's level of ego-control and resiliency is with measures of Five-Factor Model (FFM) personality traits (Costa & McCrae, 1992). Using the FFM, low scores on the neuroticism scale are characteristic of resilient individuals, and overcontrolled individuals usually have higher scores on this dimension (Letzring, Block, & Funder, 2005). Much of this work relies on cluster analytic techniques to categorize individuals into the three personality prototypes (Asendorpf,

Borkenau, Ostendorf, & Van Aken, 2001; Chapman, & Goldberg, 2011; Schnabel, Asendorpf, & Ostendorf, 2002). However, as with Bonanno's model, these *post hoc* categorizations are open to criticism. While this is a more stringent evaluation, less susceptible to social desirability factors common to many self-report measures, it is not clinically efficient to routinely administer measures of the FFM and then conduct the cluster analytic procedures necessary to determine individual membership in one of the three clusters.

Resiliency can be conceptualized as the lack of trauma-related symptoms. Presence of adaptive beliefs and personal characteristics are routinely assessed by self-report measures. This is best exemplified by the use of the Connor-Davidson Resiliency Scale (CD-RISC; Connor & Davidson, 2003). The CD-RISC assesses adaptive characteristics and permits the study of fluctuations in scores over time in response to context, interventions, and maturation. The authors of the CD-RISC define resiliency as "…personal qualities that enable one to thrive in the face of adversity" (Connor & Davidson, 2003, p. 76).

The CD-RISC is a popular instrument. A study by Campbell-Sills, Cohan, and Stein (2006) found that resiliency as assessed by the CD-RISC was statistically significantly associated with three of the FFM personality constructs including neuroticism (r = - .65), extraversion (r = .61) and conscientiousness (r = .46) (all p's <.001). These data provide some evidence of convergent validity of the CD-RISC with several important personality traits. In a study of the Block personality prototypes among caregivers of children with severe neuro-disabilities, Chang et al. (2014) found

overcontrolled caregivers had significantly lower CD-RISC scores than undercontrolled and resilient caregivers (*p's* <.05).

There is still relatively little research on how trauma impacts or changes an individual's self-reported resiliency over time. For example, McCauley et al. (2013) investigated possible differences in the development of PTSD in individuals, admitted to two Level 1 trauma centers in Houston, TX, that had experienced a mTBI or orthopedic injuries. The CD-RISC was administered at initial, 1 week, and one-month post discharge. Initial resilience, as measured by the CD-RISC, predicted outcomes following mTBI over the course of a month. Higher CD-RISC scores at initial were associated with lower TBI-related symptom reports. Importantly, the McCauley et al. (2013) study suggests that self-reported resilience is an important factor in adjustment following mTBI and it may help protect an individual from developing PTSD. However, McCauley et al., studied individuals from initial to one month post-discharge. Studies with longer time frames are needed to examine the prospective association of self-reported resilience to PTSD for an extended period of time following trauma.

Relatively few studies have studied subsequent recovery trajectories among people in general following traumatic injury. Using a shorter version of the CD-RISC, the current study aimed at clarifying what initial factors are contributory to the development of PTSD in order to provide information that is beneficial in identifying individuals who would benefit from the treatment of PTSD. It is hoped that by knowing what initial characteristics are salient in developing PTSD, clinicians and health care

providers can easily and efficiently differentiate between individuals at-risk of developing PTSD and those that are not.

CHAPTER III

METHOD

Context

This study is part of the ongoing Baylor Trauma Outcome Project (BTOP) at the Baylor Scott & White Trauma Center in Dallas, Texas. This project has been reviewed and approved by the Baylor Scott & White Medical Center Dallas Institutional Review Board. The current study has been approved by the Institutional Review Board at Texas A&M University. This comprehensive project studies outcomes and quality of life (physical and psychological) among patients receiving treatment at the Level 1 Baylor Scott & White Trauma Center. The Baylor Scott & White Trauma Center has over 2,700 trauma admissions yearly (Warren et al., 2014). Enrollment for the project began in March 2012 and participant recruitment is ongoing.

Procedure

Participants included patients who were admitted either to the Trauma or Ortho-Trauma Service at the Level 1 trauma center. Once medically stable, patients were approached and informed of the study prior to discharge from the Baylor Scott & White Trauma Center. Several inclusionary and exclusionary criteria were observed in the project.

Inclusionary Criteria

- Patients admitted to the trauma service with a stay of at least 24 hours
- Patients ages 18 and older

- Able to provide at least one contact phone number in order to be contacted for follow up at 3, 6 and 12 months.

Exclusionary Criteria

- Moderate and severe traumatic brain injury and/or premorbid cognitive deficits (i.e. dementia) such that the patient cannot provide informed consent
- Inability to understand spoken English or Spanish

Once a patient was identified as meeting inclusionary criteria, informed consent was discussed with the patient. The investigator informed the prospective participant of the purpose of the study and study requirements (e.g., completing questionnaires, follow-ups, time requirement). All informed consent took place in a private room during their admission at the hospital. After consent was obtained, individuals were given their initial questionnaires and demographic information, such as age at injury, gender, ethnicity, and education level, was gathered.

Following discharge, patients were given routine follow-ups at 3, 6, and 12 months over the phone. Once the individual was reached, the research assistant would read the IRB-approved script to further inform the patient of what was being asked of them. After giving their continued consent, the research assistant would read the assessments to the patient and record their responses. The research assistant then entered their data into an Excel spreadsheet. The research assistant would make a maximum of 12 attempts (separated by 24 hours between calls) of reaching patient on the phone for 4 weeks, and then a reminder letter was sent to their home. If no contact was made,

continued attempts were pursued at the next time interval (i.e., if no contact was made at 3 months, they would be contacted again at 6 months).

An Excel spreadsheet was created to record the data that were collected. As this is an ongoing study, new participants are added on a rolling basis and therefore, the number of participants was capped for this study. For the purpose of this study, 268 individuals were included in the study. The mean age was 45.53 years old (*SD* = 18.00 years). There were 102 women (38%) and 166 men (62%) in the sample. The racial and ethnic composition of the sample included 181 (68%) identifying as Caucasian, 62 (23%) as African American, 6 (2%) as American Indian, 1 (< 1%) as Asian/Pacific Islander, and 16 (6%) did not indicate their race/ethnicity.

Predictor and Outcome Variables

Although several variables are assessed as part of the larger BTOP protocol, for the purpose of this study only six variables were included. Six predictor variables investigated in this study were: age of injury, gender, traumatic brain injury, injury severity, injury intentionality, and self-reported resilience. All of these variables were treated as time-invariant factors (i.e., they are measured only at initial). While the self-reported resilience measure (CD-RISC 10) was administered on two occasions, initial and 12 months, the focus of the current study was on identifying which initial characteristics serve in predicting PTSD development, therefore only the initial CD-RISC 10 scores were considered. The measure of PTSD reflects the outcome (or criterion) variable.

Predictor Variables

Traumatic Brain Injury

The Baylor Scott & White Level 1 trauma center participates in the National Trauma Data Center registry established by the American College of Surgeons Committee on Trauma. The National Trauma Data Center collects specific information on patients admitted and treated, and these data are provided to the National Trauma Data Bank (NTDB). The NTDB "…is the largest aggregation of U.S. trauma registry data ever assembled" (American College of Surgeons, 2014).

Trauma physicians entered de-identified medical diagnostic information from the patient's history and physical form. This information was then retrieved by the Trauma Nurse Clinician, who obtained the ICD-9 code for each diagnosis. The ICD-9 codes were then provided to the NTDB for each patient.

For the present study, patients receiving an ICD-9 code indicative of a mild traumatic brain injury (TBI) were coded as positive for mTBI (coded as "1"). Patients who did not receive an ICD-9 code indicative of a TBI were coded as negative for TBI (coded as "0"). Examples of ICD-9 codes indicative of a mTBI include:

850.0 With no loss of consciousness

Concussion with mental confusion or disorientation, without loss of consciousness

850.1 With brief loss of consciousness

Loss of consciousness for less than one hour

850.11 With loss of consciousness of 30 minutes or less

850.12 With loss of consciousness from 31 to 59 minutes

Injury Severity Score (ISS)

The Injury Severity Score provides an overall score for patients with multiple injuries located anywhere on the body. Each area of the body (Head & Neck, Face, Chest, Abdomen, Extremity, External) is designated a set amount of points, based on the Abbreviated Injury Scale (AIS), if an injury is present. The ISS was developed from the AIS, and is unique in that it can account for multiple injuries (the AIS only accounted for the severity of individual injuries). The ISS is routinely utilized in emergency evaluations to inform patient treatment and determine whether prognostic evaluations are warranted. The ISS correlates well with mortality and length of stay in the hospital (Semmlow & Cone, 1976).

