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A Hierarchical Linear Modeling Approach to Predicting Trajectories of Posttraumatic Growth in Veterans Following Acquired Physical Disability

Lisa Goldberg Looney
Virginia Commonwealth University

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A HIERARCHICAL LINEAR MODELING APPROACH TO PREDICTING TRAJECTORIES OF POSTTRAUMATIC GROWTH IN VETERANS FOLLOWING ACQUIRED PHYSICAL DISABILITY

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

By: LISA D. GOLDBERG
Bachelor of Arts, Brandeis University, May 2008
Master of Science, Virginia Commonwealth University, December 2014

Director: Paul B. Perrin, Ph.D.
Associate Professor of Psychology
Department of Psychology

Virginia Commonwealth University
Richmond, Virginia
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Table of Contents

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List of Tables

Page

List of Figures

Page

Abstract

A HIERARCHICAL LINEAR MODELING APPROACH TO PREDICTING TRAJECTORIES OF POSTTRAUMATIC GROWTH IN VETERANS FOLLOWING ACQUIRED PHYSICAL DISABILITY

By Lisa Goldberg, M.S.

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

Virginia Commonwealth University, 2017

Major Director: Paul B. Perrin, Associate Professor. Psychology Department

The purpose of this study was to examine potential predictors of PTG across time in Veterans with acquired physical disabilities. Specifically, this study aimed to understand how various demographic and injury characteristics, coping styles, appraisals of injury, and social support might predict trajectories of PTG from discharge from inpatient rehabilitation through 12 months after baseline. Initial curvature analyses suggested that a cubic polynomial trend best fit the movement of PTG over time, generally conforming to an initial increase, decrease, and then plateau or slight increase. Four HLMs were run to examine whether demographic and injury characteristics, coping styles, appraisals of injury, and social support predicted the height of this cubic architecture of PTG across baseline, 1, 3, 6, and 12-month follow ups, and a final HLM examined whether any statistically significant fixed effects in the first four HLMs interacted with time in the prediction of participants' PTG trajectories. Estimated premorbid IQ was negatively associated, while age was positively associated with the height of PTG over time. Reframing and religious coping were positively associated with PTG over time, as were challenge appraisals. Three types of social support did not independently predict PTG trajectories, although bivariate correlations suggested the presence of isolated relationships between different types of social

support and PTG at certain time points. None of the significant predictors interacted with time in predicting participants' PTG trajectories.

A Hierarchical Linear Modeling Approach to Predicting Trajectories of Posttraumatic Growth in Veterans Following Acquired Physical Disability

Many Veterans present to Veteran Administration Medical Centers (VAMCs) with severe physical injuries, including spinal cord injury (SCI), brain injury, and polytrauma (Defense and Veterans Brain Injury Center, n.d.; Department of Veterans Affairs, 2013). The VA treats over 26,000 Veterans with SCI and related disorders annually, making it the largest single provider of care for these injuries (U.S. Department of Veterans Affairs, 2013). The United States Department of Defense (DoD) Health Care System (www.dvbic.org/TBI-Numbers.aspx) reports that there have been 339,462 DoD brain injuries since 2000, with 25,053 occurring in 2014 and 18,066 in 2015. Many of these Veterans and service members with SCI or brain injury fall under the category of polytrauma, and although a precise definition has not been agreed upon in the literature (Butcher & Balogh, 2009; Lovric, 2015), the VA defines polytrauma as two or more injuries sustained in a single incident "that affect multiple body parts or organ systems and result in physical, cognitive, psychological, or psychosocial impairments and functional disabilities" (Department of Veteran Affairs, 2013). Polytrauma may include traumatic amputations, open wounds, musculoskeletal injuries, burns, pain, auditory and visual impairments, and mental health problems (Department of Veteran Affairs, 2013). While some of these severe physical injuries are the result of recent conflicts in Iraq and Afghanistan (Gawande, 2004; O'Neil et al., 2014), many Veterans, particularly those who are older, present to the VA with these injuries as a result of falls, accidents, or vascular incidents (Dams-O'Connor et al., 2013; Hassmiller Lich et al., 2014; Maguen et al., 2012; Selvarajah et al., 2014).

SCI, brain injury, and polytrauma may create long-term negative physical, cognitive, and psychological consequences. Yet some individuals experience positive changes, termed

posttraumatic growth (PTG; Tedeschi & Calhoun, 1996), following injury. Some early research posits PTG as an outcome that may be predicted by various demographic or individual characteristics (McGrath & Linley, 2006). The Stress and Coping Model (Lazarus & Folkman, 1984) suggests a potential developmental pathway for PTG by which active and adaptive coping and the use of appraisals may contribute to the development of PTG. Other studies suggest that PTG may be a predictor of emotional outcomes, such as depression, anxiety, or posttraumatic stress disorder (Frazier et al., 2001; Mohr et al., 1999; Park, Cohen, & Murch, 1996).

While PTG has been examined in a variety of populations, it remains relatively understudied, particularly in regards to severe physical injury in Veterans. PTG is exceptionally relevant to Veterans, as they have a high rate of exposure to potentially traumatic events such as combat exposure and traumatic injury (Hoge, 2004). Yet little research has examined PTG in Veterans, and even less has considered PTG in relation to severe physical injuries in Veterans.

Previous studies of PTG are also limited in that most have examined the construct at a single time point (Chun & Lee, 2008; January, Zebracki, Chlan, & Vogel, 2015; Kalpakjian et al., 2014; Yeung, Lu, Wong, & Hunynh, 2015). The current study will examine PTG longitudinally over five time points (baseline, 1-month, 3-month, 6-month, and 12-month follow-up following injury) in military veterans with acquired physical disability. The aims of this study are: (1) to assess how various demographic variables and injury characteristics, such as age, race, injury etiology (SCI vs. brain injury), time since injury, and functional independence measures predict the trajectory of PTG over time in this population, and (2) to assess the predictive value of various coping styles, cognitive appraisals, and social support on PTG over time.

Review of the Literature

I will begin by discussing the epidemiology of spinal cord injury and polytrauma, as well as the research documenting the potential plethora of negative physical and mental health outcomes common after acquired physical disability. I will then contrast this negative, deficit-based research with the construct of posttraumatic growth (PTG) and review the literature examining this construct in various populations. Further, I will suggest that the Stress and Coping Model can be used to understand a potential pathway for the development of PTG. I will provide a brief review of the literature on appraisals and coping with regard to PTG. I will discuss the potential role of social support in the development of PTG, and then I will conclude with the rationale for the current study as well as its aims.

Spinal Cord Injury

Spinal cord injury (SCI) is defined as damage to any part of the spinal cord or spinal nerves that results in permanent functional changes at or below the site of injury (National Institute of Neurological Disorders and Stroke [NINDS], 2015). It is estimated that SCI occurs in 250,000 to 500,000 people worldwide each year (World Health Organization [WHO], 2013). In the United States, an estimated 12,000 individuals experience an SCI each year (NINDS, 2015), with a prevalence of 236,000 to 327,000 individuals currently living with SCI (Bellon et al., 2013). The vast majority of these injuries are traumatic and due to preventable causes such as motor vehicle accidents (39.2%), falls (28.3%), and violence (14.6%), while approximately 10% are due to degenerative disorders (Bellon et al., 2013; WHO, 2013).

Physical Problems after SCI. SCI results in permanent changes in strength, sensation and other body functions at or below the site of the injury, and as such, the higher the site of

the injury, the greater the loss of function and mobility (NINDS, 2015). The injury may be classified as complete, indicating that there is no communication between the brain and spinal cord below the site of injury and therefore a total lack of sensory and motor function, or incomplete, in which case the spinal cord is able to convey messages to and from the brain and some sensory and motor function may remain intact (NINDS, 2015). There are a number of secondary medical complications that may arise in individuals with SCI, including bladder, bowel, and sexual dysfunction; chronic pain; autonomic dysfunction; circulatory problems; pressure sores and ulcers; muscle spasticity; and heart problems (Adriaansen et al., 2013; NINDS, 2015).

Coura and colleagues (2012) evaluated functional disability in individuals with SCI using the Barthel Index, a measure that contains ten mobility items assessing various activities of daily living (ADLs). These included dressing, bathing, feeding, grooming, transfers from bed to chair and back, bladder and bowel control, toilet use, mobility, and climbing stairs. Coura and colleagues (2012) found that the most challenging activities for individuals with SCI to perform were climbing and descending stairs and mobility, with only 8% and 17.3% reporting functional independence for these tasks respectively, while feeding (93.3%) and grooming (88%) were the activities in which individuals with SCI demonstrated the most functional independence.

While Coura et al (2012) did not find any association between sociodemographic factors and functional disability, a later study did find an association between demographic and injury characteristics with self-care ability in individuals with SCI (Coura et al., 2013). They defined self-care as the set of actions performed by the individual to meet daily needs (Coura et al., 2013). The authors found that being male, religious, being injured during youth,

a longer time since injury, and having a higher education predicted more independence in terms of self-care abilities (Coura et al., 2013). In addition, Coura and colleagues (2013) identified specific self-care challenges in individuals with SCI. The greatest impairments were taking time to care for oneself, getting exercise or rest, soliciting support from friends, taking care of oneself as desired, and requesting information about medications (Coura et al., 2013).

Kuo and colleagues (2015) assessed function and disability of individuals with SCI using the World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0), which evaluates limitations in cognition, mobility, self-care, relationships, life activities, and participation. The greatest limitations were found in the domains of mobility and life activities, while cognition was least negatively affected (Kuo et al., 2015). Another study examined functional changes over time following SCI (Amsters, Pershouse, Price, & Kendall, 2005). In this study, individuals who had sustained an SCI more than 20 years prior to data collection were interviewed in order to assess their functional abilities following discharge from initial rehabilitation, approximately 10 years post discharge (midpoint), and current abilities at the time of data collection. Functional abilities were measured using the Functional Independence Measure (FIM) as well as a seven-point ordinal scale measuring mobility aid status (attendant propulsion; power chair only; alternation between manual and power chair; manual chair only; alternation between walking and wheelchair; walking with aids; and walking without aids) that was developed specifically for the study. Amsters and colleagues (2005) found that 46% of participants in their study had experienced a functional decline between approximately 10 years post-injury and the present, with a sharp drop in functional independence at 20 years post-injury. Furthermore, peak functional performance was

estimated to have been within one to two years following discharge from initial rehabilitation (Amsters et al., 2005). The authors posited that individuals with SCI may benefit from follow-up services after discharge from initial rehabilitation in order to optimize improvements in functional abilities.

Mental Health Problems after SCI. In addition to the many negative physical outcomes and components of functional disability, numerous negative mental health outcomes have been shown to be common in individuals with SCI (Cook, Molton, & Jensen, 2011; Craig, Tran, & Middleton, 2009; Fann et al., 2011; Hawkins & Heinemann, 1998; Findley, Banerjea, & Sambamoorthi, 2011; Kennedy & Rogers, 2000; Kolakowsky-Hayner, Kreutzer, Marwitz, Meade, & Cifu 2002; Krause, Brotherton, Morrisette, Newman, & Karakostas, 2007; Martz, Livneh, Priebe, Wuermser & Ottomanelli, 2005; Stanford, Soden, Bartrop, Mikk, & Taylor, 2007). Individuals with SCI may experience depression, anxiety, increased stress, and other related problems (Fann et al., 2011; Kennedy & Rogers, 2000; Krause et al., 2007). Craig and colleagues (2009) conducted a systematic review examining the morbidity of several psychological disorders in individuals with SCI and found that depression, anxiety, and posttraumatic stress disorder each were present in nearly a third of individuals with SCI. Approximately 30% of individuals with SCI in rehabilitation were found to meet the criteria for major depression, while 27% living in the community had elevated depressive symptoms (Craig et al., 2009). Furthermore, their review suggested that elevated symptoms of depression were associated with longer hospitalization, increased medical complications, decreased self-care abilities, more time spent in bed, and increased pain. The authors also found that as many as 30% of individuals with SCI are at risk for elevated symptoms of anxiety for up to two years post-injury, with similar rates for PTSD (Craig et al., 2009).

Substance use and suicide have been found to be more prevalent for individuals with SCI than able-bodied controls (Findley et al., 2011; Hawkins & Heinemann, 1998; Kolakowsky-Hayner et al., 2002; Stanford et al., 2007). Findley and colleagues (2011) examined the association between mental illness and substance use disorders in Veterans with traumatic SCI. They collected data from the Spinal Cord Dysfunction Registry (SCD-R), VHA utilization data showing provider visits and outpatient service use, data from Centers for Medicare and Medicaid Services, and data from the VHA Beneficiary Identification and Records Locator Subsystem (BIRLS) on mortality. Veterans with an SCI who had psychosis, depression, and substance use had significantly higher rates of mortality compared to those without these diagnoses (Findley et al., 2011), highlighting the importance of treating these mental health concerns in individuals with SCI.

Hartoonian and colleagues (2014) examined the association between various functional outcomes with depression and found that participation (defined as social integration, physical independence, occupation, and mobility) was negatively associated with somatic symptoms of depression and higher motor function was positively associated with somatic symptoms, while neither construct was associated with nonsomatic symptoms. Health-related variables (pain severity, pain interference with work, perceived health care status, and rehospitalizations during first year after injury) were positively associated with both somatic and nonsomatic symptoms of depression. Finally, nonsomatic symptoms were negatively associated with quality of life, while no association was found between somatic symptoms of depression and quality of life (Hartoonian et al., 2014).

Psychosocial Problems after SCI. Many psychosocial problems exist for individuals following SCI, including unemployment, social isolation, disrupted relationships, and limited

community integration (Burns et al., 2010; Hammell, 1994; Krause, 1997; Putzke, Elliot, & Richards, 2001). For example, estimates of unemployment for individuals with SCI range from 50% to 90% (Krause, 1997). Burns et al. (2010) explored the impact of several psychosocial factors on employment status for men with SCI and found that environmental barriers, such as requiring specialized equipment to complete their occupational duties, as well as the perception of discrimination from not only coworkers but the larger communities to which individuals belonged were negatively associated with employment following SCI. In contrast, instrumental and emotional support positively predicted employment status (Burns et al., 2010), although unfortunately several studies have documented social isolation and difficulties with social integration for individuals with SCI (Hammell, 1994; Putzke et al., 2001). Burns and colleagues (2010) argued that efforts to increase post-injury employment might focus on reducing environmental barriers, discrimination, and mental health symptoms, while strengthening social support.

Polytrauma

Polytrauma was originally defined by the Veterans Health Administration as a combination of traumatic brain injury in conjunction with other bodily system injuries resulting from exposure to a single blast (Department of Veteran Affairs, 2013). More recently, the VA has broadened the definition to be more inclusive, such that polytrauma is now defined within the VA system of care as two or more injuries incurred during a single incident that affect several body parts or organ systems and result in physical, cognitive, psychological, or psychosocial impairments and functional disabilities (Department of Veteran Affairs, 2013). Brain injury is no longer necessary for injuries to be classified as polytrauma, nor is it required that the injuries be the result of a blast. Today, polytrauma may include traumatic amputations,

open wounds, musculoskeletal injuries, burns, pain, auditory and visual impairments, and mental health problems (Department of Veteran Affairs, 2013).

Although no longer required, mild traumatic brain injury (mTBI) is often part of the clinical picture in polytrauma (Schell & Marshall, 2008). One study found that 77% of consecutive inpatient admissions to a VA Polytrauma Rehabilitation Center had a TBI (Walker, 2008). TBI occurs when the brain is damaged by a sudden trauma, such as one's head colliding with an object or when something pierces the skull and enters brain tissue (NINDS, 2015). A TBI may be mild, moderate, or severe, although most TBIs acquired by military service members in conflicts are mild (Terrio et al., 2009). TBI accounts for nearly two million emergency room visits and more than 500,000 hospital admissions in the United States every year (Kraus & McArthur, 1999). Furthermore, it has been estimated that TBI results in chronic disability for nearly six million individuals (Kraus & McArthur, 1999). TBI is most commonly sustained in young adults (15-24 years old), meaning that individuals with TBI often have long life spans during which they must cope with the resulting impairments (Kraus & McArthur, 1999). TBI has been called the signature wound of the recent conflicts in Iraq and Afghanistan (Snell & Halter, 2010), but is more often sustained in motor vehicle accidents, falls, and vascular incidents among civilians, as well as among Veterans now after the troop drawdowns in Iraq and Afghanistan (Dams-O'Connor et al., 2013; Maguen et al., 2012).

