THESIS

THE ROLE OF PHYSICAL ACTIVITY IN RESILIENCE TO

PSYCHOLOGICAL TRAUMA

Submitted by

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ABSTRACT

THE ROLE OF PHYSICAL ACTIVITY IN RESILIENCE

TO PSYCHOLOGICAL TRAUMA.

Existing research indicates that exposure to psychological trauma can negatively impact individual mental health among a broad variety of domains. Additionally, although many victims are resilient to the psychological consequences of such trauma, those who do suffer from trauma-related pathology are often resistant to benefits associated with existing treatment. Because of its well-established associations with general mental health and positive impacts on many of the domains damaged by psychological trauma, exercise was examined as a possible moderator of the relationship between trauma exposure and adult mental health. Among a sample of 587 undergraduate college students, the results of multiple regression analysis indicated that psychological flourishing was moderated by the interaction between physical exercise and number of traumatic events, as well as by physical exercise and childhood maltreatment. In both models, the overall positive association between exercise and flourishing was gradually attenuated at higher levels of trauma. In the traumatic events model, greater trauma exposure predicted higher flourishing scores at low levels of exercise, but lower flourishing scores at high levels of exercise. In contrast, childhood maltreatment was consistently associated with lower flourishing scores, regardless of exercise participation. These results have a number of implications for future research and intervention, which are explored in the discussion section.

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CHAPTER I

Introduction

In the United States and worldwide, exposure to psychological trauma during early life has become a pervasive and concerning phenomenon. In 2009 alone, Child Protective Services verified more than 700,000 cases of child maltreatment in the United States (U.S. Department of Health and Human Services, 2010). Yet although this number is alarming, prevalence estimates from the U.S. Department of Health and Human Services (2010) suggest that the true incidence of child maltreatment in the U.S. may be as much as ten times greater. Out of more than 17,000 U.S. children surveyed from 1995 to 1997, the Centers for Disease Control and Prevention (1997) found that roughly 64% had experienced at least one trauma related to abuse, neglect, or household dysfunction (i.e., violence against the mother, household substance abuse, parental separation, household mental illness, or an incarcerated household member). Additionally, more than 20% of the study sample reported having experienced at least three or more of these events. When additional categories of trauma are considered (i.e., natural disasters, death of a relative, criminal victimization, etc.), the true prevalence of early trauma exposure has been suggested as being far higher (e.g., Berman, Kurtines, Silver, & Serafini, 1996; Fitzpatrick and Boldizar, 1993; Rasmussen, Aber, & Bhana, 2004).

Despite numerous efforts to reduce the prevalence and impact of these events, a disturbing number of children and adolescents become victims of severe trauma every year. In 2009, roughly five children died every day as a result of child abuse and neglect, more than in any previous recorded year (U.S. Department of Health and Human Services, 2010). In many regions of the United States, early exposure to traumatic experiences is the norm rather than the exception. In one examination of inner-city children, Fitzpatrick and Boldizar (1993) reported

that roughly 70% of their sample had either been a victim of or witnessed community violence (e.g., physical assault, violent robbery, rape, shooting, etc.) prior to age 18. Among those exposed to such stressors, 27% met criterion for a diagnosis of PTSD. Berman et al. (1996) found that 90% of Miami high school students had witnessed community violence and 44% had been a victim of violent crime. Among a similar sample of high school students in Chicago, 28% had been physically threatened, 14% were robbed, 10% were physically assaulted, were 8% shot, and 3% were stabbed. Additionally, 90% of the sample had heard gunshots, 46% witnessed a shooting, 26% had seen someone stabbed, and 15% personally knew a victim of rape (Rasmussen et al., 2004).

Van der Kolk (1987) defines psychological trauma as an experience that overwhelms both biological and psychological coping mechanisms. Trauma occurs in many different forms, and the psychological effects of such events appear to be similarly diverse. In recent decades, a growing body of research has exposed a wide variety of psychological, emotional, behavioral, and biological changes resulting from early trauma exposure (e.g., Atlantis et al., 2004; Quirk and Beer, 2006; Vasterling et al., 2001). Yet despite a tremendous investment of time, research, and financial resources into the understanding and treatment of trauma and posttraumatic stress disorder (PTSD), the limited effectiveness of existing treatment approaches suggests that they are far from optimal (McNally, Bryant, & Ehlers, 2003; Rose & Bisson, 1998).

These failures are particularly concerning when considering individuals exposed to trauma during early life, because these experiences may contribute to chronic and debilitating consequences that extend far into adulthood (van der Kolk, 1987). In the face of uncontrollable and terrifying experiences, the human brain may produce measurable neuropsychological adaptations in order to temporarily accommodate the stressor. In most cases, recovery from

trauma is associated with eventual return to previous biological and psychological equilibrium, also referred to as homeostasis. But when these traumas are inflicted upon the vulnerable and developing brains of children, neuropsychological accommodations (and related pathologies) may persist long into adulthood (Armsworth & Holaday, 1993). In light of this, early intervention may be essential to prevent long-term maladaptive psychopathology.

Existing interventions for psychological trauma most commonly take the form of individual or group psychotherapy services. In particular, psychological debriefing (PD) is by far the most prevalent method of early intervention for instances of trauma exposure (Litz, Gray, Bryant, & Adler, 2006). In essence, psychological debriefing involves a semi-structured conversation in which trauma victims are invited to share their memories and find some order or meaning in the traumatic experience. Unfortunately, recent empirical scrutiny of these strategies has contributed to a growing disappointment with the effectiveness of PD (McNally, Bryant, & Ehlers, 2003; Rose & Bisson, 1998). While some researchers and practitioners have found success using these strategies, others have expressed concerns about the therapeutic or preventative utility of PD and related methods. Additionally, these presently-available early intervention methods have been found to be harmful in some cases. In a recent meta-analysis of randomized and controlled psychological debriefing trials, Rose and Bisson (1998) found that two interventions led to positive outcomes, two resulted in no measurable outcome, and two were associated with some negative outcomes. According to McNally et al. (2003), there currently exists no convincing evidence that psychological debriefing helps to reduce the incidence of PTSD in survivors of traumatic events.

While psychological debriefing is a relatively short-lived intervention that is intended for application shortly after trauma exposure, there also exist a number of other psychotherapeutic

interventions that can be implemented much later and for longer periods of time. Meta-analyses conducted by the Centers for Disease Control [CDC] (2008) evaluated seven of the most prominent therapeutic interventions for child and adolescent victims of trauma. These included individual and group cognitive-behavioral therapy, play therapy, art therapy, psychodynamic therapy, psychological debriefing, and pharmacologic therapy. Of the examined interventions, only individual and group cognitive-behavioral therapy demonstrated sufficient evidence to establish efficacy related to decreases in psychological harm as a result of trauma exposure. Evidence was insufficient to determine the effectiveness of all other therapies included in the meta-analyses.

At present, trauma-focused cognitive-behavioral therapy (TF-CBT) represents one of the most widely-used and empirically-validated interventions for child and adolescent victims of trauma (Kornet et al., 2008). Typically, these methods incorporate components of psychoeducation, coping and relaxation skills training, narrative retelling of the trauma, and graduated exposure to trauma-related stimuli (Cohen & Mannarino, 2008). Recently, a number of studies have suggested that the trauma-related outcomes of TF-CBT are favorable in comparison to a number of other prominent treatment strategies, including child-centered supportive therapy and nondirective play therapy (Kornet et al., 2008), and supportive counseling (Cohen, Deblinger, & Mannarino, 2004). In a recent meta-analysis, Bisson, Ehlers, Matthews, Pilling, Richards, and Turner (2007) concluded that TF-CBT should be one of the primary early response interventions for individuals suffering from post-traumatic stress disorder.

Yet while a tremendous quantity of research has already been devoted to the development of effective trauma interventions, the apparent deficiencies in a number of existing strategies

have called attention to the need for further research and development in this field (McNally et al., 2003; CDC, 2008). In particular, there appears to be a strong movement toward the development of additional intervention strategies for use either as alternatives or as adjuncts to existing treatments. According to Rose and Bisson (1998), there exists "an urgent need" for better justification of many existing treatments and investigation of new intervention possibilities. Armsworth and Holaday (1993) reflects a similar sentiment: "Although our awareness has increased in the past two decades, it also is apparent that we still have much work to do in the traumatic stress area to make our research, assessment, and treatment more precise" (p. 84). Despite decades of inquiry examining the mechanics of these stressors and numerous attempts to develop successful intervention strategies, many victims eventually suffer from severe long-term emotional and behavioral problems (Feiring, Simon, & Cleland, 2009; Gobin & Freyd, 2009).

In spite of this disturbing reality, significant differences in individual post-trauma functioning suggest that chronic trauma-related pathology is not necessarily inevitable. In fact, available data suggests that a significant percentage of individuals who are exposed to early trauma do not go on to develop PTSD or demonstrate notable deficits in adult functioning (Collishaw et al., 2007; MacMillan et al., 2001; McGloin & Widom, 2001; Mullen et al., 1996; Walsh, Dawson, & Mattingly, 2010;). In light of this, two important questions must be addressed: First, what are the existing protective factors that facilitate resilience to pathology in the majority of trauma victims? Second, how can we better develop interventions for those individuals who *do* eventually suffer from trauma-related symptoms.

The impact of psychological trauma

The negative psychological consequences of trauma exposure have been well-documented. In addition to the onset of PTSD, trauma has been associated with a diverse variety of symptoms and pathologies (e.g., Lanius, Vermetten, & Pain, 2010; Mullen et al., 1996; Shalev et al., 1998; Roberts & Lie, 1989). Shalev et al. (1998) noted comorbid depression symptoms in 44.5% of PTSD patients one month following the exposure to trauma, resulting in lower levels of overall functioning and greater symptom severity. This apparent comorbidity of depression and PTSD has also been verified by a number of other studies (e.g., Breslau, Davis, Peterson, & Shultz, 2000; O'Donnel, Creamer, & Pattison, 2004). Additionally, diagnostic symptoms of major depressive disorder have been correlated with trauma exposure even in the absence of PTSD (O'Donnel, Creamer, & Pattison, 2004; Shalev et al., 1998). Similar relationships have been found between trauma exposure and anxiety (e.g., Felitti et al., 1998; McCauley et al., 1997; Mullen et al., 1996; Silove, Steel, McGorry, & Mohan, 2007), as well as negative changes in self-esteem (Liem, O'Toole, & James, 1996), and self-concept (Apolinsky & Wilcoxon, 1991; Roberts & Lie, 1989). Additionally, it has been suggested that deficits in stress and emotion regulation may be a primary source of trauma-related pathology (Lanius et al., 2010).