One study examined the reliability of the AIS and ISS. Results showed that physicians and nurses exhibited the highest inter-rater reliability rates (.80 and .83 respectively; MacKenzie, Shapiro, & Eastham, 1985). The ISS utilizes the sum of squares of the highest AIS rating for each of the three highest rated injury regions. ISS scores range from 0 to 75; a score of 75 designates a fatal injury. This is one of the only anatomical scoring assessments used in routine practice (Baker, O'Neill, Haddon, & Long, 1974). Individuals with over a score of 50 on the ISS were not included in the study. The current study categorized an individual's injury severity based on previously designated categories: mild (ISS 0-19) and moderate (ISS 20-50) (Pal, Brown, & Fleiszer, 1989).

Injury Intentionality

An individual's trauma type was categorized in the NTDB based on one of the following categories: stab, gunshot wound, aggravated assault, fall, machine, motor vehicle collision (MVP), bicycle, motorcycle collision, auto vehicle vs. pedestrian (AVP), dive, animal, and "other." From this list, the categories were further split into *intentional* versus *unintentional* injury types based on similar categorization designations from previous studies (Russo, Katon, & Zatzick, 2013). Included in the intentional injuries category were stabbings, gunshot wounds, and aggravated assault. Unintentional injuries included fall, machine, motor vehicle collision, bicycle, motorcycle collision, AVP, MVP, dive, animal, and other. Individuals with unintentional injuries were coded as "0" and individuals with intentional injuries inflicted by others were coded as "1." Individuals that were determined to have self-inflicted intentional injuries (e.g., cutting, jumping, suicidal attempts) were excluded from the present study (n= 4).

Gender

Gender was included in the model with women coded as "0" and men coded as "1" to study the prospective relationship of gender on PTSD trajectories.

Age at Injury

An individual's age at admittance to the Level 1 trauma center was included in the model.

Connor-Davidson Resilience Scale (CD-RISC 10; Connor & Davidson, 2003)

The original 25-item CD-RISC contains five dimensions of resiliency including personal competence, trust/tolerance/strengthening effects of stress, acceptance of

change and secure relationships, control, and spiritual influences (Connor & Davidson, 2003). The scale measures the degree of self-reported resilience, and the total score has been used as a predictor of outcome to treatment with medication or psychotherapy, stress management and resilience-building, and as a marker of progress during treatment.

A methodological review of available and commonly used resilience scales found the CD-RISC to be one of the top scoring measures based on consistency, validity, agreement, reliability, responsiveness, floor and ceiling effects, and interpretability (Windle, Bennett, & Noyes, 2011). Additionally, of the 19 resiliency measures investigated, only the CD-RISC has been used pre and post intervention as a measure of change (Windle et al., 2011). The measure has also demonstrated similar psychometric properties when used across samples from different countries, including Iran (Khoshouei, 2009) and China (Yu & Zhang, 2007).

Campbell-Sills and Stein (2007) developed a 10-item Likert-scale (score range from 0-4) version of the CD-RISC based on factor analysis. The four factors retained (factor loadings ranging from .39 to .74; Campbell-Sills & Stein, 2007) were hardiness, social support/purpose, faith, and persistence. Possible total scores range from 0-40 and higher scores indicate greater self-reported resiliency. This 10-item version is used as part of the BTOP protocol and in the current study. An individual's total score was used in the study.

The internal consistency of the CD-RISC-10 has been acceptable in prior research (Cronbach's alpha ranging from .85 to .90; Campbell-Sills & Stein, 2007; Hartley, 2012). The CD-RISC 10 is highly correlated with the original CD-RISC (*r* =

.92; Campbell-Sills & Stein, 2007). Confirmatory factor analysis has supported the factor structure of resilience in the original validation study of the CD-RISC 10 (Burns & Anstey, 2010). Test-retest reliability was high (r = .90) in a study among Chinese earthquake victims after a two-week interval (Wang, Shi, Zhang, & Zhang, 2010).

Both CD-RISC versions hold promise as a method to screen people for high, intermediate or low resilience. This is particularly important in trauma research so that mental health professionals can identify individuals vulnerable for developing PTSD after a traumatic event. In the current study, the CD-RISC10 was given at initial and again at 12 months, but only initial data was used for the present study. High resilience was designated as a score one or more standard deviation above the mean and low resilience was designated as one or more standard deviation below the mean.

Outcome Variable

Primary Care Posttraumatic Stress Disorder Screen (PC-PTSD; Prins et al., 2003)

The PC-PTSD is used to screen for PTSD symptoms in the BTOP project. It was developed as a brief screening tool to quickly assess PTSD in medical settings (Prins et al., 2003). This four-item screener addresses each of the components of PTSD. A positive screen is indicated if the respondent endorses three out of the four questions as "yes." Items on the PC-PTSD include:

1. Have had nightmares about it or thought about it when you did not want to?
2. Tried hard not to think about it or went out of your way to avoid situations that reminded you of it?
3. Were you constantly on guard, watchful, or easily startled?

4. Felt numb or detached form others, activities, or your surroundings?

The measure is considered psychometrically sound for determining the presence and absence of PTSD in the civilian primary care population (Freedy & Brock, 2010). The PC-PTSD cut-off of three has shown 85% diagnostic efficiency, 78% sensitivity, and 87% specificity (Prins et al., 2003). A recent study of the PC-PTSD among Veterans with substance use disorders reported high sensitivity (.91) and specificity (.80) (Kimerling, Trafton, & Nguyen, 2006). Adding additional items does not appear to increase the diagnostic efficiency of the PC-PTSD (van Dam, Ehring, Vedel, & Emmelkamp, 2010). This particular study found the PC-PTSD to effectively detect individuals experiencing sub-threshold PTSD as well as individuals meeting full criteria. The PC-PTSD seems to perform as well, if not better than other PTSD measures that assess all 17 DSM-IV criteria for PTSD (e.g., the Posttraumatic Diagnostic Scale, PTSD Check List; van Dam et al., 2010).

In the present study, the PC-PTSD was administered at initial, 3, 6 and 12 months. The total score was used (ranging from 0 to 4) with higher scores indicating greater likelihood of PTSD.

Data Analysis

Upon completion of entering data in Excel, the spreadsheet was checked to identify possible outliers and invalid entries. Individuals with any missing item level data or demographic information at the initial assessment were not included in the study (n = 17). Once the data was cleaned, means and standard deviations were computed. The data was restructured in SPSS from wide-format to long-format in order to meet the

requirements of the Hierarchical Linear Modeling-7 (HLM-7) software. Time was recoded as the number of months from the initial (i.e., 0, 3, 6, and 12). The model was built and fit using HLM software using Restricted Maximum Likelihood Estimation with Level 1 being PC-PTSD scores with four repeated measures, while Level 2 included all predictor variables. HLM readily accounts for missing data, which is a common issue for longitudinal data sets (Hox, 2010). Individuals with complete PC-PTSD data on initial and at least one other time point (3, 6, or 12 months) following discharge were included in the study. The intra-class correlation (ICC) was calculated to describe how much variance is explained between levels versus within levels. The ICC provides information about the degree of between-level and within level variances that may be attributable to between-person differences. To predict the intercept of PTSD scores for all individuals when all the predictors are 0, the first model, a random intercept model, included only the variable Time in Level-1 but all predictors in Level-2. Age at injury and CD-RISC variables were grand mean centered as they are continuous variables and have a meaningful "0" score. The random intercept model equation was as follows:

$$\text{Level-1: } PTSD_{ij} = \pi_{0j} + \pi_{1j}*(TIME_{ij}) + r_{ij}$$

The dependent variable, PTSD_{ij}, is represented as a function of each individual (i) at a given measurement occasion (j). The intercept, in this case, the initial PTSD score, is represented by $\pi_{0j.}$ The term π_{1j} represents the slope of the variable time. $TIME_{ij}$ represents the measurement occasion for a given individual. Group error is represented as r_{ij}.

$$\text{Level-2 Model: } \pi_{0j} = \beta_{00} + \beta_{01}*(AGEINJURY_j) + \beta_{02}*(GENDER_j) + \beta_{03}*(INTENT_j) +$$

$$\beta_{04}*(TBI_j) + \beta_{05}*(BASECDRISC_j) + \beta_{06}*(\mathrm{ISS}_j) + u_{0j}$$

$$\pi_{1j} = \beta_{10}$$

Mixed Model: $PTSD_{ij} = \beta_{00} + \beta_{01}*AGEINJURY_j + \beta_{02}*GENDER_j + \beta_{03}*INTENT_j$

$$+ \beta_{04}*TBI_j + \beta_{05}*BASECDRISC_j + \beta_{06}*ISS_j + \beta_{10}*TIME_{ij} \quad + u_{0j} + r_{ij}$$

In the level 2 model, β_{00} is the intercept of the regression line, which gives the average score of initial PTSD scores. β_{0x} represents the Level-2 intercepts for each predictor. Error is represented as $u_{0j,}$ which is the average variance in intercepts. The mixed model represents the Level-2 equations being substituted into their respective terms in the Level-1 model to create one equation.