Physical Problems after Polytrauma. Polytrauma is associated with several physical problems, including gastrointestinal symptoms, fatigue, musculoskeletal and joint pain, and skin disorders (Ford et al., 2001). Individuals with brain injury in particular may experience headaches, neck pain, lightheadedness, dizziness, nausea, loss of sense of smell or taste, ringing in the ears, cognitive difficulties (i.e. memory, concentration, decision-making), fatigue, sleep

changes, increased sensitivity to lights and sounds, and blurred vision (NINDS, 2015). In more serious brain injuries, individuals may vomit, experience convulsions or seizures, and experience weakness or numbness in their extremities (NINDS, 2015). While health generally improves over time following injury, as suggested by a longitudinal study examining changes following brain injury, health-related quality of life may remain impaired (Tomberg, Toomela, Ennok, & Tikk, 2007). One study found that while Glascow Outcome Scores (GOS) suggested good functional recovery and independence in everyday life for the majority of patients several years after their injury, there was no significant improvement in most domains on a measure of health-related quality of life, which instead remained low compared to healthy controls (Tomberg et al., 2007).

However, not all functional limitations seen in Veterans with poytrauma are associated with physical impairments, but may instead be tied to comorbid diagnoses such as PTSD or chronic pain (Uomoto & Williams, 2009). Cook and colleagues (2015) examined the association between chronic pain acceptance and disability in Veterans with polytrauma. They found that depression and PTSD significantly predicted disability in this population, while chronic pain acceptance was significantly and negatively associated with disability, depression, and PTSD (Cook et al., 2015). Another study examined FIM scores for Veterans with polytrauma and found that baseline functioning was the strongest predictor of FIM gains and length of stay in inpatient rehabilitation (Sayer et al., 2008). A shorter time since injury, younger age, and higher education were associated with greater functional improvement (Sayer et al., 2008). However, the authors note that FIM may not be the best tool for assessing functional gains in polytrauma due to ceiling effects of the measure: 13% of patients achieved the maximum cognitive FIM score and 31% achieved the maximum motor FIM score by discharge (Sayer et al., 2008). Nonetheless, Sayer

and colleagues (2008) found that patients with polytrauma who entered rehabilitation with low levels of functioning made significant gains in functional independence.

Mental Health Problems after Polytrauma. Beyond physical impairments, there are also many psychological problems associated with polytrauma, and these are often a major source of stress to the injured and their families. Individuals with the brain injury feature of polytrauma may experience difficulty regulating their emotions and may experience comorbid mental health problems, including depression, anxiety, and PTSD (Bombardier et al., 2010; Schwarzbold et al., 2008; Silver, Kramer, Greenwald, & Weissman, 2001; Taylor et al., 2012). Silver et al. (2001) found that a history of brain injury is associated with an increased likelihood of having a psychiatric disorder. Specifically, they found that individuals with brain injury had a higher incidence of depression, dysthymia, OCD, phobias, panic disorder, alcohol or substance abuse/dependence, bipolar disorder, and schizophrenia compared to those without brain injury. Furthermore, individuals with brain injury were more likely than those without brain injury to have poorer physical or emotional health and be on welfare, potentially indicating a poorer quality of life for individuals with brain injury (Silver et al., 2001).

In a study of U.S. military Veterans, those with TBI were four times more likely to have comorbid PTSD and pain diagnoses compared to those without TBI (Taylor et al., 2012). In fact, more than half of Veterans with TBI (54%) had this combination of mental health diagnoses, compared to only 11% for those without a TBI. Another study examined rates and predictors of depression in TBI patients admitted to a level-one trauma center (Bombardier et al., 2010). These patients were assessed monthly for the first six months following injury and then again at 8, 10, and 12 months post injury. It was found that 53.1% of the patients met criteria for major depressive disorder during the year following injury, with the highest point prevalence (31%)

being during the first month following TBI and the lowest point prevalence (21%) after six months (Bombardier et al., 2010). Several factors were associated with depression after injury, including depression at the time of injury, history of depression prior to injury, age, and lifetime alcohol dependence. Compared to those who did not experience depression following TBI, patients experiencing depression were more likely to experience comorbid anxiety (Bombardier et al., 2010). Finally, depression following TBI was associated with poorer health-related quality of life (Bombardier et al., 2010).

Shields, Ownsworth, O'Donovan, and Fleming (2015) investigated factors common to depression, anxiety, and global distress in a post-acute sample of individuals with TBI recruited from a hospital brain injury unit. Participants completed measures of threat appraisals and avoidance behavior, self-discrepancy, emotion dysregulation, worry, negative self-focused attention, and emotional distress. Principal components analysis was then used to find two factors common to depression, anxiety, and global stress: Threats to Self and Emotion Dysregulation. Emotion Dysregulation, but not Threats to Self, accounted for variance in levels of depression, anxiety and global distress, suggesting that difficulties in identifying and regulating emotions after TBI play a key role in the emergence of mental health issues following injury (Shields et al., 2015).

Psychosocial Problems after Polytrauma. Research has also focused on psychosocial outcomes of polytrauma, such as employment (Bush, Hux, Guetterman, & McKelvey, 2016; Dahm & Ponsford, 2015). One study examined global functioning and employment status for individuals ten years after injury (Dahm & Ponsford, 2015), finding that 49.5% were not employed. Employment was positively associated with higher education, pre-injury employment, younger age, and lower severity of injury. Global functioning was similarly correlated with

higher education, younger age at injury, and lower injury severity (Dahm & Ponsford, 2015). Another study qualitatively explored the experiences of returning to work following severe TBI for five young adults (Bush et al., 2016). Thematic analysis of the data collected led the authors to conclude that job satisfaction may not be tied to monetary gains, but rather involvement in productive activities. They also surmised that adults with brain injury can successfully complete work with high cognitive demands, although job modifications and strategies may be needed (Bush et al., 2016).

Posttraumatic Growth

Posttraumatic growth (PTG) is a relatively understudied phenomenon in which individuals experience positive changes following adversity. The term was coined by Tedeschi and Calhoun (1996), who defined it as "a positive psychological change experienced as a result of the struggle with highly challenging life circumstances" (p.1). Prior to the coining of the term PTG, other names were used to describe the phenomenon, both in Tedeschi and Calhoun's earlier work and in the work of others: benefit-finding; perceived benefits; transformation of trauma; transformational coping; positive psychological changes; stress-related growth; discovery of meaning; thriving; and flourishing (Aldwin, 1994; Linley & Joseph, 2004; McMillen & Fisher, 1998; Park, Cohen, & Murch, 1996; Ryff & Singer, 1998; Tennen & Affleck, 2002).

PTG is traditionally seen as distinct from resilience. Resilience has been defined as a psychological process that facilitates healthy functioning in response to intense stress (Johnson et al., 2009). While some researchers operationalize resilience as the absence of psychopathology or adverse symptoms following trauma (Alim et al., 2008; New et al., 2009), Bonanno (2012) argues that resilience is more than that. He defines resilience as the ability to maintain relatively

stable, healthy levels of functioning when exposed to isolated and potentially highly disruptive events (i.e. death of a close friend, life-threatening situation). PTG, in contrast, refers to "a change in people that goes beyond an ability to resist and not be damaged by highly stressful circumstances; it involves a movement beyond pretrauma levels of adaptation" (Tedeschi & Calhoun, 2004, p. 4). The authors assert that PTG is a qualitative change in functioning following a traumatic event and liken PTG to the aftermath of an earthquake in which beliefs are shaken up and need to be rebuilt through cognitive processing and restructuring (Tedeschi & Calhoun 1996; Tedeschi & Cahoun, 2004).

In a response to comments on their model of PTG, Calhoun and Tedeschi (2004) asserted that there are five major domains of PTG: 1) seeing new possibilities; 2) changed relationships; 3) paradoxical view of being both stronger yet more vulnerable; 4) greater appreciation of life; and 5) changes in one's spiritual and existential beliefs. Other researchers have expanded on the concept of PTG and have suggested three broad dimensions of the construct: 1) relationships are enhanced; 2) one's view of him or herself is changed; and 3) one's life philosophy is changed (Joseph & Linley, 2006). Chun and Lee (2008) suggested that existing measures of PTG may capture overlapping domains and/or they may underestimate PTG and may not adequately capture the respondent's own experience of growth following SCI. The authors therefore intentionally selected individuals with SCI who clearly demonstrated PTG and asked them to qualitatively examine their experiences before and after their injuries. The authors utilized thematic analysis to identify three themes that emerged following SCI and suggest posttraumatic growth: 1) meaningful family relationships, 2) meaningful engagement, and 3) appreciation of life (Chun & Lee, 2008).

PTG has been examined in a variety of populations, including bereaved parents, cancer patients, survivors of intimate partner violence, military Veterans, and individuals following serious injury (Chun & Lee, 2008; Danhauer et al., 2015; Tedeschi & Calhoun, 1996). Tsai, El-Gabalawy, Sledge, Southwick, and Pietrzak (2015a) used data from the National Health and Resilience in Veterans Study, a contemporary, nationally representative survey that consists of over 3000 veterans in the United States to assess sociodemographic, military, health, and psychosocial characteristics. Tsai and colleagues (2015a) found that the majority of participants endorsed PTG. Furthermore, results revealed a curvilinear association between PTSD symptoms and PTG such that veterans who reported a moderate level of PTSD symptoms reported the greatest levels of PTG (Tsai et al., 2015a). This suggests that there may be an optimal level of distress required for the development of PTG, but that PTG does not occur when symptoms are too severe. Tsai and colleagues (2015a) found that Veterans who endorsed at least a moderate level of PTG experienced better mental functioning and general health than those who did not endorse PTG. In addition, they found that social connectedness, religiosity, and purpose in life were positively associated with PTG (Tsai et al., 2015a).

Another study examined the course of posttraumatic growth over a two-year period using a nationally representative sample of U.S. military veterans (Tsai, Sippel, Mota, Southwick, & Pietrzak, 2015b). Participants were nearly 2000 Veterans who reported at least one potentially traumatic event and provided data at two time points. Participants responded to a web-based survey that included the Trauma History Screen (THS), PTSD Checklist- Specific Stressor Version, and the Posttraumatic Growth Inventory-Short Form (PTGI-SF). Data were analyzed using bivariate correlations, logistic regression, and post-hoc analyses. Five courses of PTG were identified: consistently low, moderately declining, increasing, dramatically declining, and

consistently high, suggesting that there are varied courses of PTG over time (Tsai et al., 2015b). While most participants maintained PTG over time, more than a third experienced a decline, suggesting that PTG may not always be sustainable. Compared to those who experienced decline in PTG, those who maintained PTG over time were more likely to be White and less educated, while they were less likely to be retired (Tsai et al., 2015b). Maintainers also had lower openness to experience subscale scores, lower substance abuse factor scores, higher altruism factor scores, and higher active lifestyle factor scores compared to those who experienced decline (Tsai et al., 2015b). Some limitations of this study were that it utilized self-report measures, which may not be as accurate as clinician administered measures, and only two time points were used.

PTG, Demographics, and Injury Characteristics. Some previous literature has examined individual difference characteristics that predict the emergence of PTG (Danhauer et al., 2015; January et al., 2015; Kalpakjian et al., 2014; Linley & Joseph, 2004; Tedeschi & Calhoun, 2004; Tomberg et al., 2007). PTG has been found to be positively correlated with openness to experience, extraversion, agreeableness, conscientiousness, optimism, and religiosity, while negatively correlated with neuroticism (Linley & Joseph, 2004; Tedeschi & Calhoun, 2004; Tomberg et al., 2007).

Danhauer and colleagues (2015) examined trajectories of posttraumatic growth in a sample of 653 women with breast cancer within 8 months of a cancer diagnosis and 6, 12, and 18 months later. The authors found that women who reported moderate to high levels of PTG either consistently or gradually over time were more likely to be non-White and relatively young, and had relatively higher baseline levels of illness intrusiveness, depressive symptoms, and active-adaptive coping than women with low levels of PTG (Danhauer et al., 2015).

Another study examined associations between PTG, depression, individual differences, and injury characteristics in a community-based sample of 824 adults with SCI (Kalpakjian et al., 2014). Using structural equation modeling (explaining 5% of the variance in PTG), the authors found that greater PTG was associated with being female, younger, less educated, and less time since injury. PTG was not associated with injury severity or depression (Kalpakjian et al., 2014).

January and colleagues (2015) examined PTG in adults who had pediatric-onset spinal cord injury and were recruited from three diverse SCI programs. They administered interviews in person or via telephone and collected demographic and injury-related information, measures of PTG, coping, mental health, and satisfaction with life. January and colleagues (2015) found that nearly all (99%) participants endorsed at least one positive change as a result of their injury. They explored potential predictors of PTG and found no significant associations with injury etiology, level of injury, completeness of injury, age at injury, injury duration, gender, ethnicity, employment status, marital status, education level, anxiety, or depression. Younger age did predict PTG, as did behavioral coping, cognitive coping, satisfaction with life, and general happiness.

According to these studies, individual characteristics that may contribute to the development of PTG include female gender, younger age, optimism, openness, conscientiousness, agreeableness, extroversion, religiosity, and self-efficacy (Danhauer et al., 2015; Kalpakjian et al., 2014; Tedeschi & Calhoun, 2004; Tsai et al., 2015a). Psychosocial predictors of PTG included greater emotional support, less education, and positive health behaviors (Tsai et al., 2015b). However, across studies of PTG, there has been much inconsistency, partially due to the heterogeneity of populations and traumatic events experienced (i.e. sexual assault, combat, injury, disease, death of a loved one), suggesting a need for more

narrowly focused research. While some studies suggest that PTG is associated with female gender (Kalpakjian et al., 2014; Park et al., 1996; Tedeschi & Calhoun, 1996), racial minority status (Danhauer et al., 2015), less education (Kalpakjian et al., 2014; Tsai et al., 2015b), and the presence of mental health symptoms (Tsai et al., 2015b) others suggest no correlation between PTG and these variables (January et al., 2015) or contradictory findings (Tsai et al., 2015b).

PTG over Time. McGrath & Linley (2006) examined PTG over time using a cross-sectional design comparing individuals with early (seven months since injury) to late (ten years since injury) acquired brain injury. The authors found that the late sample reported higher levels of PTG compared to the early sample, and they suggested that this may be indicative that positive change may take some time to develop following injury (McGrath & Linley, 2006). The study also demonstrated that PTG does not preclude negative emotional outcomes or distress, as there was a positive and significant association between PTG and anxiety in the study. The association found between anxiety and PTG is in opposition to several studies described above that did not find an association between psychological distress and PTG (e.g., January et al., 2015).

Another study examined trajectories of PTG in a sample of 653 women with breast cancer, collecting data within 8 months of a cancer diagnosis and 6, 12, and 18 months later and found six trajectories (Danhauer et al., 2015). PTG was relatively stable across five of the six trajectories, such that it remained relatively low in trajectories one and two; moderate in four and five; and high in six. PTG changed drastically in trajectory three, in which it was initially low, rose sharply over the first 12-16 months, and then plateaued at a relatively moderate level. None of the PTG trajectories decreased over time. Several individual difference characteristics varied significantly across groups, including age, race, use of adaptive coping strategies, illness

characteristics, depressive symptoms, and social support. Women who reported moderate to high levels of PTG either consistently or gradually over time were more likely to be non-White and relatively young. They also had relatively higher baseline levels of illness intrusiveness, depressive symptoms, and active-adaptive coping than women with low levels of PTG, suggesting that greater difficulty and effective coping are important for promoting PTG.

Stress and Coping Model

The Stress and Coping Model developed by Lazarus and Folkman (1984) suggests a potential developmental pathway for PTG. The model posits that cognitive appraisals of a stressful event in conjunction with coping resources determine whether or not a situation results in distress. Individuals engage in what has been termed *primary appraisal*, in which they evaluate the potential impact of a stressor they are faced with, characterizing it as loss, threat, or a challenge. A loss appraisal indicates that harm has already been done (i.e. the loss of a loved one, or loss of function), threat signifies a risk for harm, and challenge refers to potential for growth. After the primary appraisal, individuals assess the potential responses to the stressful event, the coping resources available to them, and the potential for success in their coping efforts, a process known as *secondary appraisal*. Lazarus and Folkman (1984) suggest that stress arises when an individual appraises a situation as a threat or loss and feels that he or she does not have the appropriate coping resources to manage the environmental demands. Appraisals of a stressor, coping resources, and coping strategies may contribute to the development of PTG.