Available evidence suggests that that the negative outcomes associated with psychological trauma generally become more significant as a function of the severity of said trauma(s) (e.g., Brewin, Andrews, & Valentine, 2000; Maercker, Beauducel, & Shutzwohl, 2000; Spauwen, Krabbendam, Lieb, Wittchen, & van Os, 2006). In many cases, trauma severity has been identified as one of the primary risk factors of pathology, significantly predicting outcomes ranging from psychoses (Spauwen et al., 2006) to dissociation (Maercker et al., 2000) and traditional symptoms of PTSD (Brewin et al., 2000). According to a recent meta-analysis,

additional risk-factors for higher trauma-related pathology include level of education, previous traumatization, childhood adversity, family psychiatric history, and age at time of traumatic experience – with lower ages predicting worse outcomes (Brewin et al., 2000).

In particular, traumatic experiences during childhood may predict significantly worse outcomes than similar traumas encountered later in life. According to McCutcheon et al. (2010) child victims of physical abuse, sexual assault, and neglect demonstrated significantly greater risk of trauma-related pathology than subjects exposed to similar traumas in adolescence or adulthood. Additionally, the impact of childhood trauma may go well beyond typical psychological symptoms by contributing to sizable neuropsychological and/or biological changes as well. In addition to many of the psychological outcomes associated with adverse experience across the lifespan, childhood trauma has been suggested as a particular source of lasting changes in physiological stress-sensitivity and chronic risk of psychopathology. (Nemeroff, 2004).

Neuropsychological perspectives on psychological trauma

In recent years, the advent of modern neuroimaging techniques has drawn attention to a number of neuropsychological outcomes that appear to be related to severe trauma. In addition to traditional methods such as brain dissection, the use of functional magnetic resonance imaging (fMRI) and other new technologies has allowed researchers to identify specific brain structures and functions as being particularly susceptible to the negative effects of psychological trauma. In light of this new information, researchers and healthcare practitioners have increasingly begun emphasizing the importance of interventions that take these neurological considerations into account. In particular, Bremner (2008) calls for the development and implementation of early

interventions targeted specifically at regions of the brain most affected by psychological trauma - the hippocampus, amygdala, and prefrontal cortex.

In addition to advancing the general understanding of how traumatic events are experienced in the brain, recent neuropsychological studies have identified a number of specific processes and regions as being particularly vulnerable to damage resulting from psychological trauma. In particular, existing research suggests that areas of the hippocampus (Eker et al., 2009; Vasterling et al., 2001), amygdala (Kalynchuk & Meaney, 2003; Phelps & Ledoux, 2005), and prefrontal cortex (Morgan & Ledoux, 1995) may represent primary avenues of pathology resulting from trauma exposure. In many cases, these effects appear to be mediated by changes in plasticity-related processes and quantity of available brain-derived neurotrophic factor (BNDF; Cotman & Berchtold, 2002; Molteni et al., 2002). Plasticity is a measure of the brain's capacity for adaptive growth and repair, while BDNF proteins play a crucial role in the development and survival of neurons in the brain. As a result, trauma-related interference with either of these domains presents a concerning risk-factor for chronic pathology.

A number of researchers have hypothesized that PTSD symptoms and other trauma-related psychopathologies reflect lasting changes in neurological plasticity and difficulty returning to pre-trauma levels of functioning (Gilbertson et al., 2002; Soloman and Heide, 2005). Under normal circumstances, the human brain will adapt to the intrusion of a stressor by temporarily altering the body's normal homeostasis. In absence of pathology, this effect is quickly followed by a return to equilibrium once the stressor has been removed from prominence. Unfortunately, severe psychological trauma has been found to profoundly disrupt normal homeostasis and interfere with processes related to brain plasticity and adaptability (Solomon and Heide, 2005). In particular, changes in cortisol regulation have been identified as

likely contributors to the physiological disruption of homeostasis following trauma (Bevans, Cerbone, & Overstreet, 2008).

According to Yehuda and McFarlane (1995), the failure of return to prior homeostasis may represent one of the primary mechanisms resulting in the onset of PTSD. Recently, the hippocampus (Eker et al., 2009; Vasterling et al., 2001), amygdala (Kalynchuk & Meaney, 2003; Phelps & Ledoux, 2005;), and prefrontal cortex (Morgan & Ledoux, 1995) have been identified as particularly crucial to maintenance and restoration of homeostasis, as well as being uniquely vulnerable to the consequences of psychological trauma. Additionally, the action of brain-derived neurotrophic factor (BDNF) and other plasticity-related neurochemicals has been identified as an essential component of trauma resilience and recovery (Cotman & Berchtold, 2002; Molteni et al., 2002;).

Trauma and the hippocampus

A number of studies have noted significantly reduced hippocampal volumes in patients demonstrating symptoms of PTSD (Gilbertson et al., 2002; Vasterling et al., 2001). At present, there is some debate as to whether this represents a consequence of psychological trauma or simply a risk-factor for trauma-related pathology. However, some researchers have suggested that relatively limited hippocampal function interferes with a person's ability to reinterpret their traumatic experiences and adapt to new contexts in a way that might facilitate recovery (Lewitus, Cohen, & Schwartz, 2008). Others have hypothesized that a smaller hippocampus could predispose certain individuals toward stronger, more persistent emotional and stress responses in the face of traumatic experience (Gilbertson et al., 2002).

While the neurotoxic effect of psychological trauma is well-documented and thus may result in some hippocampal deterioration, pre-trauma differences in hippocampal volume also

appear to represent a significant portion of the relationship between hippocampal size and trauma-related psychopathology. Gilbertson et al. (2002) reported that monozygotic twins of PTSD sufferers showed similarly low hippocampal volume despite a disparate exposure to trauma. In contrast, trauma-exposed twin pairs who were asymptomatic were found to have significantly greater hippocampal volumes. Low hippocampal volume has also been associated with other trauma-related pathologies, including major depressive disorder (Eker et al., 2009). Changes in brain-derived neurotrophic factor are thought to be responsible for this effect (Eker et al., 2009). When considered together, these studies suggest that existing hippocampal health and BDNF activity may be important components of resilience to psychological trauma and related pathology.

Trauma, the amygdala, and the prefrontal cortex.

Trauma-related hyperarousal and PTSD have been associated with the conditioning of specific fear responses related to the initial trauma experience (Quirk and Beer, 2006). While the ability to overcome this conditioning requires new learning and therefore may rely on functions of the hippocampus, the prefrontal cortex and amygdala have also been implicated as essential to this process (Morgan and Ledoux, 1995; Phelps and LeDoux, 2005). Damage to the medial prefrontal cortex (mPFC) appears to interfere with the extinction of conditioned fears (Quirk and Beer, 2006), and the size of this region has also been related to individual differences in extinction (Milad, Orr, Pitman, & Rauch, 2005). Prolonged stress has also been shown to alter the functioning of neural circuits in the amygdala and mPFC, resulting in a hyperactive fear response to threats and a weakened ability to regulate those responses through the mPFC (Quirk and Beer, 2006).

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Psychological outcomes of physical exercise

Because of its beneficial effects on many of the same traits commonly associated with post-trauma psychology (i.e., anxiety, depression, low self-esteem), a growing number of researchers have suggested exercise as a potential protective measure or intervention for victims of psychological trauma (e.g. Asoh, Takeuchi, and Tsuji, 1986; Maniam & Morris, 2010 Schindler, 2010;). Although there is presently only limited research regarding the effects of exercise on trauma resilience and recovery, decades of study have demonstrated that strenuous physical activity can be a powerful intervention for many facets of psychological health and well-being. In particular, a number of studies have noted significant positive effects of exercise on depression (e.g., Doyne et al., 1983; Greist et al., 1979**;** Kavanagh, Shepard, Tuck, & Qureshi, 1977) anxiety (e.g., Bahrke & Morgan, 1978; Driscoll, 1976; Morgan, 1979;**),** general mood **(**e.g., Folkins, 1976**;** Lichtman & Poser, 1983), stress regulation (Long, 1984), self-esteem (Calfas & Taylor, 1994; Gruber, 1986; McDonald & Hogdon, 1991; Spece, Poon, & Dyck, 1997), self-competence (Gauvin & Brawley, 1993**;** Sonstroem & Morgan, 1989) and general cognitive functioning (Cotman & Berchtold, 2002; Lichtman, 1983**;**).

The effects of exercise on depression and anxiety are particularly well-documented and robust. With respect to depression, five different meta-analytic reviews (Calfas & Taylor, 1994; ;Craft, 1997; Kugler et al., 1994; McDonald & Hodgdon, 1991; North, McCullagh, & Tran, 1990) found consistent and significant reductions in depression following both acute and chronic exercise. According to Landers (1999), the sum of research on the relationship between exercise and depression suggests that the benefits of exercise are comparable to those associated with therapy, medication, and social contact. Similarly, six meta-analyses related to exercise and anxiety (Calfas & Taylor, 1994; Kugler, Seelback, & Krüskemper, 1994; Landers & Petruzzello,

1994; Long & van Stavel, 1995; McDonald & Hodgdon, 1991; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991) found significant reductions in anxiety across all studies reviewed.

A number of studies have also examined the impact of physical exercise on combined measures of psychological and physical functioning. In one randomized controlled trial, Atlantis et al., (2004) found that a 24-week combined aerobic and weight-training program led to significant improvements in general mental health, stress, vitality, and depression. Subjects also demonstrated notable improvements in general physical functioning, pain, and physical health. In a review of four populations in the United States and Canada, Stephens (1988) noted similar results. In particular, level of physical activity was positively correlated with general well-being and mood, as well as being negatively associated with anxiety and depression. These results were consistent across a variety of demographic variables, including age, gender, physical health, and socioeconomic status.