The second model, random slope model, was built to see how group membership impacts the longitudinal changes or trajectories of PTSD. The model equation is as follows:

Level 1: $PTSD_{ij} = \pi_{0j} + \pi_{1j}*(TIME_{ij}) + r_{ij}$

Level-2 Model: $\pi_{0j} = \beta_{00} + \beta_{01}*(AGEINJURY_j) + \beta_{02}*(GENDER_j) + \beta_{03}*(INTENT_j) + \beta$

$$_{04}*(TBI_j) + \beta_{05}*(BASECDRISC_j) + \beta_{06}*(ISS_j) + u_{0j}$$

$$\pi_{1j} = \beta_{10} + \beta_{11}*(AGEINJURY_j) + \beta_{12}*(GENDER_j) + \beta_{13}*(INTENT_j) + \beta_{14}*(TBI_j) +$$

$$\beta_{15}*(BASECDRISC_j) + \beta_{16}*(ISS_j) + u_{1j}$$

Mixed Model: $PTSD_{ij} = \beta_{00} + \beta_{01}*AGEINJURY_j + \beta_{02}*GENDER_j + \beta_{03}*INTENT_j +$

$\beta_{04}*TBI_j + \beta_{05}*BASECDRISC_j + \beta_{06}*ISS_j \quad + \beta_{10}*TIME_{ij} + \beta_{11}*AGEINJURY_j*TIME_{ij} +$

$\beta_{12}*GENDER_j*TIME_{ij} + \beta_{13}*INTENT_j*TIME_{ij} + \beta_{14}*TBI_j*TIME_{ij} +$

$\beta_{15}*BASECDRISC_j*TIME_{ij} + \beta_{16}*ISS_j*TIME_{ij} \quad + u_{0j} + u_{1j}*TIME_{ij} + r_{ij}$

In this model, the Level-1 and π_{0j} remain the same, and the only differences seen are in the slopes equation, $\pi_{1j.}$ Here, β_{1x} represents the slope, or trajectory, of each respective predictor variable. Error is represented as $u_{1j.}$

The G-Matrix for the random slope model was as follows: $\begin{bmatrix} \sigma_{00}^2 & \sigma_{01}^2 \\ \sigma_{10}^2 & \sigma_{11}^2 \end{bmatrix}$. The R-Matrix is the default identity matrix $\sigma_e^2 I$. This assumes that at each of the four time points, the Level-1 residual variance is constant.

CHAPTER IV

RESULTS

Preliminary Analysis

Table 1 shows the frequencies of each score on the PC-PTSD at each time point. Specifically, at Month 0, 44 participants had a PC-PTSD score of 3 and 42 people had a score of 4, meaning a total of 86 participants had a positive PC-PTSD screen. At 3 months, 47 people had a score of 3, and 37 had a score of 4, for a total of 84 people with a positive screen. At 6 months, 27 participants had a score of 3, 36 people had a score of 4, for a total of 63 people with a positive screen. At 12 months, 25 people had a score of 3 and 22 people had a score of 4, for a total of 47 people with a positive screen- or a total of 17.8% of the participants with positive screeners.

Table 1. Frequencies of PC-PTSD Scores at Each Time Point.

PC-PTSD Total	Month	0	3	6	12
0		96	115	138	159
1		39	38	38	23
2		47	31	29	34
3		44	47	27	25
4		42	37	36	22

Eighty participants had a positive mTBI diagnosis. Similar representation of mTBI and no TBI frequencies were found among genders (69.6% of women had no TBI, 30.4% women had mTBI; 70.5% of men had no TBI, 29.5% of men had mTBI), with no

group being significantly over or underrepresented, $\chi^2(1, N = 268) = 0.023$, $p = .879$. Among those with intentional injuries, 21% had a mTBI diagnosis versus 32% of individuals with unintentional injuries having a mTBI diagnosis. The differences between these observed frequencies was not significant, $\chi^2(1, N = 268) = 2.610$ $p = .106$.

Table 2 shows correlations between predictor variables at initial. Age and gender were significantly correlated, $r(266) = -0.17$; $p = .004$, suggesting that being male was associated with a younger age in this sample. Individuals with intentional injuries were more likely to be injured at younger ages, $r(266) = -.29$; $p = <.001$). Being female was significantly associated with intentional injuries, $r(266) = 0.25$; $p < 0.001$, and with lower resiliency scores, $r(266) = 0.122$; $p = .046$. A relationship was found between greater injury severity was significantly associated with the occurrence of a mTBI, $r(266) = 0.34$; $p = <.001$.

Table 2. Correlations Between Predictor Variables at Initial.

	1	2	3	4	5	6
1.AGEINJUY	--					
2. GENDER	-0.17**	--				
3. INTENT	-0.29**	0.25**	--			
4. TBI	0.00	-0.01	-0.1	--		
5. ISS	-0.91	0.05	-0.01	0.34**	--	
6. CDRISC	-0.06	0.122*	0.106	-0.07	-0.08	--

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

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

A chi square test revealed no significant pattern in the distribution of gender $\chi^2(1, N = 268) = 0.023$, $p = .879$) or intentionality of injury, $\chi^2(1, N = 268) = 2.610$ $p = .106$) by mTBI status. An independent samples t-test revealed no significant differences on age of injury $t(266) = -0.042$; $p = .312$) by mTBI status. There was a significant difference on initial resiliency between men ($M = 31.49$; $SD = 7.88$) and women ($M = 29.38$; $SD = 9.06$), $F(1, 266) = 4.021$; $p = .046$. The average CD-RISC 10 score for the sample was 30.69 ($SD = 8.39$). Table 3 shows descriptive statistics for each of the predictor variables.

Table 3. Descriptive Statistics of Predictor Variables.

	n	M	SD
Gender			
Male	166		
Female	102		
Age of Injury		45.53	18.00
TBI Status			
No mTBI	188		
Positive mTBI	80		
CD-RISC	268	30.69	8.39
Low Resiliency	28		
High Resiliency	29		
Injury Type			
Intentional	53		
Unintentional	251		
Injury Severity			
Mild	226		
Moderate	42		

Note. M = score mean; *SE* = standard error; *SD* = standard deviation

Random Intercept Model

The random intercept model shows whether differences are seen among the predictors on initial PC-PTSD scores. The average initial score on the PC-PTSD for all individuals (β_{00}) was 1.54 points ($p < .001$; $SD = 1.49$; $SE = 0.12$) with statistically significant differences among initial PC-PTSD scores regardless of predictor variable group membership. For every month long increase in time, an individual's PC-PTSD score is predicted to decrease by 0.056 points, holding all other variables constant, which was statistically significant ($p < .001$; $SE = 0.0079$). At 3 months, the mean PC-PTSD score was 1.37 points (SD =1.51), at 6 months the mean was 1.204 (SD= 1.48), and at 12 months the mean was 0.868 (SD =1.37). The ICC in this model was 0.382, meaning that 38.2% of the variance seen in PTSD scores was due to person effect. Table 4 presents descriptive statistics for all participants on the PC-PTSD measure.

Table 4. Descriptive Statistics of PC-PTSD Scores.

Month	0	3	6	12
n	268	268	268	263
M	1.54	1.37	1.204	0.868
SE	0.12	0.0079	0.0079	0.0079
SD	1.49	1.51	1.48	1.37

Note. *M* = PC-PTSD score mean; *SE* = standard error; *SD* = standard deviation

Table 5 shows initial values for each predictor variable. The age of injury coefficient was -0.009 ($SE = 0.004$; $p = .019$) with higher PC-PTSD scores correlated with younger age of injury. There were no statistically significant differences by gender

on initial PTSD scores (*coefficient* = -0.113; *SE* = 0.138; *p* = .416). Individuals in the intentional injury group had a 0.355 point higher PC-PTSD score on average than the unintentional injury group, holding all other variables constant, which was also statistically significant (*p* = .044; *SE* = 0.175). Mild traumatic brain injury yielded a coefficient of 0.184 (*SE* = 0.150; *p* = .221). The coefficient of CD-RISC was -0.026 (*SE* = 0.008; *p* < .001) indicating that higher resiliency scores were correlated with lower scores on the PC-PTSD at initial. Injury severity did not show statistical significance with a coefficient of 0.019 (*SE* = 0.189; *p* = .920).

Table 5. HLM Final Estimation of Fixed Effects in the Random Intercept Model.

Fixed Effect	Coefficient	Standard error	*p*-value
INTRCPT2, β_{00}	1.540	0.123	<0.001
AGEINJURY, β_{01}	-0.009	0.004	0.019
GENDER, β_{02}	-0.113	0.138	0.416
INTENT, β_{03}	0.355	0.175	0.044
TBI, β_{04}	0.184	0.150	0.221
BASECDRISC, β_{05}	-0.026	0.008	<0.001
ISS β_{06}	0.019	0.189	0.920
INTRCPT2, β_{10}	-0.055	0.008	<0.001

Random Slope Model

Table 6 reports the coefficients for all predictor variables in the random slope model. The random slope model, which detects differences in slopes or linear rates of change among predictors, indicated significant decreases in the growth rate across time in PC-PTSD scores across individuals regardless of group membership with an average rate of change coefficient of -0.038 points every month ($\tau_{11} =$ 0.00491; χ^2 (261, N = 268) = 351.26, $p < .001$;). Age of injury showed no statistically significant differences among the PC-PTSD trajectories (*coefficient* = 0.001; *SE* = 0.001; $p = .231$). No differences were seen among gender in the rate of decrease in PC-PTSD scores (*coefficient* = -0.014; *SE* = 0.018; $p = .462$). PC-PTSD scores among the intentional injury group decreased at a faster rate than those in the unintentional group (*coefficient* = -.056; *SE* = 0.023; $p = .017$), as seen graphically depicted in Figure 1. No significant differences were seen among the traumatic brain injury group on PC-PTSD trajectories (*coefficient* = -0.004; *SE* = 0.020; $p = .846$).