SCI: Appraisals and Coping. While individuals with SCI may face many negative physical, psychological, and psychosocial consequences of their injury, many cope quite well and live fulfilling lives (Craig et al., 2009; deRoon-Cassini, Hastings, de St. Aubin, Valvano, & Brasel, 2013; Galvin & Godfrey, 2001). Appraisals, or the way people think about their

injury, in conjunction with the ensuing coping strategies used significantly impact the process of adjustment to SCI (Kennedy, Lude, Elfstrom & Smithson, 2012). Research has shown that individuals who initially interpreted their injury as a challenge were more likely to use adaptive coping strategies and to have better outcomes on measures of quality of life, anxiety, and depression at one-year follow-up compared to those who initially interpreted their injury as a loss or a threat (Kennedy et al., 2012). Studies have suggested appraisals as a target for interventions by demonstrating that modification of appraisals can improve psychological wellbeing (Kennedy, Duff, Evans, & Beedie, 2003).

In a review of coping and appraisal literature, Galvin and Godfrey (2001) discuss how early studies found that appraisals of control and self-blame led to better outcomes for individuals with SCI, such that those who viewed the injury as avoidable and those who blamed themselves rather than others or the environment had less emotional distress. Later studies found that self-blame was associated with increased psychological distress (Galvin & Godfrey, 2001). Another study the authors reviewed found that "concern for the causality of the accident" was associated with adaptive coping in individuals who had been injured for greater than two years, but was associated with poorer emotional adjustment in those who were recently disabled (Van Den Bout, Ven Son-Schoones, Shipper, & Groffen, 1988).

Studies have also examined how appraisals can be used to make sense of and bring meaning to an SCI, thereby improving outcomes. In one study, researchers identified seven meaning-making themes employed by Veterans with SCI: 1) injury stagnation, defined as the sense of being stuck and unable to move forward in life; 2) positive growth, in which patients appreciated life more after their injury; 3) limiting others, the feeling of burdening those who must now care for them; 4) identity integration, the ability to integrate injury and the new

demands into one's sense of self; 5) acceptance of the injury, defined as coming to peace with it; 6) random event, which was the feeling of there being no spiritual explanation for the injury; and 7) degree of life change, defined as how significantly life changed pre- to post-injury (deRoon-Cassini et al., 2013). The authors found associations among these appraisals and with outcomes. Higher *integration* related to *positive growth*, which in turn related to greater purpose in life and improved wellbeing. *Limiting others* related to *injury stagnation* and to greater symptoms of depression, less psychological wellbeing, and less purpose in life. *Degree of life change* was associated with greater PTSD, less psychological wellbeing, and less purpose in life.

Previous studies have suggested that up to 40% of individuals with SCI use less adaptive coping behaviors than able-bodied controls, including adopting an external locus of control, which has been found to be associated with depressed mood two years after injury, increased likelihood of PTSD, severe pain, and general health problems (Craig et al., 2009). Yet researchers have found that patients with SCI tend to use adaptive strategies, such as active coping and acceptance, more frequently than maladaptive strategies, such as behavioral disengagement and denial (Kennedy, Lowe, Grey, & Short, 1995; Kennedy et al., 2000).

Kennedy and colleagues (2016) conducted a longitudinal study of coping following SCI, using the same cohort and building on results from previous studies (Kennedy et al., 2000; Pollard & Kennedy, 2007). Across all three studies, they found that the most commonly reported coping strategy was acceptance, with active coping and planning also being very common. The least frequently used coping strategies at 12 weeks post-injury (Kennedy et al., 2000), ten years post-injury (Pollard & Kennedy, 2007), and 21 years post-injury (Kennedy et al., 2016) were denial, behavioral disengagement, and substance use. Kennedy and colleagues

(2016) also examined significant differences in the use of various coping strategies across time, finding significant increases in acceptance and restraint and significant decreases in the use of emotional support, religion, mental disengagement, denial, and humor from 12 weeks post-injury to 21 years post-injury. Depression was found to be positively associated with focusing on emotion, venting, and behavioral disengagement, while it was negatively associated with positive reinterpretation and growth, active coping, and planning (Kennedy et al., 2016). It was also found that individuals from the original cohort who were deceased 21 years post-injury used significantly less active coping and humor and significantly more substance abuse ideation at 12 weeks post-injury, suggesting that these coping strategies predict mortality (Kennedy et al., 2016).

Various forms of denial, including wishful thinking and threat minimization, have been associated with higher levels of depression and perceived life stress in individuals with SCI (Galvin & Godfrey, 2001). Self-perceived problem-solving abilities have been found to be predictive of emotional outcomes, such that higher problem-solving ability is associated with decreased depression and emotional distress. Studies have also suggested that problem-focused coping yields better results than emotion-focused coping in individuals with SCI (Elliott, Godshall, Herrick, Witty, & Spruell, 1991; Moore, Bombardier, Brown, & Patterson, 1994); however, because these studies were correlational, it is impossible to determine if individuals who used problem-focused coping experienced less distress as a result of their coping, or if they chose problem-focused coping due to lower levels of emotional distress compared to those who chose emotion-focused coping.

Polytrauma: Appraisals and Coping. Research has explored the consequences of appraisals of one's brain injury (Riley, Brennan, & Powell, 2004; Riley, Dennis, & Powell, 2010;

Shotton, Simpson, Smith, 2007). Riley and colleagues (2004) found that high levels of threat appraisals following brain injury were associated with avoidance of activities. A follow-up study was conducted examining potential moderators of that relationship: self-esteem and the evaluation of coping resources (Riley et al., 2010). It was found that individuals with brain injury who had low self-esteem and those who had negative evaluations of their ability to cope were significantly more likely to engage in avoidance when they made threat appraisals (Riley et al., 2010). The authors concluded that individuals with low self-esteem are motivated to avoid valued activities due to greater need to protect their self-esteem from further threat, while those who perceive themselves as having the resources to deal with the problems posed by their brain injury do not feel the need to avoid activities (Riley et al., 2010). Time since injury and etiology of injury also moderated the relationship between threat appraisals and avoidance, such that avoidance was more likely for more recent injuries and those that were the result of assault (Riley et al., 2010).

Several studies have examined coping strategies used after brain injury (Sasse et al., 2014; Tomberg et al., 2007), and these strategies have been linked to emotional adjustment following injury (Curran, Ponsford, & Crowe, 2000). Prior studies suggest that active and problem-focused coping yield the most positive adjustment to brain injury, while emotion-focused and avoidance coping are related to maladjustment following brain injury (Curran et al., 2000; Finset & Anderson, 2000). For example, emotion-focused coping has been found to be associated with increased anxiety, depression, or other psychiatric disorders (Anson & Ponsford, 2006; Gould, Ponsford, Johnston, & Schonberger, 2011). However, the helpfulness of various coping strategies can also be dependent on demographic and injury characteristics, such as time since injury and level of disability (Sasse et al., 2014).

Sasse and colleagues (2014) examined coping strategies used by individuals following brain injury. They found that active coping, problem-oriented coping, and distraction, were used more frequently than religious coping, minimization, wishful thinking, or "quest for sense." Minimization and wishful thinking were negatively associated with health-related quality of life, while active coping and problem-oriented coping were positively associated with health-related quality of life (Sasse et al., 2014). Using factor analysis, Sasse and colleagues (2014) extracted two superordinate factors for coping strategies used by individuals after brain injury: Trivialization/Resignation (comprised of "depressive coping" and "minimization and wishful thinking") and Action/Distraction (comprised of "active, problem-oriented coping" and "distraction and self-reorganization"). Trivialization/Resignation was found to be positively associated with anxiety, depression, fatigue and anger and negatively associated with cognitive status, recovery, and work status. Action/ Distraction was conversely positively associated with health-related quality of life. The authors thus concluded that Trivialization/Resignation is maladaptive while Action/Distraction is an adaptive coping strategy. Finally, they found that individuals with a higher degree of disability following brain injury appear to be more likely to use the maladaptive strategy of Trivialization/Resignation (Sasse et al., 2014).

Tomberg and colleagues (2007) investigated changes in coping strategies, social support, and optimism several years after brain injury. They found that overall, use of social and emotional support increased significantly two to eight years after injury (Tomberg et al., 2007). However, avoidance coping remained high during that timeframe. Individual differences emerged within their sample such that individuals with brain injury who had fewer physical limitations demonstrated increased task-oriented coping styles two to eight years following their

injury, while individuals who had limited social support showed an increase in avoidant coping styles (Tomberg et al., 2007).

The use of task-oriented coping and social diversion coping, but not other forms of coping behaviors commonly used by individuals with brain injury (i.e. emotion-focused coping, avoidance), have been found to positively correlate with resilience within the first five years following brain injury (Hanks, Rapport, Perrine, & Millis, 2016). Social diversion coping is a form of avoidance coping that involves seeking company and support of friends and family. Perceived social support positively correlated with resilience as well (Hanks et al., 2016). Researchers found that the majority of a sample of patients with brain injury recruited from a rehabilitation hospital exhibited resilience similar to the rates of resilience seen in adults without cognitive impairment (Hanks et al., 2016).

Appraisals, Coping, and PTG. Although limited research has been conducted on appraisals, coping, and PTG in individuals with severe injuries, Yeung and colleagues (2015) examined the associations between appraisals, coping, and PTG in an ethnically diverse sample of college students via an online survey. Traumatic events experienced by participants included witnessing a serious accident; experiencing a natural disaster (i.e. tornado, hurricane, earthquake); being the victim of a violent crime; having been in an abusive relationship; receiving news of the serious injury or death of close others; and other traumatic events. Yeung and colleagues (2015) found that use of challenge appraisals, having one's relatedness need satisfied, emotional expression, acceptance, and positive reframing were associated with higher PTG after controlling for gender, number of different traumatic events, and the level of current distress due to the most traumatic event.

Coping has also been examined as a potential predictor of positive adjustment and PTG. Past research has found that challenge appraisals are positively associated with emotional processing, acceptance, and positive reframing (Yeung et al., 2015), and these coping styles are in turn positively associated with PTG (Moore, Varra, Michael, & Simpson, 2010). Mixed results have been found for threat and harm appraisals (Armeli et al., 2001; Yeung et al., 2015).

Problem-focused coping, acceptance, positive reinterpretation, religious coping, emotion-focused coping, and emotional support coping have all been found to be positively associated with PTG (Linley & Joseph, 2004; Park et al., 1996; Sears, Stanton, & Danoff-Burg, 2003; Zoellner & Maercker, 2006). In another study, compared to those with low levels of PTG, women with breast cancer who demonstrated high levels of PTG were more likely to use adaptive coping (Danhauer et al., 2015). Furthermore, those women who demonstrated an increase in PTG over time reported greater use of active-adaptive coping at baseline (Danhauer et al., 2015). And in the only study uncovered in this area on severe injury, January and colleagues (2015) found that PTG was significantly and positively associated with behavioral and cognitive coping strategies in individuals with SCI.

Social Support

Like appraisals and coping, social support may influence the development of PTG. Social support has been associated with several positive outcomes for individuals with SCI (Elliott, Herrick, Witty, Godshall, & Spruell, 1992). Studies have demonstrated that social support among individuals with SCI is associated with decreased emotional distress, fewer health problems, greater physical mobility, economic self-sufficiency, employment, and higher quality of life and life satisfaction (Burns et al., 2010; Dowler, Richards, Putzke, Gordon, & Tate, 2001; Sherman, DeVinney, & Sperling, 2004). Past research has underscored the importance of fulfilling

relationships, meaningful activities, feelings of responsibility, and a sense of personal control on increasing quality of life after SCI (Barker et al., 2009; Carpenter, Forwell, Jongbloed, & Backman, 2007). In turn, quality of life has been shown to be positively associated with mobility and perceived health (van Leeuwen et al., 2010) and negatively associated with physical disability and secondary medical complications (Dijkers, 2005; Post & Noreau, 2005). Research suggests that the majority of individuals with SCI report a high level of life satisfaction, which has been shown to be directly related to involvement in productive activities such as employment and social pursuits (Barker et al., 2009). However, more research and subsequent clinical application is still needed to improve life satisfaction and quality of life in individuals with SCI.

Social support has also been linked to positive outcomes in individuals with polytrauma (Hanks et al., 2016; Seidl et al., 2015). For example, individuals with TBI who have lower social support have been shown to have lower levels of satisfaction with life (Tomberg et al., 2007). Seidl and colleagues (2015) examined the association between satisfaction with life and social support in Veterans who served in recent conflicts (Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn) with mild TBI. They found that social support was significantly associated with satisfaction with life, even after controlling for age, education, and symptoms of posttraumatic stress disorder. Hanks and colleagues (2016) examined the role of social support in adjustment to TBI. They found that social diversion coping, defined as seeking the company and support of one's social network, was positively associated with resilience and positive adjustment to one's injury. Furthermore, perceived social support, which was not related to social diversion coping, also uniquely predicted positive adjustment to TBI (Hanks et al., 2016).

Several studies have specifically examined the association between social support and PTG (Danhauer et al., 2015; Linley & Joseph, 2004; Park et al., 1996; Tedeschi & Calhoun, 2004), although none in the context of acquired physical disability. Linley and Joseph (2004) conducted a review of the literature on posttraumatic growth and found that social support satisfaction was positively associated with PTG, although social support itself was not found to be associated with PTG. Tedeschi and Calhoun (2004) reported that "supportive others" aided the development of PTG, and social support was found to have a curvilinear relationship with PTG in a study of women with breast cancer, such that those with both the lowest and highest levels of PTG had the highest levels of social support (Danhauer et al., 2015). The authors explained this finding by suggesting that in the group of women with low PTG, social support may have served as a buffer to prevent the critical threshold of distress to be reached necessary for the development of PTG, while for the group of women with high PTG, social support may have served as one method of active coping (Danhauer et al., 2015). Finally, Yeung and colleagues (2015) found that one of the predictors of PTG in a diverse college sample was having one's need for relatedness met.

The Current Study

Many Veterans are presenting to VA Medical Centers for treatment of acquired physical disabilities, especially SCI and polytrauma. These injuries often create long-term negative physical, cognitive, and psychological consequences (Adriaansen et al., 2013; Bombardier et al., 2010; Bush et al., 2016; Craig et al., 2009; Dahm & Ponsford, 2015; Fann et al., 2011; Hartoonian et al., 2014; Krause et al., 2007; NINDS, 2015; Schwarzbold et al., 2008; Silver et al., 2001; Stillman, Frost, Smalley, Bertocci, & Williams, 2014; Stanford et al., 2007; Taylor et al., 2012; Tomberg et al., 2007), yet some individuals experience PTG following injury. The

Stress and Coping Model (Lazarus & Folkman, 1984) suggests a potential developmental pathway for PTG by which active and adaptive coping and the use of appraisals may contribute to the development of PTG.

While PTG has been examined in a variety of populations (Chun & Lee, 2008; Danhauer et al., 2015; January et al., 2015; Kalpakijian et al., 2014; Tedeschi & Calhoun, 1996; Tsai et al., 2015a; Tsai et al., 2015b), it remains relatively understudied, particularly in regards to acquired physical disability in Veterans. This is unfortunate because PTG is exceptionally relevant to Veterans, as they have a relatively high rate of exposure to potentially traumatic events such as combat exposure and traumatic injury (Hoge, 2004). Further, previous studies of PTG are limited in that most have examined the construct only at a single time point (Chun & Lee, 2008; January et al., 2015; Kalpakjian et al., 2014; Yeung, Lu, Wong, & Hunynh, 2015).