Yet despite extensive and growing research regarding the psychological benefits of physical activity, a number of researchers have identified negative outcomes associated with exercise when pursued either to excess or for potentially problematic reasons. Excessive and/or compulsive exercise has been linked to increases in anxiety and obsessive-compulsive symptoms, as well as perfectionism and narcissistic traits (Shroff et al., 2006; Spano, 2001). Additionally, a variety of studies have noted correlations between extreme exercise participation and disordered body image or eating habits (e.g., Gulker, Laskis, & Kuba, 2010; Shroff et al., 2006). Although a high level of physical activity can certainly be healthy in many individuals, emotional and/or compulsive attachment to exercise appears to mediate the consequences for those at particular risk of negative exercise outcomes (Mond & Calogero, 2009; Ackard, Brehm, & Steffen, 2010).

Neuropsychological outcomes of physical exercise

In addition to its well-documented association with general mental health, physical exercise may also be particularly effective in combatting many of the common neuropsychological deficits associated with traumatic experience (e.g., Erickson et al., 2010; Silva et al., 2007; Trejo, Carro, & Torres-Aleman, 2001). Exercise has been associated with particular benefits in the hippocampus (Chytrova, Ying, and Gomez-Pinilla, 2008; Erickson et al., 2010), prefrontal cortex (Colcombe et al., 2006), and amygdala (Fu-sheng et al., 2002; Silva de Lacerda et al., 2007); while also facilitating improved plasticity (e.g, Erickson et al., 2010), cortisol-regulation (Mastorakos, Pavlatou, Diamati-Kanndarakis, & Chrousos, 2005), and availability of brain-derived neurotrophic factor (e.g., Cotman & Berchtold, 2002).

Whereas psychological trauma has been associated with specific deficits in the mammalian hippocampus (Gilbertson et al., 2002; Vasterling et al., 2001), physical exercise appears to exert the opposite effect. Aerobic activity has been found to protect against age-related hippocampal deterioration, and also appears to facilitate neurogenesis in this region (Chytrova, Ying, and Gomez-Pinilla, 2008; Erickson et al., 2010). Among a sample of older adults, the addition of a regular exercise program resulted in a 2% hippocampal volume increase over the course of one year. Additionally, initial fitness levels were found to predict individual hippocampal volume (Erickson et al., 2010). These results suggest that physical exercise not only protects against age-related neural deterioration, but may also facilitate hippocampal maintenance and/or growth across the lifespan.

Other researchers have encountered similar effects, citing notable changes in the hippocampal neurogenesis of adult mammalian brains as a result of regular exercise (van Praag et al., 1999). Physical exercise has also been found to reduce growth-inhibitory molecules in the

hippocampus, as well as contributing to hippocampal recovery following traumatic brain injury (Chytrova et al., 2008). According to Chytrova et al., (2008), "the overall findings emphasize the potential therapeutic action of exercise to elevate the capacity of the injured rain for plasticity and repair" (p. 8). If limited hippocampal volume and/or damage to this region predispose individuals to heightened risk of trauma-related pathology, then exercise may help to reverse this effect by stimulating growth and aiding in recovery from damage.

A number of recent studies have also suggested that exercise may help to prevent or repair damaging changes in the amygdala and prefrontal cortex – regions often demonstrating significant deficits in the presence of psychological trauma (Morgan and Ledoux, 1995; Phelps and LeDoux, 2005). Physical exercise appears to protect against the decline of prefrontal function, and actually leads to an increase of gray and white matter volume in this region (Colcombe et al., 2006). Additionally, while kindling (sensitization to specific stimuli) in the amygdala appears to play a role in the elevation of fear response and conditioning among rats (Kalynchuk & Meaney, 2003), exercise has been shown to inhibit the onset of kindling processes in this same brain region (Fu-sheng et al., 2002). Finally, Silva de Lacerda et al. (2007) found that aerobic exercise *reverted* the accelerated amygdala kindling development in rats who had been previously been subject to pinealectomy surgery.

Sothmann, Buckworth, Claytor, Cox, White-Welkley, and Dischman (1996) also suggested a relationship between physical activity and regulation of fear responses. In this study, consistent physical exercise was associated with reductions in maladaptive fear responses to repeated stressors. In part, this may be explained by adaptive changes in cortisol regulation. According to Mastorakos et al. (2005), exercise facilitates healthy cortisol function via mild physiological "stress," mildly stimulating cortisol production but improving the body's ability to

self-regulate in response to other stressors. Given evidence suggesting cortisol-disregulation as a significant contributor to trauma-related pathology (Bevans, Cerbone, & Overstreet, 2008), this may present another uniquely-beneficial outcome of exercise participation for individuals with significant trauma exposure. Unfortunately, excessive exercise has been demonstrated as exerting the opposite effect, with extensive overtraining contributing to elevated cortisol levels and corresponding psychological distress (O'Connor et al., 2000).

Exercise, resilience, and recovery

Collectively, these studies suggest that exercise may potentially be both a powerful protective factor and a valuable intervention for negative outcomes associated with psychological trauma. In general, the neuroprotective and neurogenerative effects of physical exercise appear to be especially potent in the regions of the hippocampus, amygdala, and prefrontal cortex – regions which are particularly vulnerable to the negative consequences of psychological trauma. Additionally, exercise has been associated with more general and pervasive changes in neuropsychological functioning. Exercise leads to increases in the quantity of BDNF and other growth-related factors in many regions of the brain, and may contribute to improvements in learning, memory, neurogenesis, and resilience to neurological damage (Cotman & Berchtold, 2002). Finally, while psychological trauma has been associated with chronic deficits in synaptic plasticity and cognitive function, exercise appears to have the opposite effect (Ding et al., 2006; Fordyce & Wehner, 1993; Szabo, Ying, Radak, & Gomez-Pinilla, 2010). Overall, the sum of existing research regarding the neuropsychological benefits of exercise suggests that it may be a uniquely well-suited intervention related to resilience and/or recuperation in the face of psychological trauma.

As previously noted, many of the prominent *psychological* benefits of exercise may also be particularly relevant to victims of trauma (i.e., improved self-esteem, alleviation of depression and anxiety, etc.). When considered together, these findings suggest that exercise may not only counteract the psychological expression of trauma-related pathology, but the biological underpinnings of those symptoms are well. And because negative symptoms of trauma exposure have been suggested to result from a combined enervation of both biological and psychological coping mechanisms (van der Kolk, 1987), the apparent ability of physical exercise to bolster both of these domains suggests what may be a uniquely comprehensive strategy for facilitating trauma-related resilience and recovery.

In general, there appears to be a consensus among exercise researchers that physical activity has the potential to be both neuroprotective and restorative (i.e., Atlantis et al., 2004; Ding et al., 2006; Erickson et al., 2010; Szabo, Ying, Radak, & Gomez-Pinilla, 2010) – though it may become dangerous in excess (e.g., O'Connor et al., 2000) or when pursued for the wrong reasons (Davis, 1990; Gulker, Laskis, & Kuba, 2001). According to Deslandes et al. (2009), "the overwhelming evidence present in the literature today suggests that exercise ensures successful brain functioning" (p. 191). Additionally, Erickson et al. (2010) asserts that "results clearly indicate that exercise is neuroprotective" (p. 3021). Yet despite this apparent consensus, relatively little is understood about how the protective and recuperative mechanisms of exercise are directly reflected in trauma resilience and individual functioning across the lifespan.

Physical exercise and trauma

Although physical exercise has been linked to significant positive changes in psychological well-being (e.g., Atlantis et al., 2004; Doyne, Chambless, and Beutler, 1983; Lichtman, 1983), comparatively little research has examined direct interactions between exercise

habits and symptoms of trauma exposure**.** In some cases, this may be due to the inherent ethical difficulties of randomly assigning trauma exposure in traditional research protocols. However, while this method of research may not be applicable to human study, animal researchers have indicated a significant connection between physical exercise and recovery from trauma. Asoh, Takeuchi, and Tsuji (1986) found that regular exercise led to improved health and reduced mortality rates following later exposure to varying levels of Noble-Collip drum trauma. Although no longer used in psychological research due to ethical considerations, the Noble-Collip drum procedure - which involves a rapid revolution of test animals inside a drum-like structure - is considered to be a reliable method of inducing trauma at varying levels of severity (Meyer and Shipley, 1945).

A similar relationship between exercise and trauma recovery in rats was observed by a more recent study utilizing alternate methods of traumatic stress induction. After a period of prolonged maternal separation, Maniam and Morris (2010) noted that rats provided with opportunities for voluntary exercise demonstrated significant improvements in anxiety and depression-related behavior, as well as metabolic function, when compared with sedentary animals. Together, the results of Asoh et al. (1986) and Maniam and Morris (2010) suggest that exercise can play a role in both resilience to and recovery from psychological trauma. Additionally, the benefits of physical exercise appear to extend across varying types - as well as varying degrees - of psychological trauma.

A number of studies have also suggested exercise as a valuable treatment measure for sufferers of post-traumatic stress disorder (PTSD). Newman and Motta (2007) noted positive changes in the anxiety, depression, and PTSD symptoms of adolescents after an eight-week aerobic exercise program. In fact, many of the participants no longer qualified for a diagnosis of

PTSD after the program was completed (Newman & Motta, 2007). Diaz and Motta (2008) later replicated this finding, and noted a similarly powerful reduction in PTSD symptoms after participation in regular aerobic exercise. More recently, Smith and Rotunda (2011) provided further evidence for the trauma-symptom attenuating effects of physical exercise in a randomized and controlled clinical study. Among a sample of rape survivors exhibiting PTSD-related symptoms, the authors found that a combined intervention of cognitive-behavioral therapy and physical exercise led to significantly greater symptom improvement than CBT alone.