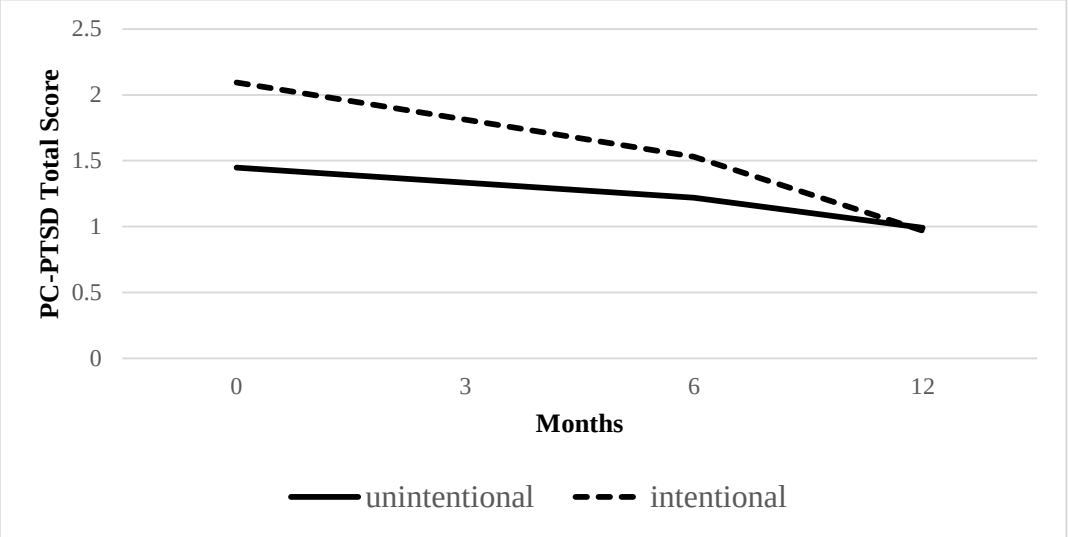
Initial CD-RISC trajectories were also found to be statistically significant with higher initial resiliency associated with slower rate of decrease seen in PC-PTSD scores (*coefficient* = 0.002; *SE* = 0.001; $p = .035$) as reflected in Figure 2. An independent samples t-test revealed statistically significant differences between high and low resiliency PC-PTSD scores at 12 months, with the higher resiliency group having statistically significantly lower PC-PTSD scores than lower resiliency individuals (low resilience *M* = 1.52; high resilience *M* = 0.90; *t(55)*= 1.636; $p = .029$). Injury severity trajectories did not reveal significant differences on PC-PTSD rate of change over time

(*coefficient* = 0.020; *SE* = 0.025; *p* = .430). The overall effect size was small (R^2 = 0.01), indicating that all variables uniquely explained 1% of the variance seen in PTSD trajectories.

Table 6. HLM Final Estimation of Fixed Effects in the Random Slope Model.

Fixed Effect	Coefficient	Standard error	*p*-value
INTRCPT2, β_{10}	-0.038	0.016	0.015
AGEINJURY, β_{11}	0.001	0.001	0.231
GENDER, β_{12}	-0.014	0.018	0.462
INTEN, β_{13}	-0.056	0.023	0.017
TBI, β_{14}	-0.004	0.020	0.846
BASECDRISC, β_{15}	0.002	0.001	0.035
ISS, β_{16}	0.020	0.025	0.430

Figure 1. HLM trajectories of PC-PTSD scores of individuals experiencing intentional versus unintentional injuries.



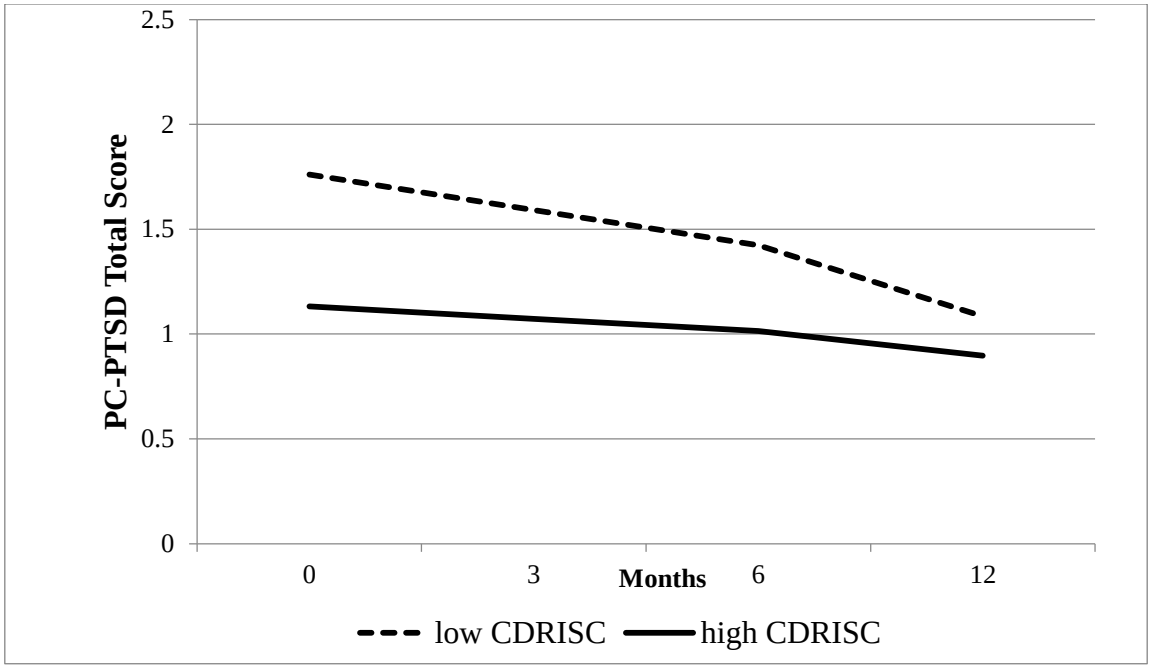


Figure 2. HLM trajectories of PC-PTSD scores comparing individuals with high versus low CD-RISC scores.

In summary, 17.8% of participants were found to have a positive PC-PTSD screen at the 12 month follow up. The mean PC-PTSD score was 1.54 points. Statistically significant initial differences were seen between predictors of age, intentional injuries, and initial CD-RISC 10 scores. Statistically significant differences were seen in PTSD trajectories among predictors of intentional injuries and initial CD-RISC 10 scores over 12 months. Notably, mTBI, gender, and injury severity group membership did not reveal statistically significant differences at initial or over 12 months on PTSD scores.

CHAPTER V

CONCLUSION

The percent of participants reporting PTSD symptoms (17.8%) in the present study is almost identical to those rates found in a similar study predicting PTSD among participants with mTBI discharged from a Level 1 trauma center (17%; Hoffman et al., 2012). Additionally, the mean score on the PC-PTSD found in the current study (*M* = 1.54) was consistent with the mean found in the original sample used to develop the PC-PTSD (*M* =1.3 at initial and *M* = 1.5 at 1 month follow up; Prins et al., 2003).

The number of participants with a positive screen, as evidenced by scoring a 3 or 4 on the PC-PTSD, was the highest at initial. However, since PTSD is not diagnosable until after 1 month post-trauma exposure, these individuals would not be deemed as having PTSD. There were only three additional participants at the three month assessment reporting a score of 3 and people reporting a score of 4 had decreased by 5 participants. Since initial data cannot be used diagnostically to indicate PTSD, it seems as though the number of "new" cases (people who did not meet criteria at initial but did at 3 months), is very low. These individuals scoring a 3 or 4 at 3 months had elevated PC-PTSD scores at initial as well. This is consistent with the Bonnano et al. (2012) study of soldiers who reported elevated trauma symptoms (measured by the PCL-C) post-deployment had significantly elevated symptoms pre-deployment. This raises the possibility that participants in the current study may have had higher PC-PTSD scores prior to their hospital admission. Future studies should control for previous reports of traumatic events to see if this accounts, in part, for higher initial scores. Additionally,

while it is not feasible to attain premorbid scores prior to their admission, a more acute follow up might illuminate whether a significant amount of individuals with a positive screener at admission quickly return to pre-injury levels before the 3 month follow up.