By contrast, the current study will examine PTG in Veterans with acquired physical disability longitudinally over five time points (baseline, 1-month, 3-month, 6-month, and 12-month follow up after injury). The aims of this study are: (1) to assess how various demographic variables and injury characteristics, such as age, race, etiology of injury (SCI vs. brain injury), time since injury, and functional independence predict the trajectory of PTG over time in this population, and (2) to assess the effects of various coping styles, cognitive appraisals, and social support on PTG over time. The hypotheses are as follows:

Hypothesis 1. Demographic and injury characteristics will be associated with PTG over time. In particular, it is hypothesized that younger age, White race vs. racial/ethnic minority status, and lower premorbid estimated IQ will be associated with greater PTG. Past studies have found that age (Danhauer et al., 2015; January et al., 2015) and education level (Kalpakjian et al., 2014; Tsai et al., 2015b) has been negatively associated with PTG, while White ethnicity has

been positively associated with PTG (Tsai et al., 2015b). Regarding injury characteristics, it is predicted that time since injury will be positively associated with PTG over time (i.e., PTG will increase over time), while age at injury and will be negatively associated with PTG over time. McGrath and Linley (2006) found that time since injury was positively associated with PTG. Younger age at injury has been associated with improved functioning following injury (Dahm & Ponsford, 2015). It is also predicted that functional independence will be negatively associated with PTG, in line with the theory that a sufficient level of trauma and distress are needed in order for PTG to develop (Danhauer et al., 2015; Tedeschi & Calhoun, 2004; Tsai et al., 2015a). We will also do an exploratory analysis to examine potential differences in trajectories of PTG in Veterans with SCI versus brain injury.

Hypothesis 2. Greater use of active, planning, reframing, and religious coping will be positively associated with PTG over time, while greater use of disengagement coping will be negatively associated with PTG over time. Women with cancer in one study who demonstrated high levels of PTG were more likely to use adaptive coping, compared to those with lower levels of PTG (Danhauer et al., 2015). January and colleagues (2015) found that PTG was positively associated with behavioral and cognitive coping strategies in individuals with SCI. In addition, problem-focused coping, acceptance, positive reinterpretation, positive religious coping, and emotional support coping have been found to be positively associated with PTG in previous studies (Linley & Joseph, 2004; Park et al., 1996; Sears et al., 2003; Zoellner & Maercker, 2006).

Hypothesis 3. Greater use of challenge appraisals will predict higher PTG over time, whereas greater use of threat and loss appraisals will predict stable but low PTG over time. Past research has found that increased use of challenge appraisals is positively associated with

emotional processing, acceptance, and positive reframing (Yeung et al., 2015), and these coping styles are in turn positively associated with PTG (Moore et al., 2010). Mixed results have been found for threat and harm appraisals (Armeli et al., 2001; Yeung et al., 2015).

Hypothesis 4. Perceived social support will be positively associated with PTG over time. Social support satisfaction and the presence of "supportive others" have been found to be positively associated with PTG (Linley & Joseph, 2004; Tedeschi and Calhoun, 2004). Social support has been associated with several positive outcomes for individuals with SCI (Elliott et al., 1992), and seeking the company and support of one's social network has been found to be positively associated with resilience and positive adjustment to polytrauma (Hanks et al., 2016).

Method

Participants

There were 90 participants who initially met inclusion criteria. However, 7 participants were excluded from the study due to missing data for the outcome variable at all time points, resulting in a final sample size of 83. Participants included military Veterans receiving comprehensive inpatient rehabilitation at the McGuire VA Medical Center (VAMC) in Richmond, VA. Veterans were recruited from the Spinal Cord Injury & Disorder's Service, Polytrauma Rehabilitation Center, and Polytrauma Transitional Rehabilitation Program through the computerized medical records system (CPRS) and clinician referrals. Participants included active duty military service members who sustained either a brain injury or spinal cord injury in a combat zone as well as active duty and retired Veterans injured in the same manner during training or in civilian accidents. Veterans were eligible for the study if they were at least 18 years old, had experienced a brain injury or spinal cord injury, were able to speak English, and were receiving inpatient rehabilitation at the time of their initial visit or had completed it within the past 7 days and continued to receive outpatient rehabilitation at the McGuire VAMC. In addition, the injury or onset of dysfunction must have occurred within the past eighteen months at the time of their initial visit. Exclusion criteria included lacking capacity to provide informed consent; lacking self-awareness of impairments, as determined by a clinician using both standardized (Self-Awareness Deficit Interview) and unstandardized assessment; poor insight, poor judgement, and/or other cognitive impairments as evidenced by a Rancho Los Amigos level below VII.

Participants were mostly men (n = 80), with three women participating. Age at baseline ranged from 20 to 84 years old (M = 52.01, SD = 17.08）. Participants identified as White (57.8

%), Black (32.5%), Hispanic (4.8%), Asain (1.2%), American Indian (1.2%), Native Hawaiian/ Pacific Islander (1.2%), and "other" ethnicity (2.4%). Most had spinal cord injuries (77.1%), while the remainder had brain injuries (22.9%).

Participants were compensated for their time, receiving $50 for completing baseline measures; $30 per follow-up sessions at 1, 3, and 6 months; $50 for the 12 month follow-up session; and a $50 bonus if all sessions were completed in a timely manner.

Procedure

The study was approved by the Institutional Review Board at the McGuire VAMC as part of a larger study on resilience, and later approved as an exempt dissertation by the Institutional Review Board at Virginia Commonwealth University (HM20008390). Informed consent was conducted with all participants. Some demographic information, injury characteristics, and other baseline data such as previous mental health treatment was collected by research staff from review of medical records or discussions with treatment team members. Data were collected from participants at baseline (targeting within three weeks of anticipated discharge date), and at several follow-up sessions: one, three, six, and 12 months after discharge.

The baseline session consisted of questionnaires and interviews administered by the research team and required approximately two hours. Assessments were administered in a single session or spread across multiple sessions depending on the availability of participants. Participants were provided with a copy of instructions and rating scales for the questionnaires (see Appendices B-E). This session was typically conducted in-person in a participant's hospital room or an office at the VAMC. A subset of measures from the larger study were used for the current study (Table 1).

Table 1. *Measures administered at baseline, 1-, 3-, 6-, and 12-month follow ups.*

Measure	Baseline	1 month	3 month	6 month	12 month
Demographics and Health Interview	X	x	x	x	x
Wechsler Test of Adult Reading (WTAR)	X				
Brief COPE subscales	X				x
Appraisal of Life Events Scale (ALE)	X				x
Multidimensional Scale of Perceived Social Support (MSPSS)	X	x	x	x	x
Posttraumatic Growth Inventory- Short form (PTGI-SF)	X	x	x	x	x

The one, three, and six month follow-up sessions consisted of a subset of questionnaires and interviews (see Table 1) and were administered by study staff via telephone, although some participants were interviewed in person at the McGuire VAMC during a regularly scheduled appointment. These sessions required approximately 25 to 45 minutes. A letter was mailed to participants approximately two weeks prior to the session and included instructions and rating scales for the questionnaires (see Appendices D-E).

The final session was a 12-month follow-up session and included questionnaires and interviews (see Table 1) administered by the research team via telephone, although some participants were interviewed in person at the McGuire VAMC during a regularly scheduled appointment. This session lasted approximately 45 to 55 minutes. A letter was mailed to participants approximately two weeks prior to the session with instructions and rating scales (see Appendices B-E).

Measures

Demographics and Health Interview. Several questions pertaining to demographic characteristics (i.e., age, gender, race, marital status, military history) and health (i.e., medical

conditions currently being treated) were assessed at baseline and all follow-up sessions (see Appendix A).

Brief COPE. The Brief COPE (Carver, 1997) is a 28-item questionnaire that measures coping styles (Appendix B). It consists of 14 subscales each composed of two items: Active Coping (α = .68), Planning (α = .73), Positive Reframing (α = .64), Acceptance (α = .57), Humor (α = .73), Religion (α = .82), Using Emotional Support (α = .71), Using Instrumental Support (α = .64), Self-Distraction (α = .71), Denial (α = .54), Venting (α = .50), Substance Use (α = .90), Behavioral Disengagement (α = .65), and Self-Blame (α = .69). Respondents indicate the extent to which they have been engaging in the behavior described by each item using a Likert-type rating scale from 1 ("I haven't been doing this at all") to 4 ("I've been doing this a lot"). Higher scores for each subscale indicate increased coping of that form. For this study, five subscales (10 questions total) corresponding to constructs that have been shown to be relevant for acquired physical disability were administered: active coping, behavioral disengagement, planning, religion, and positive reframing.

Appraisal of Life Events (ALE) Scale. The ALE (Ferguson, Matthews, & Cox, 1999; Appendix C) is a 16-item scale that measures primary appraisals. It consists of 16 adjectives designed to reflect the characteristics of primary appraisals: threat, loss, and challenge. Participants are instructed to indicate the extent to which each of adjectives describes their perceptions of a recent stressful event. An exploratory factor analysis and confirmatory factor analysis were used in the development of the ALE (Ferguson et al., 1999). The three ALE subscales demonstrate good internal reliability (Threat α = .82; Loss α = .75; Challenge α = .87; Ferguson et al., 1999). Ferguson and colleagues (1999) established good test-retest reliability, finding that appraisals across a one-month follow-up (threat: r = .90; loss: r = .77; challenge: r =

.86) and across a three-month follow-up (threat: r = .49; loss: r = .48; challenge: r = .59) were correlated with original ALE scores. The ALE is associated with stressors, coping behaviors, and health measures in the directions that would be expected based on theory (Ferguson et al., 1999).

Multidimensional Scale of Perceived Social Support (MSPSS). The MSPSS (Zimet, Dahlem, Zimet, & Farley, 1988) is a 12-item questionnaire that measures perceived social support from friends, family, and significant others (Appendix D). The scale asks participants to indicate their degree of agreement with several statements on a 7-point Likert-type rating scale from 1 ("very strongly disagree") to 5 ("very strongly agree"). Three subscales correspond to ratings of social support from friends, family, and significant others. The scale demonstrates good construct validity and adequate internal consistency (α = .87-.88; Zimet et al., 1988). Higher scores indicate more social support.

Posttraumatic Growth Inventory-Short Form (PTGI-SF). The PTGI-SF (Cann et al., 2010) is a 10-item questionnaire that measures positive changes in individuals experiencing traumatic events. It is a shortened version of the PTGI (Tedeschi & Calhoun, 1996) and was developed with the intent of reducing participant burden. The shortened scale demonstrates good reliability (α = .89) and is highly correlated with the original scale (r = .96). The PTGI-SF can be broken down into the same five factors as the original PTGI: Relating to Others (α = .81), New Possibilities (α = .72), Personal Strength (α = .82), Spiritual Change (α = .84), and Appreciation of Life (α = .75). Despite good internal consistency of these subscales, Cann et al. (2010) warn that because they consist of only two items each, they may be unreliable and the shortened scale should only be used when a single total score for posttraumatic growth is needed.

Wechsler Test of Adult Reading (WTAR). The WTAR (Psychological Corporation, 2001) is a reading test used to measure pre-morbid intellectual functioning in individuals 16-89

years old, as reading ability is relatively stable even after injury. Administration of the WTAR involves asking the participant to read a list of 50 words with irregular pronunciation out loud. The total score is calculated by adding the number of words read correctly. WTAR scores have been shown to be highly correlated with measures of verbal IQ (r = .75), verbal comprehension (r = .74), and full scale IQ (r = .73; Spreen & Strauss, 2006).

Data Analysis Plan

All variables were examined for accuracy of data entry, missing values, univariate and multivariate outliers, normality, and multicollinearity. Additionally, means and standard deviations for the primary variables under scrutiny were calculated. Then, hierarchical linear modeling (HLM) was used to examine potential predictors of PTG across baseline and the 1-month, 3-month, 6-month, and 12-month follow ups. Unconditional growth (linear), quadratic, cubic, and quartic models were run first with no predictors to determine the most accurate model for curvature of PTG over time. After the most accurate curvature model was identified, predictors were entered simultaneously as fixed effects into each HLM after being centered, along with time, time*time, and time*time*time (due to the selection of cubic curvature of PTG over time). Five sets of analyses were run. Set 1 used HLM to determine whether cubic trajectories of PTG across the various time points could be predicted by the demographic and injury characteristics of time, time*time, and time*time*time, age, minority status, premorbid estimated IQ, time since injury, brain injury vs. SCI, and functional independence (FIM) scores.

Analysis Sets 2-4 each involved the same three steps in predicting trajectories of PTG. In Step 1, time, time*time, time*time*time and all previously significant predictors from the Set 1 analyses were entered as predictors. In Step 2, coping strategies (Analysis Set 2), cognitive appraisals (Set 3), and social support (Set 4) were entered as predictors in order to examine

whether these variables predicted cubic PTG trajectories over time, after controlling for demographic and injury characteristics. The final HLM included the previously significant Step 1 predictors, any significant Step 2 predictors, time, time*time, time*time*time, and the interaction terms between time*time*time and the significant Step 2 predictors.

Results

Normality

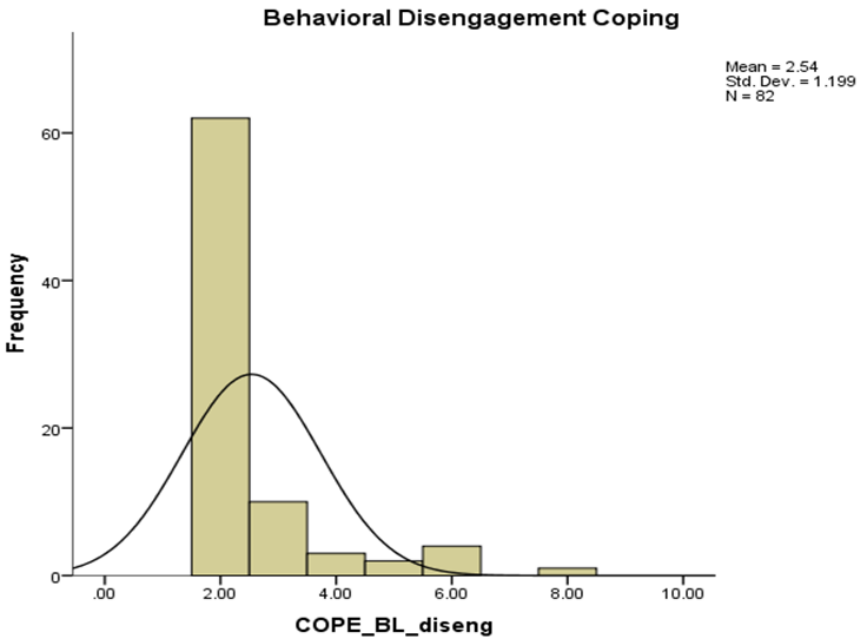
The data were generally normal, with a few exceptions (see Table 2 for skewness and kurtosis coefficients, as well as means and standard deviations).

Table 2. *Means, standard deviations, skewness and kurtosis.*

	Mean	SD	Skewness	SE of Skewness	Kurtosis	SE of Kurtosis
Age at Baseline	52.01	17.08	-.52	.26	-.87	.52
Predicted FSIQ	97.40	10.36	-.37	.27	-.54	.53
Time (Days) Since Injury at Baseline	138.18	86.28	1.78	.26	3.99	.52
FIM Total Score at Baseline	97.42	21.11	-.99	.27	-.14	.53
Reframing Coping	6.30	1.66	-.65	.27	-.69	.53
Active Coping	6.74	1.51	-1.24	.27	1.08	.53
Religious Coping	5.16	2.35	-.14	.27	-1.49	.53
Disengagement Coping	2.54	1.20	2.64	.27	6.93	.53
Planning Coping	6.90	1.50	-1.57	.27	2.12	.53
Family Social Support	22.95	5.23	-1.46	.26	2.36	.52
Friends Social Support	20.77	6.43	-.94	.26	.34	.52
Significant Other Social Support	22.70	6.03	-1.44	.26	1.48	.52
Threat Appraisals	5.83	6.68	1.44	.27	1.45	.53
Challenge Appraisals	16.63	7.21	-.43	.27	-.62	.53
Loss Appraisals	5.40	5.19	.98	.27	.21	.53
PTGI at Baseline	28.91	13.54	-.36	.28	-1.00	.55
PTGI at 1 MO	30.88	13.80	-.55	.29	-.62	.58
PTGI at 3 MO	31.68	13.60	-.69	.29	-.64	.57
PTGI at 6 MO	30.25	14.01	-.52	.31	-.95	.61
PTGI at 12 MO	31.65	13.80	-.64	.30	-.63	.59

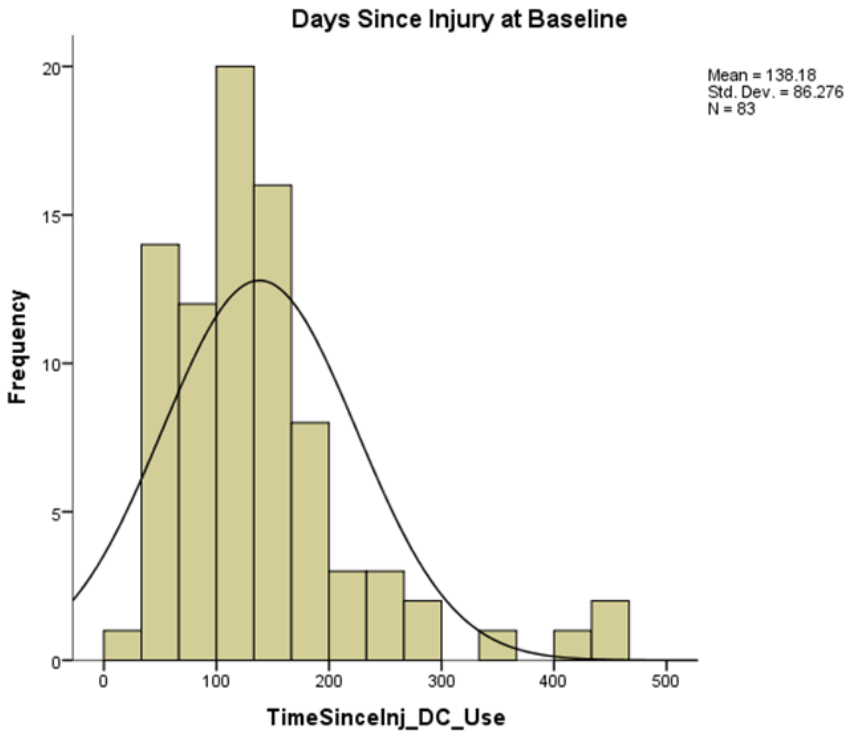
The behavioral disengagement subscale of the COPE was both skewed and kurtotic (see Figure 1), as a result of most participants endorsing the lowest possible score for this subscale (1 on each item in the scale, indicating a response of "I do not engage in this behavior").