Although the results of Asoh et al. (1986) suggest that physical exercise may contribute to trauma resilience in rats, there presently exists only limited research to indicate how this effect might generalize to human subjects. Medina et al. (2011) found that engagement in vigorous physical activities predicted a significantly lower incidence of coping-oriented alcohol use among trauma-exposed adults, which is certainly worthy of note considering the association between trauma exposure and substance abuse (Hanson et al., 2006). Additionally, the well-documented benefits of exercise as related to depression (i.e., Doyne et al., 1983; Greist et al., 1979; Kavanagh, Shepard, Tuck, & Oureshl, 1997) anxiety (i.e., Bahrke & Morgan, 1978; Driscoll, 1976; Morgan, 1979;), PTSD symptoms (Schindler, 2010), general mood (i.e., Folkins, 1976; Lichtman, 1983), stress regulation (Long, 1984), self-esteem (Calfas & Taylor, 1994; Gruber, 1986; McDonald & Hogdon, 1991; Spece, Poon, & Dyck, 1997), life satisfaction (Schindler, 2010), and self-competence (Gauvin & Brawley, 1993; Sonstroem & Morgan, 1989) suggest that physical activity may inherently counteract many of the typical symptoms of post-traumatic psychopathology. However, while these analyses have clearly identified significant relationships between exercise, psychological well-being, and the alleviation of trauma-related

symptoms; it is presently unclear whether the benefits of exercise are globally consistent or might interact uniquely with particular risk factors such as exposure to trauma.

Present study

The present study examines the relationship between exercise habits and trauma-related symptoms across the lifespan, with a particular focus on how physical activity might moderate psychological outcomes associated with traumatic experience. Previous studies have indicated that exercise aids in recuperation from the negative consequences of trauma in both rats (Asoh et al., 1986, Maniam & Morris, 2010) and humans (Diaz & Motta, 2008; Newman & Motta, 2007; Schindler, 2009; Schindler, 2010; Smith & Rotunda, 2011), but much less is known about how voluntary exercise habits might facilitate resilience and moderate the impact of psychological trauma.

With this in mind, the present study was designed to further expand upon existing research by comparing individual exercise habits with trauma history and present psychological functioning. More specifically, this study examined the relationship between trauma history, exercise habits, and present psychological functioning in order to determine whether exercise participation moderated the negative psychological consequences of trauma exposure. Given the exploratory nature of this analysis and lack of previous research regarding the potential moderator effects of physical exercise, the following questions were examined:

Research Question 1: Does physical exercise moderate the relationship between number of traumatic life experiences and psychological functioning among undergraduate students?

Research Question 2. Does physical exercise moderate the relationship between severity of traumatic life experiences and adult psychological functioning among undergraduate students?

Research Question 3. Does physical exercise moderate the relationship between childhood maltreatment and psychological functioning among undergraduate students?

CHAPTER II

Method

Participants

A total of six hundred and five undergraduate college students participated in this study during October and November 2012. Twelve of these cases were removed from the data pool due to the presence of aberrant data, failure to complete the study survey, or identification as outliers, resulting in a final sample of 593. Participants were recruited from introductory psychology classes at a large western university in the United States, and completed all necessary survey measures via an anonymous online questionnaire. Although it was made known to potential participants that exposure to trauma would be a focus of the online survey, relevant exposure was not a requirement for inclusion in this study. As compensation for enrolling in this study, all participants received additional course credit in their introductory psychology classes.

Participant demographics included 187 males (31.6%), 404 females (68.1%), and two students who did not specify a gender (0.3%). A total of 485 participants identified as Caucasian/White (81.8%), 55 (9.3%) as Latino or Hispanic, 16 (2.7%) as Asian American, nine (2.2%) as "Other," eight (1.3%) as African American/Black, eight (1.3%) as Middle Eastern American, five (0.8%) as Hawaiian/Pacific Island, and one (0.2%) as American Indian/Native American. 313 (52.8%) students reported some religious affiliation, while 277 (46.7%) did not. An additional three participants did not report their religious affiliation (or lack thereof). Mean age was 18.86 years (*SD*=1.35) for students in this sample.

Measures

Demographic Information.

General demographic information was requested via a demographic survey form provided at the beginning of study participation. This form asked participants to disclose a variety of demographic characteristics including age, year in school, gender, ethnicity, and socioeconomic status. See Appendix A.

Childhood Maltreatment

Childhood Maltreatment Questionnaires – Abuse (CMQ-A). The Childhood Maltreatment Questionnaires -Abuse (Shirley & Rosén, 2010a) asks respondents to indicate the frequency of abuse-related events experienced during childhood. These items are measured on a five-point Likert-type scale, with responses ranging from "never" to "very often." The CMQ-A consists of 19 items and 4 factors: Emotional Abuse, Physical Abuse, Sexual Abuse and Love. Confirmatory factor analysis of the CMQ-A demonstrated excellent fit, with a TLI of 0.96, CFI of 0.96, and a RMSEA of 0.06. The CMQ-A also demonstrated excellent reliability, with an overall Cronbach's alpha of 0.90 and subscale alphas ranging from 0.80 to 0.93 (Shirley & Rosén, 2010a). In the present study, the CMQ-A demonstrated an overall Cronbach's alpha of 0.86. See Appendix B.

Childhood Maltreatment Questionnaires – Neglect (CMQ-N). The Childhood Maltreatment Questionnaires – Neglect (Shirley & Rosén, 2010a) asks respondents to indicate the frequency of neglect-related events experienced during childhood. These items are measured on a five-point Likert-type scale, with responses ranging from "never" to "very often." The CMQ-N consists of 16 items and 4 factors: Emotional Neglect, Physical Neglect, Lack of Supervision, and Love. Confirmatory factor analysis revealed a TLI of 0.91, CFI of 0.93, and a RMSEA of 0.08. Reliability analysis of the CMQ-N found an overall Cronbach's alpha of 0.86,

with subscale alphas ranging from 0.80 to 0.91 (Shirley & Rosén, 2010a). In the present study, the CMQ-N demonstrated an overall Cronbach's alpha of 0.86. See Appendix C.

Trauma Exposure and Severity

Trauma History Survey (THS). Trauma exposure was defined as having experienced one of the following nine incidents: 1) Death of a close loved one, 2) Very serious medical problem, 3) Close friend, significant other, or family member suffering from a serious medical condition, 4) Accident that led to serious injury to the respondent or someone close to them, 5) Place of residence being damaged by fire or other natural causes, 6) Divorce, 7) Physical or sexual assault, 8) Victimization related to a crime such as robbery or mugging, and 9) Being stalked. This definition of trauma was taken directly from Triplett et al.'s (2011) research on trauma history and meaning in life in samples of college students. As a part of this survey, participants were asked to indicate frequencies pertaining to each traumatic event, rate the perceived severity of each traumatic event ranging from 1 ("not severe") to 5 ("extremely severe"), and note when the traumatic event occurred. This measure was used to define trauma-related variables for analysis in this study: number of traumatic life events (#TLE), and severity of traumatic life events (Sev-TLE). Among participants in this sample, reliability analysis revealed overall Cronbach's alphas of .34 for #TLE and .37 for Sev-TLE. See Appendix D.

Exercise Habits.

Seven-Day Physical Activity Recall Scale (PAR). The PAR is a 10-item questionnaire designed to assess both work-related and recreational physical activity (Dishman & Steinhardt, 1988). Respondents are asked to estimate the number of hours they slept and spent in moderate, hard, and very hard physical activity during the past week. Test-retest reliability scores for the PAR were found to be .58 and .42 at three and seven weeks, respectively (Dishman & Steinhardt,

1988). High correlations ($r = .82$) were found between the self-administered PAR and daily diaries of physical activity. Additionally, measures of discriminant validity indicate that PAR results are consistent with measured cardiopulmonary fitness (Dishman & Steinhardt, 1988). A correlation of $r = .83$ was found between self-administered and interview versions of the PAR (Dishman & Steinhardt, 1988). In the present study, physical activity was measured using a self-report version of the PAR questionnaire. Reliability analysis for participants in this sample revealed a Cronbach's alpha of 0.55. See Appendix E.

Psychological Functioning.

Flourishing Scale (FS). The Flourishing Scale (Diener et al., 2009) is an eight-item self-report measure of perceived success in a number of areas, including relationships, optimism, self-esteem, and sense of purpose. Subjects are asked to respond to each item on a Likert-type scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). An overall score of psychological well-being is obtained by summing the total score of all eight items on the FS. Psychometric research regarding the reliability of the FS has revealed a Cronbach's alpha of 0.87 (Diener et al., 2010), as well as a Cronbach's alpha of 0.91 in the present study. Analyses of convergent validity have found strong correlations with the summed scores of other psychological well-being measures, including the Basic Need Satisfaction Scale ($r=0.78$) and the Ryff Scales of Psychological Well-Being ($r=0.73$) (Diener et al., 2010). See Appendix F.

Zung Self-Rating Depression Scale (SDS). The SDS (Zung, 1965) was developed as a self-report measure of depression symptom severity. Individual items were selected based on relevance to diagnostic criteria for depression as indicated in the DSM-IV. The SDS consists of 20 total Likert-scale items, with 10 of these keyed positively and 10 keyed negatively. Subjects are asked to indicate how often each item has been occurring in the recent past, with responses

ranging from 1 ("a little of the time") to 4 ("most of the time"). Overall severity of depression symptoms is assessed by summing the scores from all 20 items.

The SDS has been evaluated for a number of psychometric properties. The split-half reliability of the SDS was found to be 0.73 within a psychiatric population sample (Zung, 1972). A community survey also revealed a Cronbach's alpha of 0.79 (Knight et al., 1983), while the present study resulted in a Cronbach's alpha of 0.85. A significant correlation was found between the Zung SDS and the Depression Scale of the Minnesota Multiphasic Personality Inventory (r = 0.65) (Zung 1967). Strong correlations (ranging from 0.68 to 0.76) have been demonstrated between the SDS and the Hamilton Rating Scale for Depression (Biggs et al., 1978). See Appendix G.

Zung Self-Raing Anxiety Scale (SAS). The SAS (Zung, 1971) is a 20-item self-report instrument for measuring the severity of anxiety-related symptoms. Each item is rated on a four-point Likert-type scale ranging from 1 to 4. For each item, respondents are asked to indicate how frequently each symptom is true for them, ranging from "none of the time" to "most of the time." Fifteen of the items are positively keyed, and five are negatively keyed. Overall severity of anxiety symptoms is assessed by summing the scores from all 20 items. Internal consistency scores of the SAS were found to fall between 0.66 and 0.80, and convergent validity scores ranged from 0.56 to 0.81 when compared to the Hamilton Anxiety Rating Scale (Zung, 1971). Among participants in this study, the reliability analysis of the SAS resulted in a Cronbach's alpha of 0.86. See Appendix H.