Similar to previous studies (see Foa, 1995; Rothbaum et al., 1992), the intentional injury group had higher initial PTSD scores than the unintentional injury group. This seems to support previous research (see Freyd, 1994; Janoff-Bulman, 1992) that individuals wrestle with certain psychological issues when they experience intentional injuries. Conceivably, an intentional injury fosters a personal loss of trust and sense of violation that complicates adjustment. Unlike previous studies, the intentional injury group experienced a decrease in their PTSD symptoms at a faster rate compared to the unintentional injury group. Figure 1 depicts the initial differences between the unintentional and intentional groups PTSD scores were no longer significant by the 12^{th} month, $t(261) = .807$; $p = .442$; unintentional = 0.752; intentional = 0.792). It appears that intentional injury may initially put one at higher risk of developing PTSD, but over time these individuals will return to levels similar to those who experienced unintentional injuries. This may be due to the phenomenon of regression towards the mean; where by individuals who are outliers at the initial evaluation will naturally score closer to the mean upon subsequent evaluations. However, given that the rate of change is different between the two groups, the possibility of an interaction effect, such as resiliency, may help explain the results. It is conceivable that individuals experiencing intentionally inflicted injuries with higher initial reported resiliency are able to return to baseline functioning at a faster rate than individuals with low CD-RISC scores and unintentional

injuries. Future studies should investigate whether initial CD-RISC scores help explain the interaction between injury modality and PTSD trajectories.

The resiliency scores on the CD-RISC 10 in the current study are similar to previous findings in another study among breast cancer survivors (M = 27.00; Scali, Gandubert, Ritchie, Soulier, Ancelin, & Chaudieu, 2012) and a more recent study using individuals from a community sample with physical disabilities (M = 28.07, SD = 7.18; Silverman, Molton, Alschuler, Ehde, & Jensen, in press). Higher resiliency scores at initial were associated with lower PC-PTSD scores at initial and 12 months. This is consistent with previous studies, further suggesting that high resilience may serve as a protective factor. The finding that higher resilience exhibits slower decreases in PTSD scores over the course of 12 months is unexpected, however. It may be possible that individuals with higher resiliency scores at initial have less room for "improvement" over time than those with lower resiliency at initial. Alternatively, when initial PTSD symptom severity is greater, the potential for improvement exceeds those with fewer PTSD symptoms and potentially accounts for the detection of a faster rate of change in individuals initially presenting with low resiliency. However, the clinical significance is limited given that the difference between the two resiliency group's PC-PTSD scores is only 0.62 points (low resilience M = 1.52; high resilience M = .90).

Last, younger participants had significantly higher PC-PTSD scores than older individuals at initial, consistent with previous studies (Russo, Katon, & Zatzick, 2013). However, age of injury did not impact PTSD slopes as there were no differences in trajectories between younger and older participants over time. This pattern may help to

explain why much of the cross-sectional research concerning age and PTSD development is inconclusive and contradictory. It may be that younger participants experiencing trauma may not employ as many coping skills compared to older adults resulting in initially higher PC-PTSD scores, but when followed over the course of a year, their age of injury no longer predicts their outcome.

These results are clinically relevant to health care personnel and demonstrate how varying types of physical injury can impact psychological distress. A given individual admitted to a trauma center can be quickly assessed based on their demographics, injury characteristics, and psychological screeners, to determine individuals that may be at higher or lower risk of developing PTSD. In particular, these findings may indicate a need for mental health services for younger individuals with intentional traumatic injuries and low self reports of resiliency within the first months following discharge from a Level 1 trauma center.

Although several variables significantly predicted PTSD trajectories, the overall effect size is quite small ($R^2 = 0.01$). Despite the statistical significance of the models, a large amount of variance remains unexplained that may be attributable to other variables not examined in this study. In summary, the present findings imply the natural trajectory of PTSD following discharge from a Level 1 trauma center may reflect a general recovery over time without intervention.

No differences were found among mild traumatic brain injury (mTBI), gender, and injury severity groups in the prediction of PTSD trajectories following discharge. This may in some part be due to the fact that the current study followed individuals for a

year regardless of whether they met criteria for PTSD. By including individuals not reporting PTSD symptoms, it is conceivable that a variable's effect on PTSD was constrained and minimized. It would be beneficial to include only individuals meeting criteria for PTSD 1 month post-injury to better assess whether a variable found insignificant in the current study may in fact impact one's trajectory of PTSD among those with positive PC-PTSD screeners. Although further research is needed to determine if these variables may be predictive of the course of PTSD, it is hoped that these results may aid in the development of more efficient and effective screeners-thus freeing clinicians from administering lengthy assessments in efforts to identify and refer individuals truly at risk.

Theoretical and Methodological Considerations

Resiliency

This study demonstrates that self-reported resilience can function as a reliable predictor of outcomes. The CD-RISC 10 seems to identify individuals with high and low resilience. This is important addition to the literature as the CD-RISC 10 has not been rigorously studied yet is routinely administered in practice. Much of the previous research has been cross sectional in nature, providing only a "snap shot" of an individual's self-reported resiliency. The results of this study show significant differences on PTSD scores between individuals with high versus low CD-RISC 10 scores at initial and resiliency predicted PTSD trajectories over time in a theoretically-consistent manner.

These findings are similar to a recent longitudinal study in which high resiliency (using the CD-RISC 10) was significantly correlated with better physical function after injury, but showed effect sizes similar to the current study in predicting outcomes assessed three years later (e.g., R^2 = .003; Silverman et al., 2015). Resiliency, as measured by the CD-RISC 10, may be a sensitive measure of predicting psychological outcomes, such as depression and anxiety, in cross-sectional designs among persons with traumatic injury. But it is possible that the fairly transparent nature of this self-report instrument makes it susceptible to transient influences that can affect scores (e.g., mood states, social desirability). This feature may weaken its ability to predict outcomes over time.

Mild Traumatic Brain Injury

Previous literature has shown conflicting results on whether mTBI puts one at risk for developing PTSD. In the military sector, secondary gains (i.e., monetary, qualifying for services, and program referrals) are often suspected and symptom validity is often used to explain the high number of participants reporting PTSD and PCS after a head injury (Howe, 2009; Nelson, Hoelzle, McGuire, Ferrier-Auerbach, Charlesworth, & Sponheim, 2010). There are limited prospective studies that have followed civilians where possible confounding factors are conceivably reduced. Hoffman et al. (2012) found that a significant minority of individuals admitted to trauma service for mTBI evidence PTSD symptoms six months post-discharge. The aim of their study, however, was to investigate what initial characteristics predicted PTSD at 6 months post-discharge in a sample of individuals diagnosed with a mTBI. This differs from the current study of

variables that predict in PC-PTSD trajectories over the 12 months post-discharge. By utilizing a heterogeneous sample in the present study, predictive power may have been a limitation in the present study as only 80 participants had a positive TBI diagnosis.

The PCL-C (PTSD Checklist- Civilian; Weather et al., 1993) was used in the Hoffman et al. (2012) study, which is a 17 item self-report measure that reflects full DSM-IV diagnostic criteria for PTSD. The PCL-C has been previously criticized because it may be susceptible to inflated rates of PTSD after brain injury due to the influence and overlap of post concussive symptoms (PCS), such as irritability and insomnia (Sumpter & McMillian, 2006). The PC-PTSD with its limited number of questions may actually limit the influence of possible PCS influence, thereby giving a more accurate picture of "pure" PTSD symptomology reports. However, it is unclear the degree to which the measure of PTSD in the current study – and possible restricted variance due to the few items on the measure -- may have contributed to these results.

A subsequent study (Bryant, Creamer, O'Donnel, Silove, Clark, & McFarlane, 2009) also included patients discharged from Level 1 trauma centers and compared PTSD development rates among participants who had sustained mild TBIs to those with no TBI. This study found individuals with mTBI were 1.86 times more likely to develop PTSD than the non-TBI group (11.8% vs. 7.5% respectively; adjusted odds ratio = 1.86). Their study had similar number of participants in the mTBI group to the current study (90 vs. 80 with mTBI) but utilized logistic regression as their statistical analysis and only followed individuals for 3 months post discharge. It's unclear as to whether significant differences would have been found in the Bryant et al. (2009) study at 12 months.

The rates of PTSD are almost identical in the current study as to those found in the Hoffman et al. (2012) article even with different mTBI samples, given their study included only individuals with document mTBI whereas the current study included both those with and without mTBI. This may suggest that the rate of PTSD does not significantly differ between those with and without a TBI. This is consistent with another study in which participants discharged from a Level 1 trauma center with mTBI were compared to general trauma (GT) patients (Levin et al., 2001). The study found no significant differences between PTSD rates among the mTBI (13%) versus the GT groups (10%) at 3 months post discharge.

Outcome Measure

PC-PTSD is reflective of the criteria specified in the DSM-IV, the most current diagnostical manual at the start of the BTOP project. With the recent release of the DSM-V manual and changes to the disorder, it would be prudent to alter the measure to reflect current PTSD criteria.