Figure 1. Distribution of the behavioral disengagement subscale of the COPE.



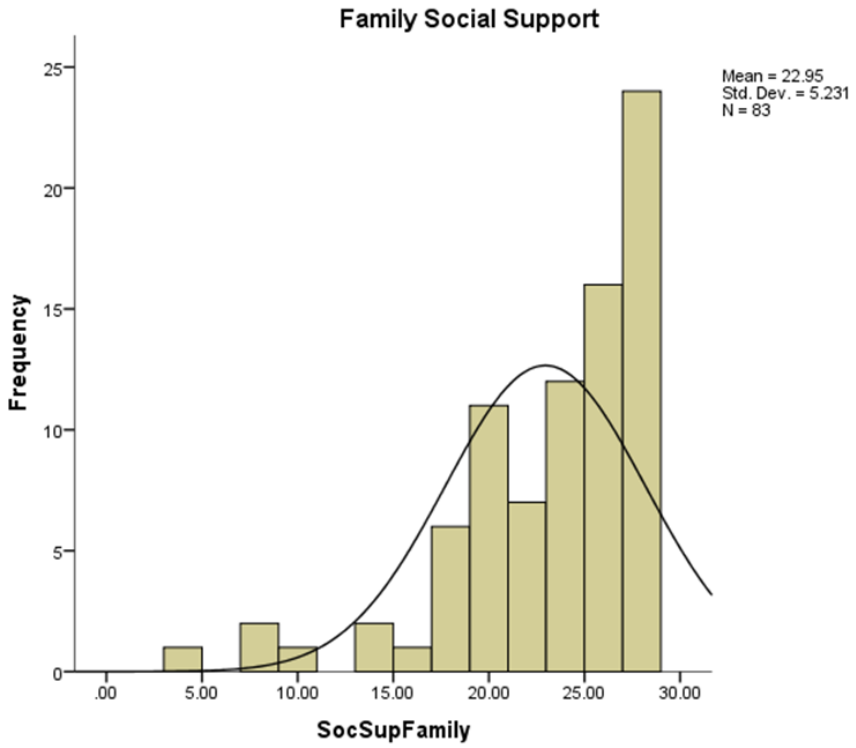
As a result, there were no transformations that would correct the skewness and kurtosis of this scale, and the original values were retained. Time since injury was kurtotic (see Figure 2).

Figure 2. Distribution of time since injury.



However, because all values for this variable were within the inclusion criteria for the study (18 months) and this variable was not skewed, the distribution of the data was retained and not transformed. Myers et al. (2017) argue that transformations should be used judiciously and typically reserved for variables with extreme departures from normality. The family subscale of the MSPSS was also slightly kurtotic (see Figure 3).

Figure 3. Distribution of family social support.



Because this was a minor violation and the variable was not significantly skewed, again no transformation was used.

Little's missing completely at random (MCAR) test (chi-square = 339.55, DF = 324, p = .265) indicated that data were completely missing at random, suggesting the suitability of using full information maximum likelihood estimation (FIML) for missing data. Prior to FIML, 9.6% of participants were missing data for the PTGI-SF at baseline, 19.3% at 1-month follow up, 18.1% at 3-month follow up, 27.7% at 6-month follow up, and 24.1% at 12-month follow-up.

Correlation Matrices

Correlation matrices were calculated to show the bivariate relationships among the variables (Tables 3 and 4).

Table 3. *Bivariate correlations between predictors and PTG.*

Variables	PTGI_BL	PTGI_1M	PTGI_3M	PTGI_6M	PTGI_12M
PTGI_1M	.750**	---			
PTGI_3M	.767**	.826**	---		
PTGI_6M	.932**	.798**	.824**	---	
PTGI_12M	.891**	.867**	.806**	.917**	---
Age at discharge	.12	.14	.10	.09	.22
Estimated IQ	-.19	-.20	-.307*	-.22	-.22
Time Since Injury	-.08	.03	.11	-.10	.04
SCI vs. Brain Injury	-.06	-.02	-.03	.04	-.05
FIM Scores	.03	-.03	-.07	.11	.03
Reframing Coping	.417**	.451**	.329**	.23	.375**
Active Coping	.06	.14	.08	.05	.08
Religious Coping	.472**	.506**	.484**	.384**	.478**
Disengagement Coping	.01	-.03	-.03	-.01	-.03
Planning Coping	.13	.20	.20	.10	.11
Threat Appraisal	.03	-.10	.04	.06	-.07
Challenge Appraisal	.323**	.372**	.295*	.293*	.263*
Loss Appraisal	-.10	-.19	-.15	-.08	-.25
Social Support-Family	.18	.17	.277*	.262*	.19
Social Support-Friends	.15	.06	.19	.20	.13
Social Support-Significant Other	.21	.21	.269*	.14	.14

Note. ** = Correlation was significant at the 0.01 level (2-tailed); * = Correlation is significant at the 0.05 level (2-tailed).

Table 4. *Bivariate correlations among predictors.*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	--														
2. IQ	-.21	--													
3. Time Since Injury	.11	-.09	--												
4. SCI v. brain injury	-.59**	.10	-.15	--											
5. FIM scores	-.33**	-.02	-.49**	.45**	--										
6. Reframing	.06	-.13	.01	.18	.16	--									
7. Active coping	-.04	.16	.10	.11	-.03	.45**	--								
8. Religious coping	.32**	-.21	.00	-.09	-.06	.35**	.24*	--							
9. Disengage-ment	.18	.06	-.14	-.08	-.11	-.21	-.36**	-.04	--						
10. Planning	.08	.03	.15	.02	-.06	.41**	.74**	.22*	-.52**	--					
11. Threat Appraisal	.16	-.12	.13	-.06	-.14	-.09	-.09	.02	.30**	-.06	--				
12. Challenge Appraisal	.11	-.08	-.02	-.19	-.04	.22*	.35**	.29**	-.18	.36**	-.03				
13. Loss appraisal	.10	.15	.14	-.07	-.17	-.19	-.15	-.17	.36**	-.17	.67**	-.14			
14. Social support- family	-.18	-.14	.09	.19	-.03	.21	.32**	.19	-.04	.29**	.05	.12	-.02		
15. Social support- friends	-.18	.13	.02	.21	.03	.13	.38**	.15	-.12	.29**	.10	.06	-.09	.65**	
16. Social support- significant other	-.03	-.19	.14	.09	-.14	.16	.08	.30**	.11	.14	.03	.18	.09	.69**	.47**

Note: ** = Correlation was significant at the 0.01 level (2-tailed); * = Correlation is significant at the 0.05 level (2-tailed).

Hierarchical Linear Model

A null, or unconditional, model was run to assess whether or not the data had hierarchical structure. The unconditional model yielded a statistically significant estimated participant variance of 145.07 (Wald Z = 30.97, $p < .001$), as well as a statistically significant estimated residual variance of 35.40 (Wald Z = 11.20, $p < .001$). The intraclass correlation coefficient was calculated to be .80, indicating that approximately 80% of the total variance of PTG scores was associated with the participant grouping and that the assumption of independence was violated. This suggests there was sufficiently large clustering of PTG score variance within participants to proceed with HLM.

The unconditional model was then run again with quadratic, cubic, and quartic time in order to determine the shape of the best fitting curve of PTG across time (Table 5).

Table 5. *Model fit for PTG over time.*

Model	-2 Log Likelihood
Unconditional Growth Model	2361.87
Quadratic	2360.69
Cubic	2351.45*
Quartic	2351.22

Note. * = Critical χ^2 value > 3.841.

An HLM examined whether cubic trajectories of PTG across baseline, 1-month, 3-month, 6-month, and 12-month follow ups could be predicted by: time, time*time, time*time*time, premorbid estimated intellectual functioning, age, minority status, time since injury, injury etiology (SCI vs. brain injury), and FIM scores. Predictors were entered simultaneously as fixed effects into the HLM after being centered. PTGI scores at each of the five time points were entered as the dependent variable. All statistically significant and non-significant fixed effects from the first HLM and their b-weights, *p*-values, and 95% confidence intervals appear in Table 6.

Table 6. *HLM 1: Demographic predictors of PTG trajectories across baseline, 1, 3, 6 and 12 month follow ups*

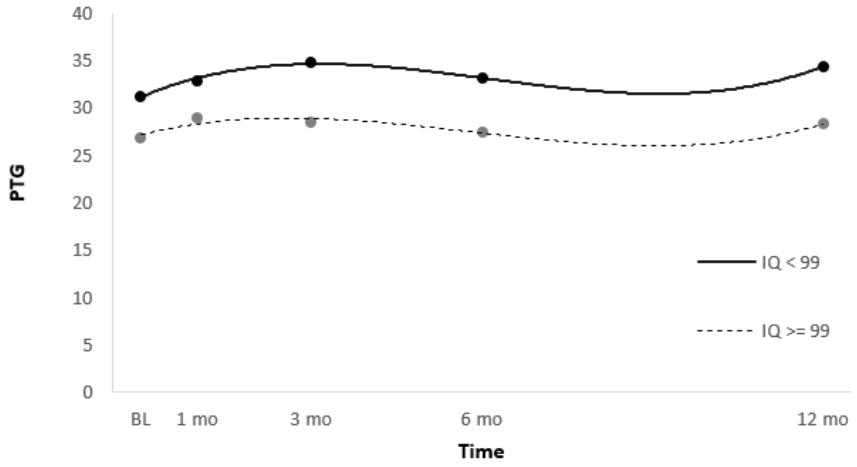
Predictor Variable	b-weight	Std. Error	df	*t*	*p*-value	95% Confidence Interval	
						Upper	Lower
Intercept	26.59	2.02	89.05	13.18	***.000	22.58	30.60
Time	2.26	.77	241.05	2.96	**.003	.76	3.77
Time*Time	-.54	.19	240.46	-2.84	**.005	-.91	-.16
Time*Time*Time	.03	.01	240.30	2.77	**.006	.01	.05
Estimated IQ	-.32	.13	79.49	-2.41	*.018	-.59	-.06
Age	.22	.10	79.11	2.15	*.030	.02	.42
Time Since Injury	.00	.02	78.29	-.16	.871	-.04	.03
FIM Score	.03	.08	78.40	.32	.751	-.14	.19

Minority Status	3.34	2.78	78.74	1.20	.232	-2.18	8.87
SCI v. Brain Injury	4.99	4.09	77.24	1.22	.226	-3.15	13.12

Note. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

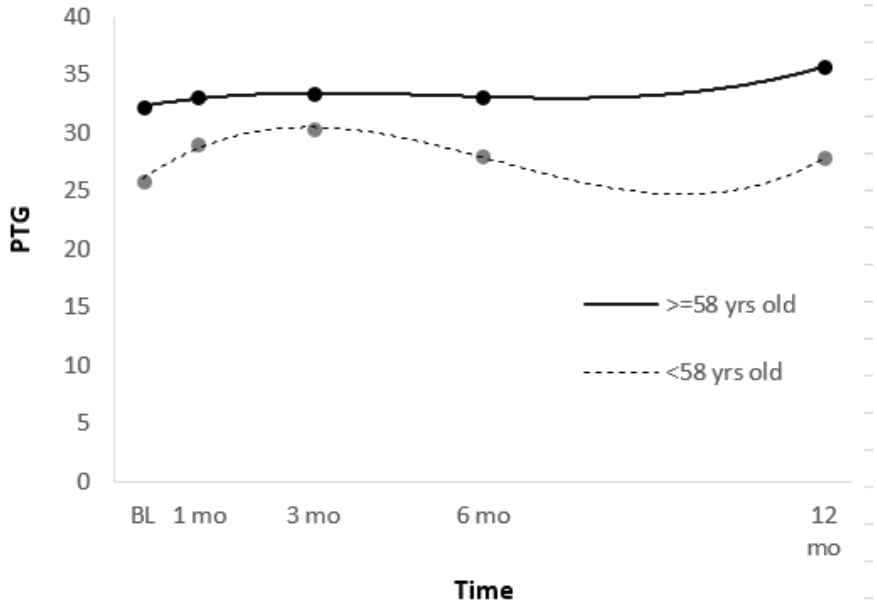
PTG showed a significant cubic trend over time, and premorbid estimated IQ and age yielded statistically significant effects on participants' PTG scores across time. Those with lower intellectual functioning experienced greater PTG (Figure 4).

Figure 4. Main effect of estimated IQ on PTG.



Older individuals had higher PTG than younger individuals (Figure 5), and there were no significant effects of time since injury, injury etiology, minority status, or FIM scores on PTG.

Figure 5. Main effect of age on PTG.



A second HLM examined whether linear trajectories of PTG across baseline, 1-month, 3-month, 6-month, and 12-month and follow ups could be predicted by coping styles after controlling for time, time*time, time*time*time, premorbid estimated IQ, and age. Predictors were entered simultaneously as fixed effects into the HLM after being centered. PTGI scores at each of the five time points were entered as the dependent variable. All statistically significant and non-significant fixed effects from the HLM and their b-weights, *p*-values, and 95% confidence intervals appear in Table 7.

Table 7. *HLM 2: Coping effects on PTG trajectories across baseline, 1, 3, 6 and 12 month follow ups*

Predictor Variable	b-weight	Std. Error	Df	*t*	*p*-value	95% Confidence Interval	
						Upper	Lower
Intercept	29.04	1.23	122.53	23.63	***.000	26.60	31.47
Time	2.44	.76	251.31	3.19	**.002	.93	3.94
Time*Time	-.57	.19	250.64	-3.00	**.003	-.94	-.19
Time*Time*Time	.03	.01	250.45	2.89	**.004	.01	.05
Estimated IQ	-.18	.12	81.67	-1.50	.137	-.42	.06

Age	-.04	.07	80.34	-.50	.617	-.18	.11
Reframing	2.24	.79	82.20	2.83	**.006	.66	3.81
Active	-1.84	1.19	81.84	-1.55	.125	-4.20	.52
Religious	2.38	.54	80.72	4.40	***.000	1.30	3.46
Disengagement	1.30	1.14	82.36	1.13	.260	-.98	3.57
Planning	1.79	1.25	81.53	1.44	.155	-.69	4.27

Note. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

Reframing coping (Figure 6) and religious coping (Figure 7) yielded statistically significant positive effects on participants' PTG scores over time, although no other forms of coping predicted PTG scores across time.

Figure 6. Main effect of reframing coping on PTG.