College Adjustment Questionnaire (CAQ). The College Adjustment Questionnaire (Shirley & Rosén, 2010b) was designed to assess the social, academic, and emotional functioning of college students. Respondents are asked to indicate the accuracy of various

statements regarding their college experiences "at this point in time." These items are measured on a five-point Likert-type scale, which ranges from "not true" to "completely true." The CAQ has been found to have an overall Cronbach's alpha of 0.83 and a split-half reliability of 0.88 (Shirley & Rosén, 2010b), as well as an overall Cronbach's alpha off 0.87 in the present study. In comparison with the Student Adaptation to College Questionnaire, the convergent validity of the CAQ was demonstrated by a Pearson product-moment correlation coefficient of r=.67 (Shirley & Rosén, 2010b). See Appendix I.

Procedure

Following approval by the Institutional Review Board in October 2012, participants were recruited via an online listing which described the general purpose of this study as well as details regarding course credit compensation. Interested subjects were then directed to an online informed consent document (see Appendix J), including a discussion of possible risks/benefits associated with participation. Student participants were also guaranteed of their anonymity and confidentiality. Although students were asked to electronically sign the informed consent document, these signatures were only used to unlock participation in the study and were not linked to survey data in any way. Upon completion of informed consent procedures, participants were allowed access to an online survey consisting of demographic questions as well as the SDS, SAS, THS, PAR, CMQ, CAQ, and FS. Demographic questions were presented first, followed by a randomized sequence of all additional measures in order to control for any priming effects that might be related to order of presentation.

Because participants were asked about sensitive topics such as trauma history and present psychological functioning, post-survey debriefing included relevant psychoeducation as well as contact information for counseling and emergency services (see Appendix K). All students who

fully participated in this study received credit toward required elements of their introductory

psychology course as compensation.

CHAPTER III

Results

The majority of the statistical analysis included in this study was conducted via multiple linear regression, which necessitates the preliminary testing and validation of specific assumptions regarding sample data. In order to evaluate the assumption of normality, each of the variables of interest included in this study (number of traumatic events, severity of trauma exposure, weekly exercise, anxiety, depression, and college adjustment) was constructed as an individual distribution. These distributions were then evaluated both visually and statistically for evidence of extreme skewness and/or kurtosis, with all variables resulting in distributions skewed greater than two standard errors from zero. In order to produce distributions more congruent with the assumption of normality, each of the original variable sets was uniquely transformed. Variables with positive skew (traumatic events, severity, childhood maltreatment, physical exercise, depression, anxiety) were transformed either via log or square root transformation, while variables with negative skew (flourishing, college adjustment) were manipulated using reflected versions of these transformations. These types of statistical transformations have been recommended for the investigation of variously skewed data (Cohen, Cohen, West & Aiken, 2003; Howell, 2007; Tabachnik & Fidel, 2007;).

The assumptions of linearity and homogeneity of variance (homoscedasticity) are also crucial to the process of multiple linear regression. In order to verify these assumptions, individual scatter plots were generated based on predicted values (following transformation) for all possible pairs of dependent and independent variables. Linearity and homoscedasticity were verified via visual inspection of the resulting scatter plots, revealing no apparent violations of these assumptions across transformed variables.

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Locating Outliers

Prior to evaluating the hypotheses outlined above, a variety of visual and statistical analyses were conducted in order to assess for the possibility of outliers which might drastically alter the relationships between examined variables. First, all individual cases were visually scanned to check for signs of invalid data. A total of six cases were initially removed due to the identification of responses inconsistent with the survey questionnaire (i.e., reporting "drinking" as a source of physical activity). Further visual exploration revealed a number of cases demonstrating significant missing data, with a total of four cases removed based on the omission of at least one entire survey measure. Finally, visual examination of the remaining data was also accomplished via the generation of a series of box-plot graphs, resulting in the elimination of two cases reporting physical activity greater than two standard deviations above the mean and well beyond realistic possibility given the reporting period of one week.

These visual scanning procedures were also supplemented using statistical analysis of studentized residuals and Cook's Distance values, which provide a statistical representation of each case's residual error and resulting influence on the overall model (Belsley et al., 1980; Cook, 1982). Cases were identified as potentially problematic when resulting in a Cook's Distance value greater than $4/n$ (.006) (Bolen & Jackman, 1990) or a studentized residual exceeding +/- 2 (Belsey et al., 1980). These cases were then further visually examined in order to assess whether they represented valid data or instances of unrealistic/faulty survey response. A total of five additional cases were removed during this final step, resulting in a total sample of 587 participants to be included in further analysis.

Missing Data

In pursuit of maximum statistical accuracy and maintenance of acquired data, the process of multiple imputation (MI; Rubin, 1987) was used to facilitate analysis (rather than deletion) of cases with limited missing values. In multiple imputation, the original dataset is scanned and examined by statistical computing software, in order to evaluate scoring patterns and relationships between survey responses. Identified patterns are then used to generate multiple additional datasets, each with missing values replaced by unique imputations drawn from a distribution of likely values (Ruben, 1987). For the relevant analyses in this study, I generated a total of five new datasets, complete with imputed values. Results of this imputation process were then pooled, with the resulting data utilized in all statistical analyses.

Preliminary Analyses

An initial set of correlation analyses were conducted in order to evaluate the strength and directionality of the relationships between measures of trauma (CMQ, #TLE, Sev-TLE), weekly physical exercise (PAR-wkly), and psychological functioning (SDS, SAS, FS, CAQ). Resulting correlation coefficients can be found in Table 1, along with the pooled means and standard deviations of examined variables.

Correlational analysis between trauma exposure/severity and psychological functioning/college adjustment resulted in a number of disparate effects. Total CMQ scores were weakly and negatively correlated with CAQ $(r=-.28, p<.001)$ and FS $(r=-.22, p<.001)$, as well as demonstrating a weak positive correlation with SDS $(r=.29, p<.001)$, and a moderate correlation with SAS $(r=.30, p<.001)$. However, while #TLE and Sev TLE were associated with higher scores on depression and anxiety, they did not demonstrate any significant relationship with CAQ or FS. #TLE was weakly correlated with SDS at $(r=.10, p=.01)$, and SAS at $(r=.13,$

p=.002), while the association of Sev TLE with these variables [SDS *(r*=.13, *p*=.003), SAS *(r*=.16, *p*<.001)] was similarly significant and resulted in weak positive associations with both. See Table 1 for means and correlations of all examined variables.

Results of this data analysis also revealed significant relationships between PAR-wkly and a number of measures of adult psychological functioning. PAR-wkly scores were weakly and positively correlated with both CAQ *(r*=.10, *p*=.02), and FS *(r*=.17, *p*<.001), and demonstrated a weak negative correlation with SDS *(r*=-.11, *p*=.007). PAR-wkly was not similarly associated with SAS scores (*r*=-.07, *p*=.10). However, although total weekly exercise (PAR-wkly) was identified as the primary exercise variable of interest in the present study, both "high" (e.g., jogging) and "very high" (e.g., strenuous running) intensity physical activity were further evaluated in order to better understand the relationship between exercise and anxiety within this study sample. Interestingly, both "high" (*r*=-.11, *p*=.006) and "very high" (*r*=-.11, *p*=.009) intensity physical exercise were significantly and negatively (though weakly) correlated with anxiety, while "moderate" intensity exercise (*r*=.02, *p*=.57) was not. See Table 1 for means and correlations of included variables.

Research Question 1: Exercise as a moderator of the impact of traumatic events

A series of moderation analyses were conducted in order to test the hypothesis that PAR-wkly would significantly impact the strength and/or direction of the relationship between #TLE and adult psychological functioning measures (CAQ, SDS, SAS, FS). For this type of moderated multiple regression, Aiken and West (1991) suggested that each included variable first be centered at its respective mean. During moderation analysis, this process is crucial for limiting multillinearity and facilitating maximum interpretability of results (Barron & Kenny, 1986). For

the purposes of this study, each variable of interest was individually centered by subtracting respective variable means from all included cases.

The potential moderator effect of PAR-wkly on the relationship between #TLE and psychological functioning was evaluated using a sequence of multiple linear regression analyses. In the first of such procedures, PAR-wkly was evaluated as a potential moderator of the presumed relationship between #TLE and FS (See Table 2). This analysis revealed no significant predictive relationship between #TLE and FS (b=.11, p=.62), while PAR-wkly did appear as a significant predictor (b=.63, p<.001) when controlling for the effects of all other included variables.

Additionally, the hypothesized relationship between #TLE and FS was significantly moderated by the interaction between PAR-wkly and #TLE (b=-1.753, p=.02), with the individual effects of #TLE and PAR-wkly held constant. Analysis of simple slopes revealed that #TLE was associated with FS scores at one standard deviation below the mean of PAR-wkly (b=0.64, p=.049) but not at the mean (b=0.11, p=.8) or one SD above (b=-0.43, p=.15). When reverse-transformed, these regions correspond with PAR-wkly values of approximately seven, 17, and 33 weekly exercise hours. Using the procedures outlined by Preacher, Curran, & Bauer (2006) to probe a significant interaction, it was determined that PAR-wkly ceased to be associated with FS at #TLE values greater than 2.34. See Figure 1 for graphical representation of this moderation effect. Across the five datasets included in this pooled model, an average of 4% of the variance in FS was explained by the independent variables (R^2=.04).

Multiple linear regression analysis was also conducted to explore the relationship between #TLE, PAR-wkly, and CAQ scores (see Table 2). Results of this analysis indicated no significant relationship between #TLE and CAQ (b=-.38, p=.11) when controlling for all other

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included variables. PAR-wkly did significantly predict CAQ (b=.42, p=.01), though the interaction between #TLE and PAR-wkly was not similarly predictive (b=.004, p=.99). A total of approximately 2% of the variance in CAQ was accounted for by this model (R^2=.02).