Hierarchical Linear Modeling Limitations

A limitation of the current study is that the HLM model was designated for exploratory purposes and therefore did not include specific classes or subgroups. This restricted the ability to see whether previously found trajectories were seen with the present sample. For example, studies of the Bonanno model (Bonanno, 2004; Bonanno et al., 2012) have repeatedly shown with latent growth modeling that there are four different trajectories of adjustment (resilience, recovery, delayed, and chronic) after exposure to potentially traumatic events or loss. deRoon-Cassini, Mancini, Rusch, and

Boanno (2010) found consistent subgroups when investigating PTSD and depression trajectories after physical injuries. In the current study, individuals were collapsed into high or low resiliency scores based on scoring one standard deviation above or below the mean. This did not allow for investigation of previously designated trajectories and while the findings are still significant, it is conceivable that more variance would be accounted for had these categories been designated. Although PTSD scores decrease over time for the total sample, there appears to be a subgroup of "chronic" individuals that report elevated trauma symptoms over the course of a year as evidenced by the high number of individuals with positive screeners at initial. In future studies, HLM may still be an appropriate statistical method, however, studying quadratic terms that investigate curvilinear relationships may be an important addition. Clinically, the development of a self-report assessment used to identify individuals with a chronic trajectory would be an important step in the continued efforts of referring and treating those who report PTSD.

Limitations and Future Directions

While this study provides further insight into the trajectories of PTSD, there are some limitations that should be noted. One issue concerns the generalizability of the results. The data from this study were limited to one Level 1 trauma center and includes a disproportionate number of males and lacks in racial and ethnic diversity. While initial differences were found among individuals, these were accounted for using HLM. In the future, it would be interesting to see if there are differences between diverse populations to get a more representative sample to increase generalizability.

Individuals being admitted to the Level 1 trauma center are unlikely to report a mild TBI as their main concern and instead are admitted for more emergent physical injuries, leaving mTBI to potentially go unnoticed. Therefore, the number of individuals with a documented mTBI designation may not accurately reflect the true number of individuals experiencing a mild traumatic brain injury in this study. The present study assessed TBI severity based on physician evaluation; however, oftentimes it is difficult, especially with less severe TBIs to determine exact duration of LOC and PTA in order to accurately assign TBI severity. More recently, the addition of brain imaging has been incorporated into best practice guidelines (Lee & Newberg, 2005). While routine brain imaging may not always be available and is a costly endeavor, Level 1 trauma centers are equipped with brain imaging machines and tasked with the responsibility of conducing relevant research.

Additionally, while the aim of this study was to investigate a initial characteristic's predictability of PTSD, evaluating self-reported resiliency at each time point would be beneficial in the future to see whether resiliency remains stable or fluctuates over time.

Last, the current study can be expanded in future work that specifically examines individuals who develop PTSD as there are unique aspects among this group that may be ignored by previous methodologies. Fitting separate trajectory models for individuals with and without PTSD would allow researchers see if the variables produce different results, both at initial and over time.

REFERENCES

Agustini, E. N., Asniar, I., & Matsuo, H. (2011). The prevalence of long-term post-traumatic stress symptoms among adolescents after the tsunami in Aceh. *Journal of Psychiatric and Mental Health Nursing, 18,* 543–549.

American College of Surgeons. (2014). *About NTDB.* National Trauma Data Bank, 1. Retrieved from https://www.facs.org/quality%20programs/trauma/ntdb

American Congress of Rehabilitation Medicine Head Injury Interdisciplinary Special Interest Group. (1993). Definition of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation, 8,* 86-87.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th. ed.).Washington, DC: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Publishing.

Anthony, J. L., Lonigan, C. J., & Hecht, S. A. (1999). Dimensionality of posttraumatic stress disorder symptoms in children exposed to disaster: Results from confirmatory factor analyses. *Journal of Abnormal Psychology, 108,* 326–336.

Asendorpf, J. B., Borkenau, P., Ostendorf, F., & Van Aken, M. A. (2001). Carving personality description at its joints: Confirmation of three replicable personality prototypes for both children and adults. *European Journal of Personality, 15*(3), 169-198.

Bahraini, N. H., Breshears, R. E., Hernandez, T. D., Schneider, A. L., Forster J. E., & Brenner, L. A. (2014). Traumatic brain injury and posttraumatic stress disorder. *Psychiatric Clinic of North America*, *37*(1), 55-75.

Baker, S. P., O'Neill, B., Haddon, W., & Long, W. B. (1974). The injury severity score: A method for describing patients with multiple injuries and evaluating emergency care. *Journal of Trauma*, *14*(3), 187-196.

Bal, A., & Jensen, B. (2007). Post-traumatic stress disorder symptom clusters in Turkish child and adolescent trauma survivors. *European Child and Adolescent Psychiatry*, *16*, 449–457.

Belanger, H. G., Kretzmer, T., Vanderploeg, R. D., & French, L. M. (2010). Symptom complaints following combat-related traumatic brain injury: Relationship to traumatic brain injury severity and posttraumatic stress disorder. *Journal of the International Neuropsychological Society, 16*, 104–100.

Block, J., & Kremen, A. M. (1996). IQ and ego-resiliency: Conceptual and empirical connections and separateness. *Journal of Personality and Social Psychology, 70* (2), 349–361

Bombardier, C., Fann, J., Temkin, N., Esselman, P., Pelzer, E., Keough, M., & Dikmen, S. (2006). Posttraumatic stress disorder symptoms during the first six months after traumatic brain injury. *The Journal of Neuropsychiatry and Clinical Neurosciences, 18*(4), 501-508.

Bonnie, R. J., Fulco, C. E., & Liverman, C. T. (1999). *Reducing the burden of injury: Advancing prevention and treatment.* Washington, DC: National Academy Press.

Bonanno, G. A. (2004). Loss, trauma and human resilience: Have we underestimated the human capacity to thrive after extremely aversive events? *American Psychologist, 59*(1), 20 - 28.

Bonanno, G. A., Mancini, A. D., Horton, J. L., Powell, T. M., LeardMann, C. A., Boyko, E. J., ... & Smith, T. C. (2012). Trajectories of trauma symptoms and resilience in deployed US military service members: prospective cohort study. *The British Journal of Psychiatry*, *200*(4), 317-323.

Bonanno, G. A. & Diminich, E. D. (2013). Annual research review: Positive adjustment to adversity- trajectories of minimal-impact resilience and emergent resilience. *Journal of Child Psychology and Psychiatry, 54*(4), 378-401.

Bremner, J. D., Southwick, S. M., & Charney, D. S. (1995). Etiological factors in the development of posttraumatic stress disorder. In C. M. Mazure (Ed.), *Does stress cause psychiatric illness?* (pp. 149-185). Washington, DC: American Psychiatric Press.

Brewin, C. R., Andrews, B., & Valentine, J. D. (2000). Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology, 68*(5), 748-766.

Breslau, N., Chilcoat, H. D., Kessler, R. C., & Davis, G. C. (1999). Previous exposure to trauma and PTSD effects of subsequent trauma: Results from the Detroit Area Survey of Trauma. *American Journal of Psychiatry, 156,* 902 – 907.

Breslau, N. (2009). The epidemiology of trauma, PTSD, and other posttrauma disorders. *Trauma, Violence, & Abuse, 10,* 198–210.

Bryant, R. A., & Harvey, A. G. (1999). Postconcussive symptoms and posttraumatic stress disorder after mild traumatic brain injury. *The Journal of Nervous and Mental Disease, 187*(5), 302-305.

Bryant, R. A., Creamer, M., O'Donnell, M., Silove, D., Clark, C. R., & McFarlane, A. C. (2009). Posttraumatic amnesia and the nature of posttraumatic stress disorder after mild traumatic brain injury. *Journal of the International Neuropsychological Society, 15*, 862–867.

Burns, R. A., & Anstey, K. J. (2010). The Connor-Davidson Resilience Scale (CD-RISC): Testing the invariance of a uni-dimensional resilience measure that is independent of positive and negative affect. *Personality and Individual Differences, 48*, 527–531.

Campbell-Sills, L., Cohan, S. L., & Stein, M. B. (2006). Relationship of resilience to personality, coping, and psychiatric symptoms in young adults. *Behaviour Research and Therapy, 44*, 585-599.

Campbell-Sills, L., & Stein, M. B. (2007). Psychometric analysis and refinement of the Connor-Davidson Resilience Scale (CD-RISC): Validation of a 10-item measure of resilience. *Journal of Traumatic Stress, 20*(6), 1019-1028.

Carlson, K. F., Kehle, S. M., Meis, L., Greer, N., MacDonald, R., Rutks, I., . . . Wilt, T. J. (2011). Prevalence, assessment, and treatment of mild traumatic brain injury and posttraumatic stress disorder: A systematic review of the evidence. *Journal of Head Trauma and Rehabilitation, 26*, 103–115.

Centers for Disease Control and Prevention. (2014). *Traumatic Brain Injury. Injury Prevention and Control*, Retrieved from http://www.cdc.gov/TraumaticBrainInjury/

Chang, J. E, Elliott, T., Berry, J. W., Warren, R. H., Blucker, R., Nelson, C., & Warren, A. M. (2014). *Resilience among family caregivers of children with severe neurodisabilities: Differences in theory, measurement, and clinical correlates*. Manuscript in preparation.

Chapman, B. P., & Goldberg, L. R. (2011). Replicability and 40-year predictive power of childhood ARC types. *Journal of Personality and Social Psychology, 101*(3), 593-606.