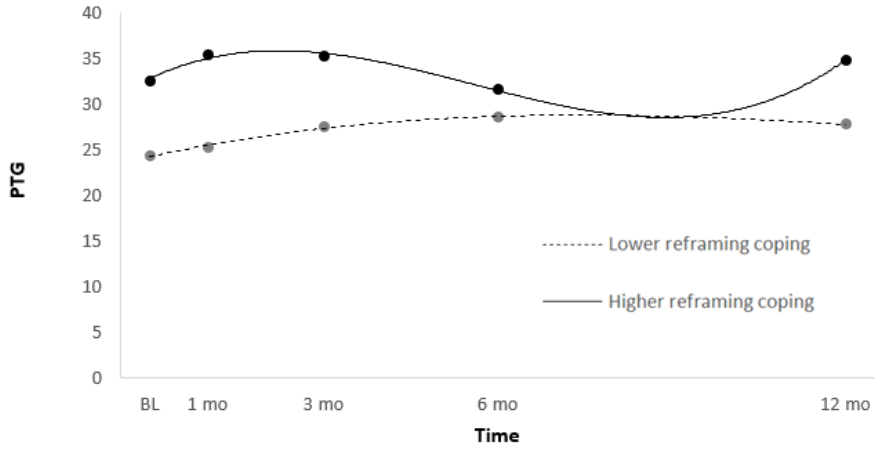
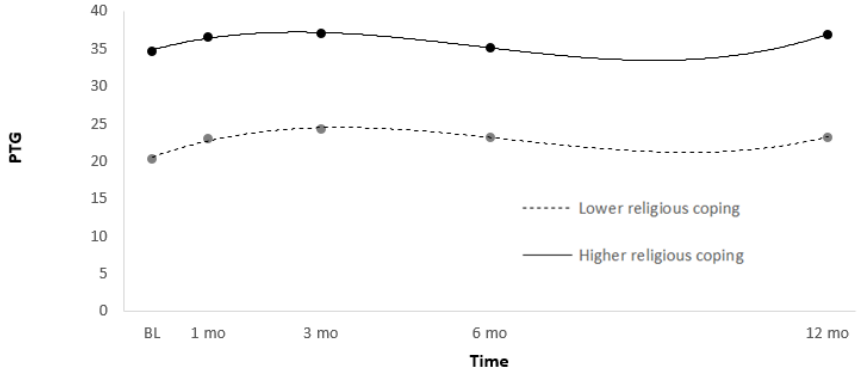


Figure 7. Main effect of religious coping on PTG.



A third HLM examined whether linear trajectories of PTG across baseline, 1-month, 3-month, 6-month, and 12-month follow ups could be predicted by cognitive appraisals after controlling for time, time*time, time*time*time, premorbid estimated IQ, and age. Predictors were entered simultaneously as fixed effects into the HLM after being centered. PTGI scores at each of the five time points were entered as the dependent variable. All statistically significant and non-significant fixed effects from the HLM and their b-weights, p-values, and 95% confidence intervals appear in Table 8.

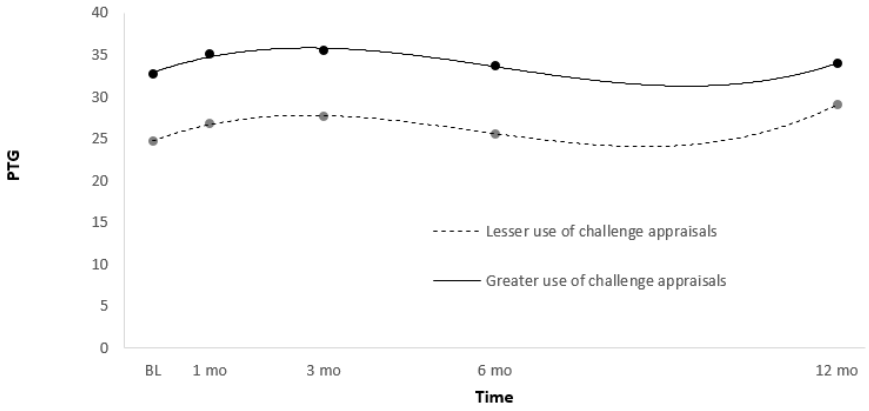
Table 8. *HLM 3: Appraisal predictors of PTG trajectories across baseline, 1, 3, 6 and 12 month follow ups.*

Predictor Variable	b-weight	Std. Error	df	*t*	*p*-value	95% Confidence Interval	
						Upper	Lower
Intercept	29.09	1.38	111.29	21.14	**.000	26.36	31.81
Time	2.44	.76	249.91	3.20	**.002	.94	3.95
Time*Time	-.57	.19	249.28	-3.02	**.003	-.94	-.20
Time*Time*Time	.03	.01	249.11	2.91	**.004	.01	.05
Estimated IQ	-.23	.13	81.60	-1.70	.093	-.49	.04
Age	.08	.08	80.44	1.04	.303	-.07	.23
Threat Appraisals	.19	.27	81.64	.70	.486	-.34	.72
Challenge Appraisals	.54	.18	80.17	2.98	**.004	.18	.91
Loss Appraisals	-.38	.35	81.32	-1.09	.278	-1.08	.31

Note. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

Participants who used more challenge appraisals experienced higher levels of PTG (Figure 8). Threat and loss appraisals did not predict PTG scores across time.

Figure 8. Main effect of challenge appraisals on PTG.



A fourth HLM examined whether linear trajectories of PTG across baseline, 1-month, 3-month, 6-month, and 12-month follow ups could be predicted by social support after controlling for time, time*time, time*time*time, premorbid estimated IQ, and age. Predictors were entered simultaneously as fixed effects into the HLM after being centered. PTGI scores at each of the five time points were entered as the dependent variable. All statistically significant and non-significant fixed effects from the HLM and their b-weights, *p*-values, and 95% confidence intervals appear in Table 9. None of the types of social support predicted PTG over time.

Table 9. *HLM 4: Social Support predictors of PTG trajectories across baseline, 1, 3, 6 and 12 month follow ups*

Predictor Variable	b-weight	Std. Error	df	*t*	*p*-value	95% Confidence Interval	
						Upper	Lower
Intercept	29.21	1.42	109.13	20.62	***.000	26.41	32.02
Time	2.44	.76	249.80	3.20	**.002	.94	3.95
Time*Time	-.57	.19	249.17	-3.00	**.003	-.94	-.20
Time*Time*Time	.03	.01	249.00	2.90	**.004	.01	.05
Estimated IQ	-0.26	.14	81.68	-1.90	.061	-.54	.01
Age	.13	.08	80.17	1.67	.098	-.03	.30
Social Support- Family	.25	.41	80.33	.60	.550	-.57	1.07
Social Support- Friends	.22	.28	80.24	.79	.432	-.34	.78

Social Support-Significant Other	.15	.30	81.45	.50	.618	-.45	.75

Note. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

In order to examine whether any of the statistically significant fixed effects in the HLMs interacted with cubic time in the prediction of participants' PTG trajectories, a fifth HLM was run (Table 10). In this model, the fixed effects were participants' premorbid estimated IQ, age, reframing coping, religious coping, and challenge appraisals, along with time, time*time, time*time*time and the interaction terms between time*time*time and each of these variables. None of the interaction terms were statistically significant, suggesting that the slopes of participants' PTG trajectories did not differ over time as a function of IQ, age, coping styles, or use of challenge appraisals.

Table 10. *HLM 5: Previously significant predictors of PTG trajectories across baseline, 1, 3, 6 and 12 month follow ups*

Predictor Variable	b-weight	Std. Error	Df	*t*	*p*-value	95% Confidence Interval	
						Upper	Lower
Intercept	29.11	1.22	122.84	23.83	***.000	26.69	31.52
Time	2.44	.76	252.05	3.22	**.001	.95	3.93
Time*Time	-.57	.19	251.30	-3.04	*.003	-.94	-.20
Time*Time*Time	.03	.01	251.10	2.94	*.004	.01	.05
Estimated IQ	-.20	.11	87.34	-1.75	.083	-.42	.03
Age	-.01	.07	85.42	-.15	.883	-.15	.13
Reframing Coping	1.68	.73	86.37	2.30	*.024	.23	3.14
Religious Coping	2.05	.55	85.43	3.73	***.000	.96	3.15
Challenge Appraisals	.33	.17	85.77	1.99	*.050	.00	.66
Estimated IQ* Time*Time*Time	.00	.00	256.21	1.00	.317	.00	.00
Age*Time*Time*Time	.00	.00	255.46	.86	.392	.00	.00
Reframing *Time*Time*Time	.00	.00	254.16	.63	.531	.00	.00
Religious *Time* Time*Time	.00	.00	256.17	.54	.590	.00	.00
Challenge Appraisals*Time*Time*Time	.00	.00	253.35	-.92	.360	.00	.00

Note. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

Discussion

The purpose of this study was to examine potential predictors of PTG across time in Veterans with acquired physical disabilities. Specifically, this study aimed to understand how various demographic and injury characteristics, coping styles, appraisals of injury, and social support might predict trajectories of PTG from discharge from inpatient rehabilitation through 12 months after baseline. Initial curvature analyses suggested that a cubic polynomial trend best fit the movement of PTG over time, generally conforming to an initial increase, decrease, and then plateau or slight increase. Four HLMs were run to examine whether demographic and injury characteristics, coping styles, appraisals of injury, and social support predicted the height of this cubic architecture of PTG across baseline, 1, 3, 6, and 12-month follow ups, and a final HLM examined whether any statistically significant fixed effects in the first four HLMs interacted with time in the prediction of participants' PTG trajectories. Estimated premorbid IQ was negatively associated, while age was positively associated with the height of PTG over time. Reframing and religious coping were positively associated with PTG over time, as were challenge appraisals. Three types of social support did not independently predict PTG trajectories, although bivariate correlations suggested the presence of isolated relationships between different types of social support and PTG at certain time points. None of the significant predictors interacted with time in predicting participants' PTG trajectories.

The sample overall had an approximately average IQ score, as would be expected. Participants' FIM scores suggested that the sample largely required "modified dependence." The mean FIM score was above that of rehabilitation populations in France (Ravaud, Delcey, & Yelnik, 1999) and the U.S. (Granger, & Hamilton, 1992, 1993) at the time of admission to a

rehabilitation facility, as well as above scores for individuals with SCI at 20 weeks post-injury (Kennedy et al., 2003) and 12 weeks post-SCI (Kennedy et al., 2012).

Participants tended to use a "medium amount" of reframing, active, and planning coping, and a "little bit" to "medium amount" of religious coping, while their scores for disengagement coping suggested that they usually do not use that form of coping or only use it a "little bit." Past studies examining coping strategies in rehabilitation populations have found similar levels of responses for these types of coping styles (Kennedy et al., 2010, 2012).

Scores from the MSPSS suggest high levels of social support across family, friends, and significant others for participants in this study, comparable to MSPSS scores in cancer survivors (Cormio et al., 2013), individuals with SCI (Tramonti, Gerini, & Stampacchia, 2015), and patients with mild and moderate to severe TBI following hospital admission for these injuries (Malec, Testa, Rush, Brown, & Moessner, 2007), but lower than those found in a sample of patients with new lower limb amputations (Williams, Ehde, Smith, Czerniecki, Hoffman, & Robinson, 2004).

Participants in the current study endorsed low use of threat and loss appraisals. In fact, they endorsed using these types of appraisals less than individuals with SCI in previous studies (Kennedy et al., 2010, 2012). Participants in the current study endorsed moderate use of challenge appraisals at a somewhat higher rate than found in previous studies (Kennedy et al., 2010, 2012). The lower use of loss and threat appraisals and higher use of challenge appraisals could be reflective of "mental toughness" that is taught to military service members. For instance, various service branches have creeds that encourage service members to avoid demonstrating vulnerability, such as the Soldier's Creed which states "I am … physically and mentally tough." Burnam et al. (2008) discuss how service members must develop a culture of

"toughness, independence, not needing help, not being weak, and expecting to be able to master any and every stress without problems" (p.276) and may have trouble acknowledging a problem even to themselves, let alone to others. This may be reflected in appraising situations more often as challenges than threats or losses, compared to other populations.

Participants endorsed PTG to a "moderate degree" across all time points. One past study examining PTG in U.S. Veterans found that half the sample endorsed PTG to at least a moderate degree, although the mean PTG scores in that study were lower than those found in the current study (Tsai et al., 2015a). A study that examined PTG in Danish military Veterans after deployment found similar scores to those found by Tsai and colleagues (2015a). Mean PTG scores across many other samples (women with breast cancer, medical illness, SCI, etc.) also tended to be lower than those found in the current study (Calhoun, Cann, Tedeschi, & McMillan, 2000; Cordova, Cunningham, Carlson, & Andrykowski, 2001; Pollard & Kennedy, 2007; Min et al., 2014; Maercker & Langner, 2001; Marotta-Walters, Choi, & Shaine, 2015; Tedeschi & Calhoun, 1996). It is possible that Veterans in the current study endorsed higher levels of PTG due to the same culture of strength and growth through traumatic life events in the U.S. Veteran population outlined above, at least in comparison to non-Veteran samples.

Hypothesis 1

It was hypothesized that younger age, White race vs. racial/ethnic minority status, and lower premorbid estimated IQ would be associated with greater PTG over time. Although age has been negatively associated with PTG in past studies (Danhauer et al., 2015; January et al., 2015; Kalpakjian et al., 2014), and younger age at injury has been associated with improved functioning following injury (Dahm & Ponsford, 2015), PTG was higher over time in older participants in the current study. Many of these past studies had similar age ranges to the current

study (20-84 years), with the range being 25 to 96 years old in the study by Danhauer and colleagues (2015) and 18 to 83 years old in that by Kalpakijian and colleagues (2014). One potential explanation for the current finding may be the positivity bias that has been documented in older adults compared to younger adults and suggests that as people age, they work to optimize positive affect (Mather & Carstensen, 2005). In line with the positivity bias, it is possible that older Veterans focused more on potential positive outcomes of their injury compared to younger Veterans. Another possible explanation for the current findings are that older adults may have developed better coping skills. In fact, past research has suggested that older adults have greater emotion regulation compared to younger adults (Gross et al., 1997).

As predicted, premorbid estimated IQ was negatively associated with PTG, such that PTG was higher across time in individuals with lower IQ. There is a dearth of research examining IQ and posttraumatic growth, but one study suggested that verbal skills and reading may assist in the construction of existential questions after a traumatic event and may therefore be positively associated with posttraumatic growth (Russell, White, & White, 2006), opposite of the current study's findings. Nonetheless, much of the literature has found that lower education was a significant predictor of PTG (Kalpakjian et al., 2014; Teixeira, Grac, & Pereira, 2013; Tsai et al., 2015b; Widows et al., 2005). One possible explanation for the current finding that lower estimated IQ predicted increased PTG could be that an optimal level of distress is necessary for the development of PTG (Tsai et al., 2015a). Those individuals with lower IQ may have been in more physically demanding or "blue collar" jobs that may no longer be an option. This could cause distress, which may lead to the development of PTG. Alternatively, individuals with higher IQs (and therefore higher levels of professional or social functioning) may feel they have lost more after acquiring a physical disability, which could possibly produce too much distress for

the development of PTG, at least in comparison to individuals with lower IQs. However, it should be noted that these speculations are very tentative, so future research should further investigate the effects of IQ or other similar variables on PTG after injury.

No other demographic factors examined in this study were predictive of PTG. Some past studies found that White race was positively associated with PTG (Tsai et al., 2015b), while others suggested non-White individuals were more likely to experience moderate to high levels of PTG (Danhauer et al., 2015). The current finding that minority status was unrelated to PTG is therefore not surprising, given inconsistencies across past studies.

PTG did not increase linearly over the 12-month data collection interval, but it did show an S-shaped curvature, as a cubic polynomial trend best fit the movement of PTG over time, generally conforming to an initial increase, decrease, and then plateau or slight increase. This may be reflective of initial optimism or enthusiasm at early gains following rehabilitation, which by the 6-month follow up may have dissipated somewhat as a fuller realization of impairment levels set in. There appears to be a slight increase at the 12-month follow up, but this was not statistically significant and may instead be an artifact of graphing the cubic trend.

There were no significant differences in PTG by injury etiology, and functional independence did not predict PTG. Although McGrath and Linley (2006) found that time since injury was positively associated with PTG, this direct association was not found in the current study. While it is possible that time since injury and etiology truly were not predictive of PTG, it is also possible that no association was found due to the study being underpowered. A general rule of thumb for HLMs is to have at least 10 participants per predictor (VanVoorhis & Morgan, 2007) and the HLM examining demographic and injury characteristics had 9 predictors (time, time*time, time*time*time, age, IQ, minority status, time since injury, etiology, and FIM score)

but only 83 participants. Despite this cautionary note, the HLMs were able to find many other statistical effects, so the effects of these non-significant demographic and injury-related predictors would be no larger than those that did come out as significant in the current study.