The relationships between #TLE, PAR-wkly and negative outcome variables (SDS, SAS) were also explored via multiple linear regression (see Table 2). Both #TLE (b=.35, p=.02) and PAR-wkly (b-.30, p=.002) were uniquely predictive of SDS, though the interaction between these two variables was not a significant moderator (b=.35, p=.49). In sum, an approximate average 3% of the variance in SDS was accounted for by this model (R^2=.03). SAS scores were also significantly predicted by #TLE (b=.42, p=.002), but not by PAR-wkly (b=-.15, p=.09) or the interaction between these two predictors (b=.24, p=.61). See Table 2. This model accounted for an average of roughly 2% of the variance in SAS. (R^2=.02).

Research Question 2: Exercise as a moderator of the impact of trauma severity

A similar series of moderation analyses were conducted in order to test the hypothesis that PAR-wkly would significantly moderate the strength and/or direction of the hypothesized relationship between Sev-TLE and measures of adult psychological functioning (CAQ, SDS, SAS, FS). In the first multiple linear regression analysis, PAR-wkly was evaluated as a potential moderator of the relationship between Sev-TLE and FS (See Table 3). This analysis revealed no significant predictive relationship between Sev-TLE and FS (b=.01, p=.73), while PAR-wkly did appear as a significant predictor (b=.61, p<.001). In this model, the interaction between Sev-TLE and PAR-wkly was not a significant moderator of the relationship between Sev-TLE and FS (b=-.23, p=.07). Sev-TLE, PAR-wkly, and the interaction between these variables accounted for an approximate average of 3% of the variance in (R^2=.03).

Multiple linear regression analysis was also conducted to explore the predicted relationship relationship between SEV-TLE, PAR-wkly, and CAQ (see Table 3). With all other variables held constant, results of this analysis indicated a non-significant relationship between Sev-TLE and CAQ (b=-.08, p=.067). PAR-wkly did uniquely predict CAQ (b=-.41, p=.01), though the interaction between Sev-TLE and PAR-wkly was not similarly predictive (b=.05, p=.72). Across imputed datasets, this model accounted for an approximate average of 2% of the variance in CAQ (R^2=.02).

Similar exploration of the relationship between Sev-TLE, PAR-wkly, and SDS revealed significant associations between both Sev-TLE (b=.08, p=.003) and PAR-wkly (b=-.30, p=.003) as they related to SDS scores. The interaction between these two variables was not similarly predictive (b=.02, p=.87). Overall, this model predicted an average of approximately 3% of the variance in SDS (R^2=.03).

While Sev-TLE (b=.09, p<.001) was also significantly associated with SAS scores, PAR-wkly (b=-.15, p=.11) was not, and neither was the interaction between Sev-TLE and PAR-wkly as related to SAS (b=-.02, p=.76). See Table 3. Together, Sev-TLE, PAR-wkly, and the Sev-TLE/PAR-wkly interaction variable accounted for an average of 3.0% of the variance in SAS (R^2=.03).

Research Question 3: Exercise as a moderator of the impact of childhood maltreatment

The hypothesis that PAR-wkly would significantly moderate the presumed relationship between the CMQ and adult psychological functioning was also evaluated using multiple linear regression. In the initial model, PAR-wkly was evaluated as a potential moderator of the association between CMQ and FS (See Table 4). Both CMQ (b=-.44, p<.001) and PAR-wkly (b=.60, p<.001) independently predicted FS. Additionally, FS scores were significantly

moderated by the interaction between CMQ and PAR-wkly (b=-.57, p=.050), with the positive association between PAR-wkly and FS being gradually attenuated at higher levels of CMQ (see Figure 2). The simple slopes presented in this figure are significantly greater than zero at one standard deviation below the PAR-wkly mean (b=-0.26, p =.04), as well as at the mean (b=-0.44, p <.001) and one *SD* above (b=-0.61, p<.001). Following reverse-transformation, these regions corresponded with PAR-wkly values of approximately seven, 17, and 33 hours. Further probing this interaction via the procedures suggested by Preacher, Curran, & Bauer (2006) revealed that PAR-wkly was no longer associated with FS at CMQ scores of 36 or greater. Overall, this model accounted for an approximate average of 9% of the variance in FS (R^2=.09).

The hypothesized relationship between the CMQ, PAR-wkly, and CAQ was also examined via multiple linear regression (see Table 4). In this model, both CMQ (b=-.62, p<.001) and PAR-wkly (b=.37, p=.02) significantly predicted college adjustment. The interaction between these two variables was not similarly predictive of college adjustment (b=-.04, p=.89), indicating that PAR-wkly did not significantly moderate the impact of CMQ on CAQ. Across imputed datasets, this model predicted an approximate average of 9.0% of the variance in CAQ (R^2=.09).

A final pair of multiple linear regression models was generated to examine the predicted causal relationships between the CMQ, PAR-wkly, and SDS/SAS (see Table 4). Both CMQ (b=.38, p<.001) and PAR-wkly (b=-.30, p=.002) were significantly predictive of SDS. However, the interaction between these two variables was not similarly significant in predicting SDS (b=.38, p=.10). Together, these variables predicted an average of approximately 10% in the variance in SDS (R^2=.10).

CMQ scores ($b=.36$, $p<.001$) were also significantly associated with SAS, though the relationship between PAR-wkly and SAS ($b=-.14$, $p=.11$) was not similarly predictive. Among participants in this sample, SAS was not predicted by the interaction between PAR-wkly and CMQ ($b=.25$, p=.19). Imputed datasets of this model accounted for an average variance of 9% in SAS scores ($R^2=.09$).

CHAPTER IV

Discussion

Previous research has produced a significant body of evidence supporting the value of physical exercise as it relates to both physical and psychological health. In particular, the mental health benefits of physical activity have been demonstrated within multiple populations and across a wide variety of factors related to psychological well-being. In recent decades, the research base supporting exercise as an intervention for depression (i.e., Doyne et al., 1983; Greist et al., 1979; Kavanagh, Shepard, Tuck, & Oureshl, 1997) and anxiety (i.e., Bahrke & Morgan, 1978; Driscoll, 1976; Morgan, 1979;) has grown particularly robust, with additional areas of benefit including self-esteem (Calfas & Taylor, 1994; Gruber, 1986; McDonald & Hogdon, 1991; Spece, Poon, & Dyck, 1997), stress regulation (Long, 1984), PTSD symptoms (Schindler, 2010), and general mood (i.e., Folkins, 1976; Lichtman, 1983). Yet while existing research has thoroughly established the mental health benefits of physical exercise in broad terms, relatively less is known regarding possible selective benefits of physical activity as an intervention or protective factor for specific at-risk populations.

Individuals exposed to significant life traumas represent one particular population of interest. Although many individuals appear to demonstrate significant resilience in the face of such events, psychological trauma has nevertheless been identified as a crucial area for additional study and improved intervention. Additionally, it is important not only to identify promising treatment procotols for those suffering the effects of such traumas, but also to better understand the factors contributing to notable resilience (or lack thereof) when confronted with traumatic adversity. For these reasons, I chose to examine the possibility of physical exercise as a moderator of the negative impacts of psychological trauma. While physical exercise is

associated with wide-ranging mental health benefits among both humans and animals, including those with some traumatic exposure (i.e., Asoh et al., 1986; Maniam & Morris, 2010; Schindler, 2009; Bahrke & Morgan, 1978; Smith & Rotunda, 2011) there do not appear to be any existing studies regarding the possibly of differential exercise effects as a function of traumatic exposure.

Results of correlational analysis between variables included in this study were largely consistent with relationships identified in previous research. Among participating students, exercise was positively associated with flourishing and college adjustment, and negatively associated with depression. Interestingly, total weekly exercise was not significantly correlated with reductions in anxiety. However, this appears to have resulted from a significant presence of moderate-intensity physical activity (i.e., walking) within the PAR-wkly variable. When "high-intensity" exercise (e.g., jogging) and "very high-intensity" exercise (e.g., strenuous running) were directly examined, both of these measures were significantly and negatively correlated with anxiety scores. These results are consistent with previous studies, which have indicated that changes in both cortisol regulation (Jacks, Sowash, Anning, McGlouphlin, & Andres, 2002) and anxiety levels (Petruzello, Landers, Hatfield, Kubitz, & Salazar, 1991) occur specifically as a result of high-intensity aerobic exercise.

Childhood maltreatment was associated as expected with all included outcome variables, demonstrating negative associations with college adjustment and flourishing, as well as positive associations with depression and anxiety. This consistency was not obtained when examining number and severity of traumatic event exposures, however. Both number and severity of traumatic events were positively associated with depression and anxiety, but did not demonstrate signficant relationships with college adjustment or flourishing.

In part, this disparity might be explained by the inclusion of relatively normative traumatic experiences (e.g., death of a loved one) in the #TLE and Sev-TLE measures, which might result in notable symptoms of depression and/or anxiety but perhaps not the chronic and debilitating long-term effects often associated with childhood maltreatment (e.g., Nemeroff, 2004) and other more pervasive traumas. Although age of traumatic experience was not explicity examined in this study, it may also be that CMQ-identified traumas are more predictive of negative long-term consequences than #TLE and Sev-TLE simply because they are specific to the vulnerable stages of childhood and not broadly occuring across the lifespan. Alternatively, perhaps the "normative" traumas included in #TLE and Sev-TLE might increase symptoms of anxiety and depression without corresponding impacts on positive factors included in flourishing and college adjustment such as self-esteem, social relationships, etc. In other words, while some of the more normative experiences included in #TLE are assuredly traumatic, they may not be disruptive, debilitating, or life-altering to an extent that would significantly impact adult functioning beyond an increase in subjective psychological distress.

The differential impacts of childhood maltreatment, trauma exposure, and trauma severity can perhaps be best explained in light of the moderation analyses included in this study. Despite demonstrating a positive association with college adjustment and a negative association with symptoms of anxiety and depression, physical exercise did not significantly impact the strength or direction of the influence of trauma on either of these outcome variables. In other words, while exercise was related to general benefits in college adjustment and depression symptoms among participants, these effects were not differentially expressed across varying levels of trauma exposure and severity. Though physical exercise remains a viable candidate for facilitating resilience or recovery in the face of psychological trauma, it does not result in any

unique benefits for trauma-exposed individuals when compared to college students with lesser traumatic experience.