Cicerone, K. D., & Kalmar, K. (1995). Persistent postconcussion syndrome: The structure of subjective complaints after mild traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *10*(3), 1-17.

Connor, K. M. & Davidson, J. R. T. (2003). Development of a new resilience scale: The Connor-Davidson Resilience Scale (CD-RISC). *Depression and Anxiety, 18*, 76-82.

Contractor, A. A., Layne, C. M., Steinberg, A. M., Ostrowski, S. A., Ford, J. D., & Elhai, J. D. (2013). Do gender and age moderate the symptom structure of PTSD? Findings from a national clinical sample of children and adolescents. *Psychiatry Research*, *210*(3), 1056-1064.

Copeland, W. E., Keeler, G., Angold, A., & Costello, E. J. (2007). Traumatic events and posttraumatic stress in childhood. *Archives of General Psychiatry, 64*(5), 577-584.

Costa Jr, P. T., & McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual Differences, 13*(6), 653-665.

Davydov, D. M., Stewart, R., Ritchie, K., & Chaudieu, I. (2010). Resilience and mental health. *Clinical Psychology Review, 30*(5), 479-495.

deRoon-Cassini, T. A., Mancini, A. D., Rusch, M. D., & Bonanno, G. A. (2010). Psychopathology and resilience following traumatic injury: A latent growth mixture model analysis. *Rehabilitation Psychology, 55*(1), 1-11.

Dikmen, S., Machamer, J., Fann, J.R., & Temkin, N.R. (2010). Rates of symptom reporting following traumatic brain injury. *Journal of the International Neuropsychological Society, 16*, 401–411.

Ditlevsen, D. N., & Elklit, A. (2011). Gender, trauma type, and PTSD prevalence: A re-analysis of 18 Nordic convenience samples. *Annals of General Psychiatry, 11*(26), 11-26.

Finklestein, E. A., Corso, P. S., & Miller, T. R. (2006). *The incidence and economic burden of injuries in the United States.* New York: Oxford University Press

Foa, E. B. (1995). *Failure of emotional processing: Post trauma psychopathology.* Paper presented at the World Congress of Behavioural & Cognitive Therapies, Copenhagen, Denmark.

Frans, O., Rimmo, P. A., Aberg, L., & Fredrikson, M. (2005). Trauma exposure and post-traumatic stress disorder in the general population. *Acta Psychiatrica Scandinavica, 111*, 291 -299.

Freedy, J. R., & Brock, C. D. (2010). Spotting - and treating - PTSD in primary care. *Journal of Family Practice*, *59*(2), 75-80.

Freyd, J. (1994). Betrayal trauma: Traumatic amnesia as an adaptive response to childhood abuse. *Ethics & Behavior*, *4*, 307 – 329.

Garmezy, N. (1991). Resilience and vulnerability to adverse developmental outcomes associated with poverty. *American Behavioral Scientist*, *34* (4), 416–430.

Garmezy, N. (1993). Children in poverty: Resilience despite risk. *Psychiatry, 56*, 127–136.

Giannopoulou, I., Strouthos, M., Smith, P., Dikaiakou, A., Galanopoulou, V., & Yule, W. (2006). Post-traumatic stress reactions of children and adolescents exposed to the Athens 1999 earthquake. *European Psychiatry*, *21*,160–166.

Greenspan, A. I., Stringer, A. Y., Phillips, V.L., Hammond, F. M., Goldstein, F. C. (2006). Symptoms of post-traumatic stress: Intrusion and avoidance 6 & 12 months after TBI. *Brain Injury*, *20*, 733–742.

Hartley, M. T. (2012). Assessing and promoting resilience: An additional tool to address the increasing number of college students with psychological problems. *Journal of College Counseling*, *15*(1), 37-51.

Hetzel-Riggen, M. D., & Roby, R. P. (2011). Trauma type and gender effects on PTSD, general distress, and peritraumatic dissociation. *Journal of Loss and Trauma*, *18*(1), 41-53.

Hickling, E., Gillen, R., Blanchard, E., Buckley, T., & Taylor, A. (1998). Traumatic brain injury and posttraumatic stress disorder: A preliminary investigation of neuropsychological test results in PTSD secondary to motor vehicle accidents. *Brain Injury*, *12*(4), 265-274.

Hoffman, J. M., Dikmen, S., Temkin, N., & Bell, K. R. (2012). Development of posttraumatic stress disorder after mild traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, *93*(2), 287-292.

Hoge, C. W., Castro, C., Messer, S. C., McGurk, D., Cotting, D. I., & Koffman, R. L. (2008). Mild traumatic brain injury in U.S. soldiers returning from Iraq. *The New England Journal of Medicine, 358,* 453−463.

Howe, L. L. (2009). Giving context to post-deployment post-concussive-like symptoms: Blast-related potential mild traumatic brain injury and comorbidities. *The Clinical Neuropsychologist, 23*(8), 1315-1337.

Hox, J. J. (2010). *Multilevel analysis: Techniques and applications*. New York, NY: Routledge.

Janoff-Bulman, R. (1992). *Shattered Assumptions: Towards a New Psychology of Trauma*. New York, NY: Free Press.

Jones, E., & Wessely, S. (2005). *Shell shock to PTSD: Military psychiatry from 1900 to the Gulf War*. Hove, East Sussex: Psychology Press.

Kaplow, B., Dodge, K. A., Amaya-Jackson, L., & Saxe, G. N. (2005). Pathways to PTSD, Part II: Sexually abused children. *American Journal of Psychiatry, 162,* 1305–1310.

Kar, N., Mohapatra, P. K, Nayak, K. C., Pattanaik, P., Swain, S. P., & Kar, H. C. (2007). Post-traumatic stress disorder in children and adolescents one year after a super-cyclone in Orissa, India: Exploring cross-cultural validity and vulnerability factors. *BMC Psychiatry, 7*, 8-17.

Kessler, R. C., Sonnega, A., Bromet, E., Hughes, M., & Nelson, C. B. (1995). Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, *52*(12), 1048-1060.

Kessler, R. C. (2000). Posttraumatic stress disorder: The burden to the individual and to society. *Journal of Clinical Psychiatry, 61*, 4–14.

Khoshouei, M. S. (2009). Psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) using Iranian students. *International Journal of Testing, 9*, 60-66.

Kimerling, R., Trafton, J. A., & Nguyen, B. (2006). Validation of a brief screen for post-traumatic stress disorder with substance use disorder patients. *Addictive behaviors*, *31*(11), 2074-2079.

King, N. (2008). PTSD and traumatic brain injury: Folklore and fact? *Brain Injury*, *22*, 1-5.

Lee, B., & Newberg, A. (2005). Neuroimaging in traumatic brain imaging. *NeuroRx, 2*(2), 372–383.

Letzring, T. D., Block, J., & Funder, D. C. (2005). Ego-control and ego-resiliency: Generalization of self-report scales based on personality descriptions from acquaintances, clinicians, and the self. *Journal of Research in Personality, 39,* 395-422.

Levin, H. S., Brown, S. A., Song, J. X., McCauley, S. R., Boake, C., Contant, C. F., ... & Kotrla, K. J. (2001). Depression and posttraumatic stress disorder at three months after mild to moderate traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 23*(6), 754-769.

MacKenzie, E. J., Shapiro, S., & Eastham, J. N. (1985). The Abbreviated Injury Scale and Injury Severity Score: Levels of inter- and intrarater reliability. *Medical Care, 23*(6), 823-835.

Mancini, A. D., & Bonanno, G. A. (2009). Predictors and parameters of resilience to loss: Toward an individual differences model. *Journal of Personality, 77*(6), 1805-1831.

Marshall, R. P., Jorm, A. F., Grayson, D. A. and O'Toole, B. I. (2000), Medical-care costs associated with posttraumatic stress disorder in Vietnam Veterans. *Australian and New Zealand Journal of Psychiatry, 34*, 954–962.

Mayou, R., Bryant, B., & Duthie, R. (1993). Psychiatric consequences of road traffic accidents. *British Medical Journal, 307,* 647–651.

Mayou, R., Black, J., & Bryant, B. (2000). Unconsciousness, amnesia and psychiatric symptoms following road traffic accident injury. *British Journal of Psychiatry, 177,* 540–545.

Meares, S., Chores, E. A., Taylor, A. J., Batchelor, J., Bryant, R. A., Baguley, I. J., . . . Marosszeky, J. E. (2011). The prospective course of postconcussion syndrome: The role of mild traumatic brain injury. *Neuropsychology, 25*(4), 454-465.

McCauley, S. R., Wilde, E. A., Miller, E. R., Frisby, M.L, Garza, H. M., Varghese, R., … McCarthy, J. J. (2013). Preinjury resilience and mood as predictors of early outcome following mild traumatic brain injury. *Journal of Neurotrauma, 30,* 642-652.

Morissette, S. B., Woodward, M., Kimbrel, N. A., Meyer, E. C., Kruse, M. I., Dolan, S., & Gulliver, S. B. (2011). Deployment-related TBI, persistent postconcussive symptoms, PTSD, and depression in OEF/OIF Veterans. *Rehabilitation Psychology, 56*(4), 340-350.