Hypothesis 2

It was predicted that active coping, planning, positive reframing, and religious coping would predict greater PTG over time, while disengagement coping would predict lower PTG. However, of the five coping styles examined in the current study, only positive reframing and religious coping were associated with PTG over time, and the use of these forms of coping predicted higher levels of PTG across time. These findings are in line with previous studies that found the use of positive reinterpretation and religious coping to be associated with PTG (Linley & Joseph, 2004; Park et al., 1996; Sears et al., 2003; Zoellner & Maercker, 2006). However, while active coping was associated with the healthiest adjustment to brain injury in past studies (Curran et al., 2000; Finset & Anderson, 2000), and both active coping and planning have been found to be negatively associated with depression for individuals with SCI (Kennedy et al., 2016), these forms of coping were not associated with PTG in the current study. Planning has not been specifically linked to PTG, but similar constructs such as problem-focused coping have been found to be positively associated with PTG (Linley & Joseph, 2004; Zoellner & Maercker, 2006), and Danhauer and colleagues (2015) found that women who demonstrated an increase in PTG over time reported greater use of active-adaptive coping at baseline. Perhaps no association was found in the current study for active or planning coping because although certain aspects of post-SCI and -brain injury functioning can be malleable through rehabilitation, there are many aspects of both types of injury that are not, particularly after acute rehabilitation has ended. As a result, increased use of active coping (taking actions to improve a situation) or planning coping

(identifying a concrete strategy of actions to take) may actually be maladaptive after injury, when perhaps positive reframing or religious coping may be more effective because individuals can adjust their attitude about their injury, something that actually is malleable. Although it was predicted that behavioral disengagement coping would be negatively associated with PTG over time, no association was found. Again, behavioral disengagement has not been directly linked to PTG in the past. In fact, Hanks and colleagues (2016) found that it was not correlated with resilience in the first five years following brain injury. Therefore, it makes sense that it would not be related to PTG, a similar construct.

Hypothesis 3

As predicted, greater use of challenge appraisals was associated with higher PTG over time, in line with previous findings (Yeung, et al., 2015). It makes conceptual sense that challenge appraisals, which are defined as evaluating the situation as a potential for growth, would be positively associated with PTG. Prior research has suggested that individuals may recast a traumatic life event as a challenge as a way of looking for the "silver lining" (Fontana & Rosenheck, 1998). Research has noted that individuals may use challenge appraisals in order to regain a sense of control and mastery over their lives following a traumatic event (Fontana & Rosenheck, 1998), so this type of cognitive appraisal style may be a central component to PTG as Veterans adapt psychologically to a new acquired physical disability.

Threat and loss appraisals were not independently associated with PTG over time. Unlike challenge appraisals, these negative cognitive appraisals are not conceptually similar to PTG, and so it is not surprising that they do not predict trajectories of PTG over time. An alternative potential reason for not finding an association between loss or threat appraisals and PTG may be due to there being multicollinearity between the loss and threat appraisals (correlated at $r = .67$),

which may have canceled out any effects they would each have had on PTG across time. However, neither was correlated with PTG cross-sectionally in the correlation matrix at any individual time point, so it is more likely that neither variable actually predicted PTG over time. As a result, it is likely that neither form of appraisal is a central catalyst of PTG after acquired physical disability.

Hypothesis 4

Although it was predicted that social support would be positively associated with PTG over time, none of the social support subscales were significant unique predictors. This is somewhat surprising, as past studies have found that "social connectedness" and the presence of "supportive others" are positively associated with PTG (Tedeschi & Calhoun, 2004; Tsai et al., 2015a). Yeung and colleagues (2015) found that one of the predictors of PTG in a diverse college sample was having one's need for relatedness met. Social support has been associated with several positive outcomes for individuals with SCI (Elliott et al., 1992), and seeking the company and support of one's social network has been found to be positively associated with resilience and positive adjustment to polytrauma (Hanks et al., 2016). Nonetheless, some research suggested that although social support satisfaction predicted PTG, social support itself was not associated with PTG (Linley & Joseph, 2004). Furthermore, the one study that examined the association of social support and PTG in a military sample had small effects, even with a sample of 3157 Veterans ($d \leq .10$; Tsai et al., 2015a).

One reason that none of the social support subscales were found to be significantly associated with PTG in the current study may be the way in which social support was measured. The MSPSS asks participants to rate their level of social support from friends, family, and a significant other, but these categories may not be appropriate for the current sample whose

sources of support may have not fit cleanly into these categories. For example, some Veterans in the current study maintained close relationships with former spouses who could potentially have been categorized into family, friends, or social support.

It is also important to note that although none of the subscales of the MSPSS independently predicted PTG trajectories, bivariate correlations suggested the presence of isolated relationships between different types of social support and PTG at certain time points. One reason why social support may not have predicted PTG in the fourth HLM is because the three subscales examined were all significantly correlated with one another (with one correlation at r = .65 and another at r =.69, both approaching the traditional .70 index for multicollinearity), and this may have canceled out any unique effects of social support on PTG over time, masking a true (but likely small) association that may have emerged if the total social support score was used.

HLM 5

The final HLM explored whether any of the statistically significant fixed effects in the first four HLMs interacted with cubic time in the prediction of participants' PTG trajectories. None of the interaction terms was statistically significant, suggesting that the slopes of participants' PTG trajectories did not differ over time as a function of IQ, age, coping styles, or use of challenge appraisals. In other words, while lower IQ, older age, greater use of positive reframing and religious coping, and greater challenge appraisals predicted higher levels of PTG over time, these associations were indicative of the magnitude of PTG in relation to the comparison groups and not the rate of the increase in PTG. The likely primary reason that no predictors had a differential effect on PTG over time (i.e., a significant interaction with time) is that PTG did not increase when considering the entire 12-month data-collection period. As a

result, there was no increase in PTG to actually predict. PTG does not necessarily imply continued improvement over time, but rather signifies that growth has occurred at some point between the time of the traumatic event and the time of measurement of PTG. If PTG scores from the first three months had been isolated, there may have been differential predictive linear effects over that briefer time period. However, re-running the HLM with only the first three months of PTG scores would be problematic because it would not truly reflect the movement of PTG over time.

Clinical Implications

The findings of the current study can be used to better understand and improve outcomes for Veterans with acquired physical disabilities. The findings suggest that Veterans who are older, have lower estimated premorbid IQ, use reframing coping, religious coping, and challenge appraisals may experience more PTG. Age and intellectual functioning are not modifiable, but learning more about why older age and lower premorbid estimated IQ are associated with greater PTG may allow clinicians to better serve Veterans following acquired physical disabilities. For example, clinical researchers may investigate why older Veterans and those with lower premorbid IQ demonstrate better PTG, as the findings could inform intervention research with Veterans who are younger or have higher premorbid IQ and demonstrate reduced PTG.

These findings can also be applied to the development or adaptation of early interventions following acquired physical disability in the context of intervention research, which may in turn lead to improved outcomes for these Veterans. Appraisals are modifiable and have been suggested as potential targets for intervention to improve Veteran outcomes (de Ridder & Schreurs, 2001; Dean & Kennedy, 2009). Kennedy, Lude, Elfstrom, and Smithson (2010) found that adjustment to SCI begins early during rehabilitation, and "initial appraisals are important to

how an individual will cope with their injury and to their psychological well-being" (p. 762). Interventions designed to increase PTG may involve helping Veterans to appraise an acquired physical disability as a challenge, rather than solely as a threat or loss, in order to improve adjustment. Similarly, interventions could help Veterans develop and use positive reframing coping, as well as religious coping for those who are religious.

Cognitive behavioral therapies have been shown to increase PTG in past studies (Lechner & Antoni, 2004; Roepke, 2015). For example, Lechner and Antoni (2004) found that a cognitive behavioral stress management intervention for women with cancer led to increased PTG over time, whereas a control group who did not receive the intervention did not have any increase in PTG. The intervention taught cognitive and behavioral strategies in a supportive group setting with modules designed to increase effective coping strategies, improve awareness of stress and provide skills to reduce it, and augment patients' social support networks. This particular intervention was in a group format, and Lechner and Antoni (2004) suggested that group interventions may be ideal for increasing PTG, as they provide access to supportive others during the process. Future interventions could also explore pairing Veterans who demonstrate higher levels of PTG with those who experience lower levels of PTG as another way of providing access to supportive others within this or other interventions. A similar intervention to Lechner and Antoni's cognitive behavioral stress management group intervention might be applied to Veterans with acquired physical disability in order to evaluate its effectiveness in increasing PTG over time for that population.

Another intervention that may be promising for increasing PTG in Veterans with acquired physical disabilities is Coping Effectiveness Training (CET; Chesney & Folkman, 1994). CET is a group intervention based on Lazarus and Folkman's (1984) stress and coping

model that normalizes stress reactions, introduces appraisal skills and adaptive coping strategies, discusses connections between thoughts, feelings, and behaviors, and teaches a strategy for selecting appropriate ways of coping. It has been found to increase use of positive coping skills and reduce symptoms of depression for patients with HIV (Chesney & Folkman, 1994). Moreover, individuals with SCI who received this intervention demonstrated significantly greater reductions in depression and anxiety compared to a control group who did not receive the intervention (King & Kennedy, 1999; Kennedy et al., 2003), although no change in coping strategies was noted for individuals with SCI. Kennedy et al. (2003) found that CET resulted in increased positive appraisals. Future studies might examine whether CET or similar interventions that target appraisals and coping increase PTG after an injury. Studies may also adapt or develop additional interventions to increase PTG after acquired physical disability and test the efficacy and effectiveness of such interventions.

Limitations and Future Directions

The present study has several limitations which suggest directions for future research. First, there was missing data at various time points for the outcome variable, PTG, although this concern was mitigated by using full information maximum likelihood estimation (FIML) to impute missing values. Future studies may aim for lower rates of missing data. In addition, there was a sampling limitation. A general rule of thumb for power analyses is to have at least 10 participants per predictor (VanVoorhis & Morgan, 2007). While most of the HLMs in the study had adequate power, a larger sample could have been important for HLM 5. Future studies should use larger samples to run these analyses with at least 10 participants per predictor. However, because PTG was collected across 5 time points and FIML was used to impute missing values for participants who were missing data at various follow ups, the current methodology

and analytic strategy represented the best possible options for the study's sample size. Also, there were too few women (only 3) to compare the effect of gender on PTG. However, the sample was representative of those who present to VA Hospitals for these types of injuries.

An additional limitation was that the current study did not examine potential cohort differences that may have existed and could have accounted for some of the age differences observed. For example, there could be systematic differences in education levels, marital status, or other characteristics by cohort. Future studies may examine these potential cohort effects.

The current study only looked at PTG globally, rather than examining the subscales of PTG (i.e. Relating to Others, New Possibilities, Personal Strength, Spiritual Change, and Appreciation of Life), due to Cann et al.'s (2010) suggestion that the subscales of the PTGI-SF may be unreliable as there are only two items per subscale. Future studies might use the full PTGI rather than the short-form to enable researchers to examine how various predictors are associated with specific facets of PTG. There may also be risk of response bias for the PTGI-SF, as participants may have felt pressure to appear to be doing well in response to their injuries, particularly because they were verbally responding to items in the presence of the interviewer. Future studies might better control for response bias by having respondents complete surveys coded only with their study IDs to make the process more anonymous. But because many of the participants in this study had mobility impairments (e.g., those with tetraplegia), the oral administration approach used in the current study may have been the most feasible.

Just as Cann et al. (2010) warned that the two-item subscales of the PTGI-SF may be unreliable, so too may be subscales of the Brief COPE, which also consist of just two items each. As a result, the Brief COPE subscales may have substantial error variance and limit their ability to accurately measure different types of coping strategies. Another potential measurement issue

with the Brief COPE is that the study used the dispositional version of the scale, asking participants how they generally respond to stress rather than focusing explicitly on the injury. Similarly, the ALE asked participants "to rate your perceptions of your current circumstances. That is your perception of your environment right now." Future studies may consider having participants respond to these scales (or more reliable and comprehensive ones) specifically in relation to their injury.

There may be other types of social support that the MSPSS did not measure, and future studies may consider using other measures or assessing social support in a different way to see if different findings (i.e. a significant association between social support and PTG) may emerge. Future studies may also use a different measure of injury severity rather the FIM, as there are no cutoff scores or specifiers to characterize the injury when using the FIM total score or the cognitive and motor subscales. Other researchers have noted this limitation of the FIM, stating that "the total score does not describe a sole entity and does not measure any defined phenomenon" (Ravaud, Delcey, & Yelnik, 1999, p. 38). Perhaps use of a more sophisticated or nuanced measure of functioning would have resulted in its predictive ability of PTG for Veterans with acquired physical disabilities.

Another limitation to this study is the timing of measurement occasions. The current study examined trajectories of PTG up to 12 months. However, future studies might extend this time range beyond one year, as some past studies (Danhauer et al., 2015; McGrath & Linley, 2006) have shown that PTG continues to evolve beyond the first year after injury. A related measurement timing limitation was that some of the original participants completed a baseline session and discharge session in addition to the one, three, six, and twelve month follow ups. However, later participants completed only a baseline session timed just before their discharge

date, as the time between baseline and discharge was sometimes only a span of days. For analyses, the data that were used for baseline were those which were collected immediately before discharge, whether that was officially a baseline session or discharge session. The reason that immediately before discharge was chosen for the baseline is because at that time, participants would have reached a limit on what they would be able to accomplish in inpatient rehabilitation, making discharge a somewhat consistent starting point. Future studies should more cleanly standardize the first data collection.

The HLMs could not easily account for different curvatures at different levels of a predictor. For example, looking at Figure 6, it appears that Veterans with high use of reframing coping may follow a cubic trajectory of PTG, while those with lower use of reframing coping may experience a more linear or quadratic trajectory of PTG across time. Future studies may investigate whether or not additional analyses can predict differential trajectories of PTG at different levels of each predictor. Another limitation is that there is a lot of item overlap between some of the predictors and PTG, which could potentially inflate associations between the two. Therefore, researchers and clinicians should use caution in generalizing these findings to actual clinical intervention, and should instead use the results of this study for clinical intervention research.

A final limitation of the present study is that it did not examine what role, if any, distress may have in the development of PTG. Past studies have demonstrated that PTG does not preclude negative emotional outcomes or distress (McGrath & Linley, 2006), and some even suggest that distress is a necessary condition for the development of PTG (Danhauer et al., 2015; Tedeschi & Calhoun, 2004; Tsai et al., 2015a). However, other studies have not found any association between psychological distress and PTG (e.g., January et al., 2015). Future studies

would benefit from including measures of distress (e.g. depression, anxiety, PTSD) as a potential predictor of PTG.

Conclusions

The current study examined whether various demographic and injury characteristics, coping styles, cognitive appraisals, and social support predict trajectories of PTG over time in Veterans with acquired physical disability. A cubic trend was discovered, and it was found that older age, lower estimated premorbid IQ, positive reframing, religious coping, and challenge appraisals predicted higher levels of PTG across time. Although none of the social support subscales independently predicted PTG trajectories, bivariate correlations suggested the presence of isolated relationships between different types of social support and PTG at certain time points that may have been masked by multicollinearity between the social support subscales examined in this study. The slopes of participants' PTG trajectories did not differ over time as a function of IQ, age, coping styles, or use of challenge appraisals.

These findings point to ways in which clinical researchers can better understand PTG following acquired physical disability and investigate the honing of psychological interventions to more precisely target specific modifiable predictors of PTG. Researching the adaptation of interventions that target challenge appraisals or religious and positive reframing coping may have the potential to illuminate techniques that lead to improved outcomes for Veterans with acquired physical disabilities. Such honed interventions could include cognitive behavioral therapies, cognitive behavioral stress management, or Coping Effectiveness Training, as well as novel interventions that have not yet been explored. Future studies may then examine the efficacy and effectiveness of these interventions in increasing PTG in Veterans following acquired physical disability.