The interaction between physical exercise and psychological trauma was not identified as a significant predictor of depression, anxiety, or college adjustment, but weekly exercise did significantly interact with both childhood maltreatment and trauma exposure (#TLE) as related to psychological flourishing (FS). Despite demonstrating a significant correlation with psychological flourishing in general, the relative benefits of exercise were progressively attenuated at higher levels of traumatic experience. In both models, weekly physical exercise was identified as a significant contributor to psychological flourishing at low and moderate levels of trauma exposure, but this effect was reduced to non-significance at high levels of such exposure.

Rather than contributing to selective benefits for the physiological and psychological processes most damaged by exposure to trauma, it may instead be that such damage inherently limited the ability of physical activity to exert positive influence on these areas (at least as they relate to psychological flourishing). Alternatively, perhaps this result simply reflects the previously-identified difficulties in treating severe traumatic experience (Armsworth & Holaday, 1993; Nemeroff, 2004) - indicating more global resistance to treatment or impairment of resilience that is not exclusive to exercise-based interventions alone. While this is a concerning possibility, it is certainly not unreasonable to suggest that individuals most "damaged" would face the most difficult road to recovery.

The apparent attenuation of exercise-related flourishing benefits at high levels of trauma might also be explained by general differences in the type or purpose of exercise participation. Although exercise may typically be a healthy practice among individuals with relatively limited trauma-exposure, high levels of exercise may be more likely to represent compulsive, negative

coping practices among those with greater traumatic experience. In theory, this phenomenon might not only explain the attenuated benefits of exercise among high-trauma subjects, but could potentially also *inhibit* psychological flourishing among some individuals as a function of this behavior. In either case, the presence of such an effect could potentially mask any significant benefits that might be associated with physical activity among those high-trauma individuals who maintain healthy exercise habits.

As previously mentioned, the results of this moderation analysis also suggest some interesting phenomena behind the observed differences in symptom presentation related to childhood maltreatment (CMQ) and trauma exposure (#TLE) within this sample. Individuals with low levels of exercise produced the lowest flourishing scores, yet those in this group actually demonstrated higher flourishing at greater levels of trauma exposure (#TLE). Although this effect was actually reversed at higher levels of exercise, it may indicate some contribution of even minimal exercise as a moderator of trauma-related pathology. Among individuals with extreme trauma exposure, perhaps the addition of even a relatively minor protective factor may contribute to significant benefits with regard to resilience and recovery – though this effect is gradually attenuated as exercise levels increase toward the point of possible excess.

Alternatively, this effect may be explained in part by the phenomenon of posttraumatic growth (Tedeschi and Calhoun, 1996), or some form of positive psychological change as a result of facing and overcoming adversity. At higher levels of traumatic exposure (#TLE) and low levels of exercise, participants' greater flourishing may perhaps be attributed to experiencing (and overcoming) trauma itself. Although posttraumatic growth was not explicity measured by this study, its presence has been identified across a wide variety of trauma-exposed populations

(e.g., Engelkemeyer & Marwit, 2008; Levine et al., 2008) and thus may have contributed to the observed relationship between trauma and flourishing in the #TLE model.

The overall assocation between exercise, trauma, and flourishing was similar in the childhood maltreatment model; with the general benefits of exercise becoming gradually attenuated at higher levels of maltreatment. However, while there were some positive associations between trauma and flourishing in the #TLE model, greater childhood maltreatment was consistently related to lower psychological flourishing at all levels of physical exercise. Whether due to the occurrence of identified traumas during the vulnerable stages of childhood or inherent differences in the *types* of traumas reported, there was no significant evidence of any trauma-related benefits in the childhood maltreatment model.

Limitations and Directions for Future Research

There are a number of limitations to the present study that should be considered by any researchers wishing to replicate or build upon these results. First, it should be noted that the sample included in this study was comprised entirely of undergraduate students who are likely to be in some ways more privileged or higher-functioning than the general population. In many ways, this is supported by the observed skew in many of the included variable distributions, with "negative variables" (#TLE, Sev-TLE, SDS, SAS) all demonstrating positive skew, and positive outcome variables (FS, CAQ) all demonstrating negative skew. Additionally, the fact that all included subjects are current participants in higher education suggests that they have (in many ways) been largely resilient in the face of previous traums. If true, this may not only have limited the impact of traumatic experiences within this sample, but also contributed to the possible influence of posttraumatic growth in the FS/#TLE moderation model. In light of this, further

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research is recommended prior to generalizing the results of this analysis to more varied demographic populations.

This study was also limited in many ways by the reliance on self-report data for the measurement of all examined variables. Although traumatic experience cannot be easily or ethically replicated in a clinical research setting, the benefits of physical activity on individual functioning are likely to be best measured via random assignment of a carefully-controlled exercise protocol. Additionally, while the Physical Activity Recall is considered a valid measure of both short and long-term exercise habits (Dishman & Steinhardt, 1988), bulk measurement of hourly exercise does little to control for the potentially disparate effects of exercise type (i.e., yoga, jogging, etc.). This is especially problematic when considering the possibility of compulsive exercise, overtraining, or negative coping; which might contribute to significantly different ouctomes than more adaptive forms of physical activity. Though exercise *intensity* was differentiated during data collection, this was not included as a variable of interest due to the emphasis of target hypotheses on overall exercise habits. For these reasons, future studies might better evaluate the impact of exercise on post-trauma functioning via inclusion of activity measures with greater discrimination of exercise type and intensity.

It may also be beneficial for future studies to examine a greater variety of trauma and outcome measures. Because trauma exposure (#TLE), severity (Sev-TLE), and childhood maltreatment (CMQ) each demonstrated unique relationships with measures of psychological functioning, there appears to be a significant amount of variance in the impact of different types of traumas. In particular, it would be useful to more clearly differentiate any distinctions between the impact of trauma during childhood and later in life. Although childhood maltreatment demonstrated a much greater impact on psychological outcomes than number of traumatic events

or severity of those traumatic events; it is presently unclear whether this effect results from age of exposure, type of traumas measured, or possible differences in the validity of these measures. In light of this, further exploration of these disparities may provide important insight into future intervention development for varying types or degrees of trauma exposure.

Finally, it would be useful for future studies to include a greater variety of psychological outcome measures. While flourishing was significantly predicted by the interaction between exercise and trauma exposure/childhood maltreatment, it is unclear what properties of this variable resulted in such a relationship when anxiety, depression, and college adjustment were not similarly predicted. Because the Flourishing Scale provides only a very broad measure of individual well-being, examination of more specific outcome variables (e.g., self-esteem) might better identify any components of psychological well-being that become more resistant to intervention following trauma.

Implications

Previous studies have identified a broad variety of physiological and psychological benefits associated with participation in physical exercise. Yet while some researchers have examined the possibilities of exercise specifically as an intervention for victims of psychological trauma, very little has been done to evaluate whether any resulting benefits might be differentially expressed based on severity of trauma. In the present study, I examined whether physical exercise might demonstrate differential associations with psychological functioning as a function of increasing trauma exposure. Rather than resulting in greater benefits for those with significant trauma-exposure, exercise-related mental health benefits were either consistent across varying trauma levels or became attenuated at higher levels of trauma.

These results are not surprising given previously-identified difficulties associated with the treatment of severe trauma victims. With this in mind, it is in fact encouraging to note that the benefits of physical exercise on college adjustment, depression, and anxiety were similarly significant regardless of trauma exposure, and that psychological flourishing – though attenuated at higher trauma levels – was predicted by exercise participation within the total sample. Overall, while exercise did not demonstrate any particularly strong associations with psychological well-being at high levels of trauma exposure, many of the general benefits were largely maintained regardless of traumatic experience. Based on these findings, healthy physical exercise continues to present a promising form of intervention related to physical and psychological health, not only for members of the general population but for victims of trauma as well.

Tables

Table 1

Variable Means, Standard Deviations, and Intercorrelations

Variable	M	SD	1	2	3	4	5	6	7	8
1. #TLE	1.73	1.23	1							
2. Sev-TLE	6.91	5.18	.96**	1						
3. CMQ	10.12	13.38	.18**	.17**	1					
4. FS	48.97	6.17	.02	.01	-.22**	1				
5. SDS	37.29	8.90	.10*	.13**	.29**	-.62**	1			
6. SAS	33.34	7.93	.13**	.16**	.30**	-.45**	.75**	1		
7. CAQ	52.31	9.51	-.07	-.08	-.28**	.58**	-.61**	-.50**	1	
8. PAR-wkly	17.20	13.49	.002	-.003	.004	.16**	-.12**	-.07	.10**	1

   *Indicates significance at <.05

   **Indicates significance at <.01

Table 2.

Results of multiple regression analysis exploring weekly exercise as a potential moderator of the relationship between trauma exposure and 1) psychological flourishing 2) college adjustment 3) anxiety, and 4) depression.

	B	SE (B)	t	p
Dependent Variable: Flourishing				
Traumatic Life Events	.11	.22	.49	.62
Total Weekly Exercise	.63	.15	4.2	<.001
Traumatic Life Events x Weekly Exercise	-1.75	.73	-2.37	.02
Constant	2.62			
Dependent Variable: College Adjustment				
Traumatic Life Events	-.42	.05	-1.68	.09
Total Weekly Exercise	.38	.24	2.40	.02
Traumatic Life Events x Weekly Exercise	-.004	.80	0.04	.94
Constant	4.16			
Dependent Variable: Depression				
Traumatic Life Events	.35	.15	2.35	.02
Total Weekly Exercise	-.30	.10	-3.05	.002
Traumatic Life Events x Weekly Exercise	.35	.50	069	.49
Constant	6.06			
Dependent Variable: Anxiety				
Traumatic Life Events	.42	.14	3.06	.002
Total Weekly Exercise	-.15	.09	-1.68	.09
Traumatic Life Events x Weekly Exercise	.24	.47	0.51	.61
Constant	5.7			

Note: R^2 = .04 in flourishing model, .02 in college adjustment model, .03 in depression model, and .02 in anxiety model.

Table 3.

Results of multiple regression analysis exploring weekly exercise as a potential moderator of the relationship between trauma severity and psychological flourishing, college adjustment, anxiety, and depression.