National Center for PTSD. US Department of Veterans Affairs (2004). *The Iraq War Clinician Guide*, Second Edition.

Nelson, N. W., Hoelzle, J. B., McGuire, K. A., Ferrier-Auerbach, A. G., Charlesworth, M. J., & Sponheim, S. R. (2010). Evaluation context impacts neuropsychological performance of OEF/OIF veterans with reported combat-related concussion. *Archives of Clinical Neuropsychology, 8,* 713-723.

Norris, F. H., Foster, J. D., & Weisshaar, D. L. (2002). The epidemiology of sex differences in PTSD across developmental, societal, and research contexts. In R. Kimerling, P. Ouimette, & J. Wolfe (Eds.), *Gender and PTSD*, 3-42. New York: Guilford Press.

Orr, S. P., Metzger, L. J., Lasko, N. B., Macklin, M. L., Peri, T., & Pitman, R. K. (2000). De novo conditioning in trauma-exposed individuals with and without posttraumatic stress disorder. *Journal of Abnormal Psychology, 109*, 290-298.

Pal, J., Brown, R., & Fleiszer, D. (1989). The value of the Glasgow Coma Scale and Injury Severity Score: Predicting outcome in multiple trauma patients with head injury. *Journal of Trauma-Injury, Infection, and Critical Care, 29*(6), 746-748.

Powers, M. B., Warren, A. W., Rosenfield, D., Bennett, M, Reynolds, M. C., Davis, M. L., Foreman, M. L., Petrey, L. B., & Smits, J. A. (2014). Predictors of PTSD symptoms in adults admitted to a level I trauma center: A prospective analysis. *Journal of Anxiety Disorders, 28*(3), 301-309.

Prins, A., Ouimette, P., Kimerling, R., Cameron, R. P., Hugelshofer, D. S., Shaw-Hegwer, J., … Sheikh, J. I. (2003). The primary care PTSD screen (PC-PTSD): development and operating characteristics. *Primary Care Psychiatry, 9*, 9-14.

Reese, C., Pederson, T., Avila, S., Joseph, K., Nagy, K., Dennis, A.,… Bokhari, F. (2012). Screening for traumatic stress among survivors of urban trauma. *Journal of Trauma Acute Care Surgery,* 73(*2*), 462-467.

Resnick, H. S., Kilpatrick, D. G., Dansky, B. S., Saunders, B. E., & Best, C. L. (1993). Prevalence of civilian trauma and posttraumatic stress disorder in a representative national sample of women. *Journal of Consulting and Clinical Psychology*, *61*(6), 984-991.

Richmond, T. S., Ruzek, J., Ackerson, T., Wiebe, W. J., Winston, F., & Kassam-Adams, N. (2011). Predicting the future development of depression or PTSD

after injury. *General Hospital Psychiatry, 33*(*4*), 327-335.

Rothbaum, B. O., Foa, E. B., Riggs, D. S., Murdock, T. & Walsh, W. (1992). A prospective examination of post-traumatic stress disorder in rape victims. *Journal of Traumatic Stress,* 5(*3*), 455-475.

Russo, J., Katon, W., & Zatzick, D. (2013). The development of a population-based automated screening procedure for PTSD in acutely injured hospitalized trauma survivors. *General Hospital Psychiatry, 35*, 485-491.

Sbordone, R. J., & Liter, J. C. (1995). Mild traumatic brain injury does not produce post-traumatic stress disorder. *Brain Injury, 9,* 405–412.

Scali, J., Gandubert, C., Ritchie, K., Soulier, M., Ancelin, M. L., & Chaudieu, I. (2012). Measuring resilience in adult women using the 10-items Connor-Davidson Resilience Scale (CD-RISC). Role of trauma exposure and anxiety disorders. *PLoS ONE, 7*(6): e39879. doi:10.1371/journal.pone.0039879

Schnabel, K., Asendorpf, J. B., & Ostendorf, F. (2002). Replicable types and subtypes of personality: German NEO-PI-R versus NEO-FFI. *European Journal of Personality, 16*(S1), S7-S24.

Semmlow, J. L. & Cone, R. (1976). Utility of the injury severity scale: A confirmation. *Health Services Research, 11*(1), 45-52

Scott, W. J. (1990). PTSD in DSM-III: A case in the politics of diagnosis and disease. *Journal of Social Problems, 37*(3), 294-310.

Silverman, A. M., Molton, I. R., Alschuler, K. N., Ehde, D. M., & Jensen, M. P. (2015). Resilience predicts functional outcomes in people aging with disability: A

longitudinal investigation. *Archives of Physical Medicine and Rehabilitation, 96*(7), 1262-1268.

Sumpter, R. E., & McMillan, T. M. (2006). Errors in self-report of post-traumatic stress disorder after severe traumatic brain injury. *Brain Injury, 20,* 93–99.

Tanielian, T., Jaycox, L. H., Schell, T. L, Marshall, G. N., Brunam, M. A., Eibner, C.,… Vaiana, M. E. (2008). *Invisible Wounds of War: Summary and Recommendations for Addressing Psychological and Cognitive Injuries.* Santa Monica, CA: RAND Corporations.

Tugade, M. M., & Fredrickson, B. L. (2004). Resilient individuals use positive emotions to bounce back from negative emotional experiences. *Journal of Personality and Social Psychology*, *86* (2), 320–333.

van Dam, D., Ehring, T., Vedel, E., & Emmelkamp, P. M. G. (2010). Validation of the Primary Care Posttraumatic Stress Disorder screening questionnaire (PC-PTSD) in civilian substance use disorder patients. *Journal of Substance Abuse Treatment, 39* (2), 105-113.

Vanderploeg, R., Belanger H., & Curtiss, G. (2009). Mild traumatic brain injury and posttraumatic stress disorder and their associations with health symptoms. *Archives of Physical Medicine and Rehabilitation, 90*, 1084-93.

Vasterling, J. J., Verfaellie, M., & Sullivan, K. D. (2009). Mild traumatic brain injury and posttraumatic stress disorder in returning Veterans: Perspectives from cognitive neuroscience. *Clinical Psychology Review, 29*(8), 674-684.

Vasterling, J. J., Bryant, R. A., & Keane, T. M. (2012). Understanding the interface of

traumatic stress and mild traumatic brain injury. In J. J. Vasterling, R. A. Bryan, & T. M. Keane (Eds.), *PTSD and Mild Traumatic Brain Injury* (pp. 3-14). New York, NY: The Guilford Press.

Vasterling, J. J. & Dikmen, S. (2012) Mild traumatic brain injury and posttraumatic stress disorder: Clinical and conceptual complexities. *Journal of International Neuropsychological Society, 18*, 390-393.

Wang, L., Shi, Z., Zhang, Y., & Zhang, Z. (2010). Factor structure and psychometric properties of the Connor-Davidson resilience scale among Chinese adolescents. *Psychiatry and Clinical Neurosciences, 64*, 499-504.

Warren, AM., Stucky, K., & Sherman, J. J. (2012). Rehabilitation psychology's role in the Level 1 trauma center. *Journal of Trauma and Acute Care Surgery, 75*(5), 1357-1362.

Warren, A. M., Foreman, M. L., Bennett, M. M., Betrey, L B., Reynolds, M., Patel, S., & Roden-Foreman, K. (2014). Posttraumatic stress disorder following traumatic injury at 6 months: Associations with alcohol use and depression. *Journal of Trauma Acute Care Surgery, 76* (2), 517-522.

Waugh, C. E., Wager, T. D., Fredrickson, B. L., Noll, D. C., & Taylor, S. F. (2008). The neural correlates of trait resilience when anticipating and recovering from threat. *Social Cognitive and Affective Neuroscience, 3*(4), 322-332.

Waugh, C. E., Fredrickson, B. L., & Taylor, S. F. (2008). Adapting to life's slings and arrows: Individual differences in resilience when recovering from an anticipated threat. *Journal of Research in Personality, 42*(4), 1031-1046.

Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility. *In Annual Convention of the International Society for Traumatic Stress Studies.* San Antonio: International Society for Traumatic Stress Studies.

Werner, E. E. (1995). Resilience in development. *Current Directions in Psychological Science, 4* (3), 81–85.

Windle, G., Bennett, K. M., & Noyes, J. (2011). A methodological review of resilience measurement scales. *Health and Quality Life Outcomes, 9* (8), 1-18.

Yeates, K. O. (2010). Mild traumatic brain injury and postconcussive symtpoms in children and adolescents. *Journal of International Neuropsychological Society, 16*(6), 953-960.

Yu, X., & Zhang, J. (2007). Factor analysis and psychometric evaluation of the Connor-Davidson Resilience Scale (CD-RISC) with Chinese people. *Social Behavior and Personality: An International Journal, 35*(1), 19–30.

Zatzick, D. F., Rivara, F. P., Jurkovich, G. J., Hoge, C. W., Wang, J., Fan, M. Y. …Mackenzie, E. J. (2010). Multisite investigation of traumatic brain injuries, posttraumatic stress disorder, and self-reported health and cognitive impairments. *Archives of General Psychiatry, 67*, 1291-1300.