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Appendix A

Demographics and Health Interview

VARIABLE	BL	After DC	1MO	3MO	6MO	12M
Age [Age]: (Age in years)						
Gender [Gender]: (M, F)						
Race: (Y, N)						
American Indian or Alaska Native [AmericanIndian]						
Native Hawaiian or Other Pacific Islander [NativeHawaiian]						
White/Caucasian [White]						
Black/African-American [Black]						
Asian [Asian]						
Hispanic/Latino [Hispanic]						
Other [Other]: _____						
Marital Status [MaritalStatus]:	**BL**	**After DC**	**1MO**	**3MO**	**6MO**	**12M**
What is your current marital status?						
1=Married 2=Separated or Divorced 3=Single (never married) 4=Widow(er) (not currently married)						
Living Arrangements [LivingArrangements]:	**BL**	**After DC**	**1MO**	**3MO**	**6MO**	**12M**
BL: *At the time of your injury, what were your living arrangements?*						
BL: *What will be your living arrangements after discharge?*						
1MO-12MO: *What are your current living arrangements?*						
1=Alone 2=Spouse/common-law partners (7 or more years) 3=Significant other (not married) 4=Parent(s) 5=Sibling(s) 6=Child(-ren, under 21yrs old) 7=Other relatives or adult child(-ren, 21+yrs old) 8=Roommate(s)friend(s) 9=Boarding house or other group living 10=Hospital or nursing home 11=Homeless 12=Further inpatient rehabilitation 13=Unknown to patient						
Living arrangements were/are on a military base, in a VA hospice/care center, or other government-funded military or veteran facility [LivingArrangements_2]: (Y,N)						

Home Health Care [HomeHealthCare]:	**BL**	**After DC**	**1MO**	**3MO**	**6MO**	**12M**
BL: *At the time of your injury, did you have home health care visits or a live-in care provider?**						
BL: *Will you have home health care visits or a live-in care provider after discharge?**						
1MO-12MO: *Do you have home health care visits or a live-in care provider?**						
* (does not include family members unless the family member is in a caregiver role documented by SSDI or VA)						
1=None 2=Live-in personal care attendant 3=Daily (4+ hours) 4=Daily (<4 hours) 5=3+ days per week 6=<3 days per week						
Work and Education:	**BL**	**After DC**	**1MO**	**3MO**	**6MO**	**12M**
BL: *At the time of your injury, what was your source of income?*:						
BL: *What will be your source of income after discharge?*:						
1MO-12MO: What are your sources of income?:						
work full-time [WorkFT] : (Y, N)						
work part-time [WorkPT] : (Y, N)						
receive disability compensation or benefits [ReceiveDisability] : (Y, N)						
receive retirement benefits [Retirement] : (Y, N)						
am not working but have another source of income (e.g., spouse's income, trust fund) [NotWorking.OtherIncome] : (Y, N)						
am not working and do not have another source of income [NotWorking.NoIncome]: (Y, N)						
other [OtherIncome]: _____						
Service Connection:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
BL: *At the time of your injury, did you have a VA service connected disability?* [SC_AtInjury]: (Y, N)						
Currently, do you have a VA service connected disability? [SC_Current]: (Y, N)						
Have you recently applied, or do you intend to apply, for a VA						

service connected disability? [SC_Intend]: (Y, N)						
Current percentage [SCPercentage]:						
Education:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
BL: *Were you taking classes toward a degree at the time of your injury?* [TakingClasses_BL]: 1=not taking classes 2=taking classes part-time (1-11 credits hours or equivalent) 3=taking classes full-time (12 credit hours or equivalent)						
BL: *Are you currently taking classes or have you taken classes toward a degree since your injury?* [TakingClasses_Now]: 1MO to 12MO: *Are you currently taking classes or have you taken classes toward a degree since your last study session?* [TakingClasses_Now]: 1=not taking classes 2=taking classes part-time (1-11 credits hours or equivalent) 3=taking classes full-time (12 credit hours or equivalent)						
BL: *What is the highest Diploma/Degree that you have completed?* [HighestDegree] 1MO-12MO: Ask: *Have you been awarded a degree since the last study visit?* If "yes," Ask: *What is the highest Diploma/Degree that you have completed?* [HighestDegree] If "no," record the highest degree recorded at the last session and skip to the next section (**Military Service**). 1=Non-High School graduate (record highest grade completed): _____ 2=High School graduate or GED 3=Some college or technical/trade training, no degree 4=Associate's degree or completed 2-year or equivalent technical/trade school 5=Bachelor's degree 6=Master's degree or other post-Bachelor's degree						
Military Service:*	**BL**		**1MO**	**3MO**	**6MO**	**12M**
*If patient was separated or retired at the last study session, just ask whether the subject re-entered the Uniformed Services since the last session. If not, record the response provided at the last session and skip to the section, **Health and Medical History**.						
*In which military branch did you serve **most recently**? [MilitaryBranch]:* 1=Army, 2=Air Force, 3=Navy, 4=Marine Corps, 5=Coast Guard						
What is your current status [CurrentMilitaryStatus]?: 1=Active Duty 2=Selective Reserves – Reserve 3=Selective Reserves - National Guard 4=Ready Reserves 5=Separated (e.g., discharged) 6=Medical Retirement 7=Retirement (not Medical)						
What is the highest rank you achieved? [HighestRank]: (record the pay grade classification (without dashes), for example, E4, O2, etc.)						
Era of Service:	**BL**		**1MO**	**3MO**	**6MO**	**12M**

What years did you serve? [YearsActive]*:* _____						
Pre-World War II (1937-38) [era1] (Y, N)						
World War II (1939-45) [era2] (Y, N)						
Pre-Korean War (1946-49) [era3] (Y, N)						
Korean War (1950-53) [era4] (Y, N)						
Between Korean and Vietnam Wars (1954-59) [era5] (Y, N)						
Vietnam War (1960-75) [era6] (Y, N)						
Post-Vietnam/Pre-Gulf (1975-1990) [era7] (Y,N)						
Gulf War (1990-91) [era8] (Y, N)						
Post Gulf War (1991-2001) [era9] (Y, N)						
Operations Enduring Freedom, Iraqi Freedom, and New Dawn (2001-Present) [era10] (Y, N)						
Deployment History:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
Ask: Were you ever deployed to a region of military conflict?						
Korean War (1950- 1953). [DeployedKorea] (Y, N)						
Vietnam War (1950-1975). [DeployedVietnam] (Y, N)						
Gulf War (1990-1991). [Deployed1stGulf] (Y, N)						
The region of conflict (e.g., Iraq, Kuwait) during the Gulf War (1990-1991). [DeployedRegion1stGulf] (Y, N)						
Iraq or the region of conflict (e.g., Kuwait) in 2003 to August 2010. [DeployedIraq03] (Y, N)						
Iraq or the region of conflict (e.g., Kuwait) after August 2010. [DeployedIraqPost2010] (Y, N)						
I was deployed to Afghanistan or the region of conflict after September 11, 2001. [DeployedAfghanistan] (Y, N)						
I was deployed for a combat or peace keeping mission not otherwise specified above [DeployedPeaceKeeping]. Details: _____ (Y, N)						
Health and Medical History:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
Do you smoke cigarettes or have you ever smoked cigarettes regularly [Smoker]?:*						
1=Current smoker 2=Currently smoking but trying to quit 3=Not smoking but using NRT 4=Ex-smoker 5=Never been a smoker *The patient can self-designate smoking status. If asked, provide guidance from the CDC DHDS system: smoking >=100 cigarettes in one's lifetime but currently does not smoke at all is considered a "former smoker." Respondents who have smoked >=100 cigarettes in one's lifetime and currently smoke either every day or some days is defined as a current smoker.						
(If currently a smoker): *On average, how many cigarettes do you smoke per day?[CigsPerDayifSMOKE]*						
1=0-2 2=3-7 3=8-12 4=13-17 5=18-22 (about a pack) 6=21-27 7=28-32 8=33-37 9=38 or more (about 2 or more packs)						

Do you use other tobacco products?: _____ (Y/N)						
Are you currently being treated for:						
High blood pressure (Hypertension) [Hypertension1]						
High cholesterol [Cholesterol] (Y, N)						
Diabetes [Diabetes1] (Y, N)						
Kidney disease [KidneyDisease1] (Y, N)						
Liver disease [LiverDisease1] (Y, N)						
Respiratory Disease or Asthma [RespiratoryDiseaseAsthma1] (Y, N)						
Influenza, a Cold, or Allergies [Sick] (Y, N)						
Cancer [Cancer1] (Y, N)						
Heart trouble [HeartTrouble1] (Y, N)						
Hepatitis [Hepatitis] (Y, N)						
Stroke [Stroke] (Y,N)						
Blood or circulatory problems, such as those treated with blood thinners [Blood] (Y, N)						
Arthritis/gout [ArthritisGout1] (Y, N)						
Epilepsy or Seizures [Seizures1] (Y, N)						
An infection [Infection] (Y, N)						
Pressure ulcers/sores [Sores] (Y, N)						
Back Pain [BackPain] (Y, N)						
Headaches [Headaches] (Y, N)						
Alzheimer's disease or dementia [Dementia] (Y, N)						
Traumatic Brain Injury [TBI_treatment] (Y, N)						
Depression [Depression_treatment] (Y, N)						
Posttraumatic Stress Disorder [PTSD_treatment] (Y, N)						
Anxiety or "nerves" [Anxiety_treatment] (Y, N)						
(Other) Mood swings or emotional or mental health problems [OtherMH_treatment] (Y, N)						
Alcohol use [Alcohol_treatment] (Y, N)						
Illicit drug use or abusing medications [Drug_treatment] (Y, N)						
Any other medical condition (MS, Parkinson's, Sickle Cell, etc.) [Other_treatment]: _____ (Y, N)						
Prior Injuries:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
BL only: *Before your injury, did you have an amputation or spinal cord injury?* Describe: _____ ____ _____ _____						
1MO-12MO: *Since your last study session, did you have an*						

amputation, spinal cord injury, or another injury that required medical treatment? Describe: _____ _____ _____ _____						
Treatment History:	**BL**		**1MO**	**3MO**	**6MO**	**12M**
BL only: *Did you receive any INPATIENT rehabilitation for [your recent injury] before coming to the Richmond VA Medical Center's Spinal Cord Injury & Disorders Clinic?* [OtherInpatientRehab] (Y, N) Describe: _____ _____ _____ _____						
BL only: *Did you receive any OUTPATIENT rehabilitation for [your recent injury] before coming to the Richmond VA Medical Center's Spinal Cord Injury & Disorders Clinic?* [OtherOutpatientRehab] (Y, N) Describe: _____ _____ _____ _____						
1MO-12MO: *Have you received any INPATIENT rehabilitation for [your injury] since your last study session?* [RecentInpatientRehab] (Y, N) Describe: _____ _____ _____ _____						

Appendix B

FORM D - Brief COPE (Carver: Dispositional version)

We are interested in how people respond when they confront difficult or stressful events in their lives. There are lots of ways to try to deal with stress. This questionnaire asks you to indicate what you generally do and feel, when you experience stressful events. Obviously, different events bring out somewhat different responses, but think about what you usually do when you are under a lot of stress.

Then respond to each of the following items by circling one number on your answer sheet for each, using the response choices listed just below. Please try to respond to each item separately in your mind from each other item. Choose your answers thoughtfully, and make your answers as true FOR YOU as you can. Please answer every item. There are no "right" or "wrong" answers, so choose the most accurate answer for YOU--not what you think "most people" would say or do. Indicate what YOU usually do when YOU experience a stressful event.

1	2	3	4
I usually don't do this at all	I usually do this a little bit	I usually do this a medium amount	I usually do this a lot

1.	I concentrate my efforts on doing something about the situation I'm in.	1	2	3	4
2.	I give up the attempt to cope.	1	2	3	4
3.	I take action to try and make the situation better.	1	2	3	4
4.	I try to see it in a different light, to make it seem more positive.	1	2	3	4
5.	I try to come up with a strategy about what to do.	1	2	3	4
6.	I give up trying to deal with it.	1	2	3	4
7.	I look for something good in what is happening.	1	2	3	4
8.	I try to find comfort in my religion or spiritual beliefs.	1	2	3	4
9.	I think hard about what steps to take.	1	2	3	4
10.	I pray or meditate.	1	2	3	4

Appendix C

FORM E - ALE Scale - (Situational version)

We would like you to rate your **perceptions** of your current circumstances. That is your perception of your environment **right now**. Use the following six point scales (where 0 = not at all to 5 = very much so) to indicate the extent to which each of the adjectives best describes your **perceptions** now. Do this by circling the appropriate point on the scales. Please respond as quickly as possible as first responses are usually more accurate. Please make a response to each adjective.

I FIND MY CURRENT CIRCUMSTANCES: (0 = not at all to 5 = very much so)

(1) Threatening:
0 1 2 3 4 5

(2) Fearful:
0 1 2 3 4 5

(3) Enjoyable:
0 1 2 3 4 5

(4) Worrying:
0 1 2 3 4 5

(5) Hostile:
0 1 2 3 4 5

(6) Challenging:
0 1 2 3 4 5

(7) Stimulating:
0 1 2 3 4 5

(8) Exhilarating:
0 1 2 3 4 5

(9) Painful:
0 1 2 3 4 5

(10) Depressing:
0 1 2 3 4 5

(11) Pitiful:
0 1 2 3 4 5

(12) Informative:
0 1 2 3 4 5

(13) Exciting:
0 1 2 3 4 5

(14) Frightening:
0 1 2 3 4 5

(15) Terrifying:
0 1 2 3 4 5

(16) Intolerable:
0 1 2 3 4 5

Appendix D

FORM H - MSPSS

Instructions: We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement.

1	2	3	4	5	6	7
Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very Strongly Agree

1.	There is a special person who is around when I am in need.	1	2	3	4	5	6	7
2.	There is a special person with whom I can share my joys and sorrows.	1	2	3	4	5	6	7
3.	My family really tries to help me.	1	2	3	4	5	6	7
4.	I get the emotional help and support I need from my family.	1	2	3	4	5	6	7
5.	I have a special person who is a real source of comfort to me.	1	2	3	4	5	6	7
6.	My friends really try to help me.	1	2	3	4	5	6	7
7.	I can count on my friends when things go wrong.	1	2	3	4	5	6	7
8.	I can talk about my problems with my family.	1	2	3	4	5	6	7
9.	I have friends with whom I can share my joys and sorrows.	1	2	3	4	5	6	7
10.	There is a special person in my life who cares about my feelings.	1	2	3	4	5	6	7
11.	My family is willing to help me make decisions.	1	2	3	4	5	6	7
12.	I can talk about my problems with my friends.	1	2	3	4	5	6	7

Appendix E

FORM J - PTGI-SF

Indicate for each of the statements below the degree to which this change occurred in your life as a result of your crisis, using the following scale:

0_**I did not experience this change** as a result of my crisis.
1_I experienced this change **to a very small degree** as a result of my crisis.
2_I experienced this change **to a small degree** as a result of my crisis.
3_I experienced this change **to a moderate degree** as a result of my crisis.
4_I experienced this change **to a great degree** as a result of my crisis.
5_I experienced this change **to a very great degree** as a result of my crisis.

1.	I changed my priorities about what is important in life.	0 5	1	2	3	4
2.	I have a greater appreciation for the value of my own life.	0 5	1	2	3	4
3.	I am able to do better things with my life.	0 5	1	2	3	4
4.	I have a better understanding of spiritual matters.	0 5	1	2	3	4
5.	I have a greater sense of closeness with others.	0 5	1	2	3	4
6.	I established a new path for my life.	0 5	1	2	3	4
7.	I know better that I can handle difficulties.	0 5	1	2	3	4
8.	I have a stronger religious faith.	0 5	1	2	3	4
9.	I discovered that I’m stronger than I thought I was.	0 5	1	2	3	4
10.	I learned a great deal about how wonderful people are.	0 5	1	2	3	4

Vita

Lisa Diane Goldberg was born on October 15, 1985 in Boston, Massachusetts and is an American citizen. She graduated from Burlington High School in 2004 and received her Bachelor of Arts in Psychology from Brandeis University in Waltham, Massachusetts in 2008. After graduation, she worked as a full-time research assistant for Bradley Hospital in Providence, Rhode Island for two years. She subsequently worked for two years as a resiliency services coordinator for a military resiliency training program called Families OverComing Under Stress (FOCUS) through UCLA, located on a naval base in Coronado, California. She earned her Master of Science in Psychology from Virginia Commonwealth University in Richmond, Virginia in 2014. She will be completing her clinical psychology internship at the Malcolm Grow Medical Clinic & Surgery Center at Joint Base Andrews with the U.S. Air Force, after which she will work as an Air Force psychologist.