	B	SE (B)	t	p
Dependent Variable: Psychological Flourishing				
Severity of Traumatic Events	.01	.04	0.35	.69
Total Weekly Exercise	.61	.15	4.09	<.001
Severity of Traumatic Events x Weekly Exercise	-.23	.13	1.79	.07
Constant	2.62			
Dependent Variable: College Adjustment				
Severity of Traumatic Events	-.08	.04	-1.83	.07
Total Weekly Exercise	.41	.16	2.56	.1
Severity of Traumatic Events x Weekly Exercise	.05	.14	0.36	.72
Constant	4.16			
Dependent Variable: Depression				
Severity of Traumatic Events	.08	.03	2.97	.003
Total Weekly Exercise	-.30	.10	-3.00	.003
Severity of Traumatic Events x Weekly Exercise	.02	.09	0.17	.87
Constant	6.06			
Dependent Variable: Anxiety				
Severity of Traumatic Events	.09	.02	3.72	<.001
Total Weekly Exercise	-.15	.09	-1.60	.11
Severity of Traumatic Events x Weekly Exercise	-.02	.08	-0.30	.76
Constant	5.7			

Note: R^2 = .03 in flourishing model, .02 in college adjustment model, .03 in depression model, and .03 in anxiety model.

Table 4.

Results of multiple regression analysis exploring weekly exercise as a potential moderator of the relationship between childhood maltreatment and psychological flourishing, college adjustment, anxiety, and depression.

	B	SE (B)	t	p
Dependent Variable: Psychological Flourishing				
Childhood Maltreatment	-.44	.09	-4.86	<.001
Total Weekly Exercise	.62	.15	4.07	<.001
Childhood Maltreatment x Weekly Exercise	-.57	.29	-1.97	.05
Constant	2.62			
Dependent Variable: College Adjustment				
Childhood Maltreatment	-.62	.10	-6.20	<.001
Total Weekly Exercise	.37	.16	2.30	.02
Childhood Maltreatment x Weekly Exercise	-.04	.32	-0.14	.89
Constant	4.15			
Dependent Variable: Depression				
Childhood Maltreatment	.38	.06	6.53	<.001
Total Weekly Exercise	-.30	.10	-3.03	.002
Childhood Maltreatment x Weekly Exercise	.30	.19	1.65	.10
Constant	-6.05			
Dependent Variable: Anxiety				
Childhood Maltreatment	.36	.06	6.20	<.001
Total Weekly Exercise	-.14	.90	-1.59	.11
Childhood Maltreatment x Weekly Exercise	.25	.19	1.31	.19
Constant	5.73			

Note: R^2 = .09 in flourishing model, .09 in college adjustment model, .10 in depression model, and .09 in anxiety model.
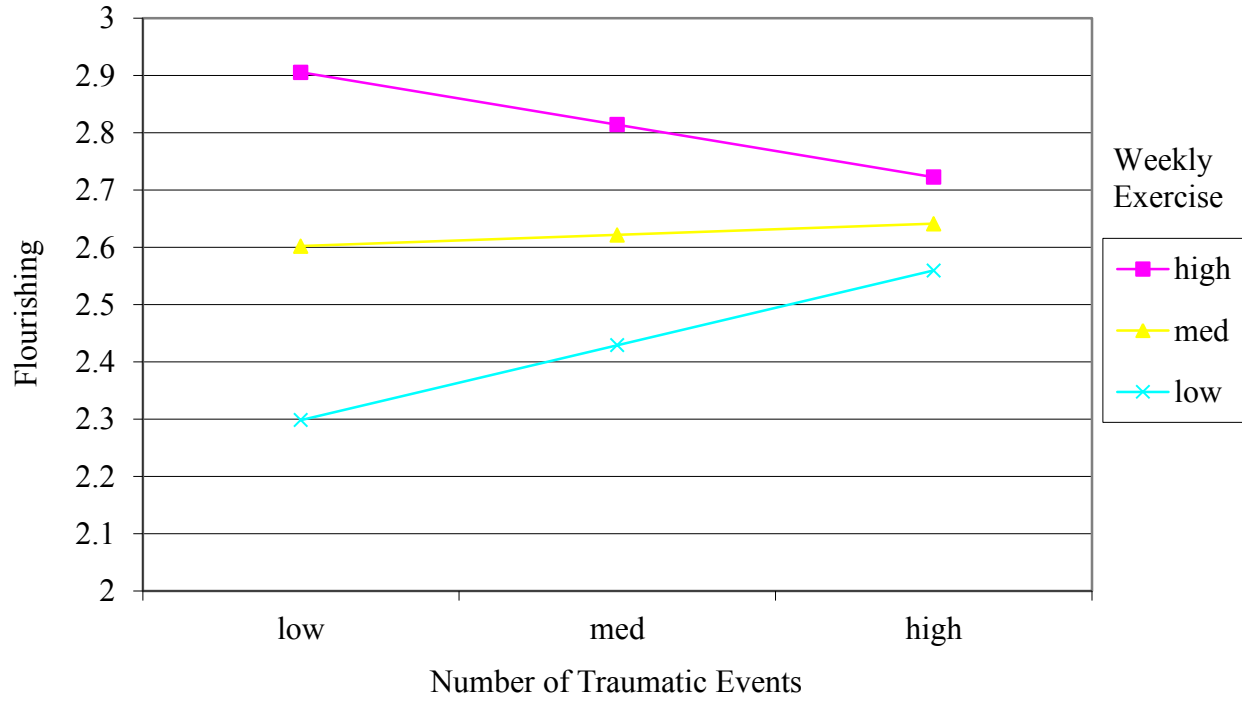
Figure 1. Differential Effect of Traumatic Events on Flourishing by Weekly Physical Exercise

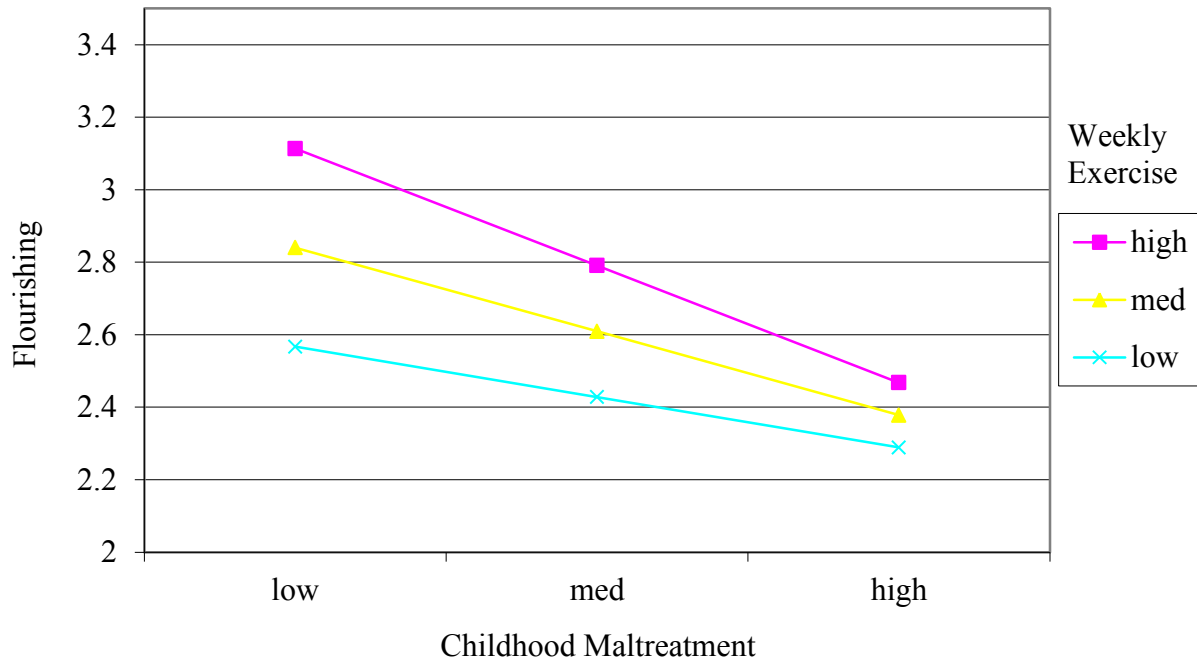Note: Figure describes relationships between transformed variables.

Figure 2. Differential Effect of Childhood Maltreatment on Flourishing by Weekly Physical Exercise

Note: Figure describes relationship between transformed variables.

References

Apolinsky, S. R., & Wilcoxon, S. A. (1991). Adult survivors of childhood sexual victimization: A group procedure for women. *Family Therapy, 18,* 37-45.

Apolinsky, S. R., & Wilcoxon, S. A. (1991). Symbolic confrontation with women survivors of childhood sexual victimization. *Journal for Specialists in Group Work, 16,* 85-90.

Armsworth, M. W., & Holaday, M. (2001).The effects of psychological trauma on children and adolescents. *Journal of Counseling & Development, 72,* 49-56.

Asis, M. A., Mello, M. F., Scorza, F. A., Cadrobbi, M. P.,, Schooedl, A. F., Silva. S. G., de Albuquerqe, M., da Silva, A. C., Arida, R. M. (2008). Evaluation of physical activity habits in patients with posttraumatic stress disorder. *Clinics, 63,* 473-478.

Asoh, T., Takeuchi, Y., Tsuji, H. (1986). Effect of voluntary exercise on resistance to trauma in rats. *Circulatory Shock, 20,* 259-267.

Atlantis, E., Chow, C. M., Kirby, A., & Singh, M. F. (2004). An effective exercise-based intervention for improving mental health and quality of life measures: A randomized controlled trial. *Preventative Medicine, 39*, 424-434.

Bahrke, M. S., & Morgan, W. P. (1978). Anxiety reduction following exercise and meditation. *Cognitive Therapy and Research, 2,* 323-333.

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: psychometric properties. Journal of Consulting and Clinical Psychology, 56, 893–897.

Berman, S., Kurtines, W., Silverman, W., & Serafini, L. (1996). The impact of exposure to crime and violence on urban youth. *American Journal of Orthopsychiatry, 66,* 329-336.

Bremner, J. D., (2008). Effects of traumatic stress on brain structure and function: Relevance to early responses to trauma. *Journal of Trauma & Dissociation*, *6*, 51-68.

Breslau, N., Davis, G. C., Peterson, E. L., & Schultz, L. R. (2000). A second look at comorbity in victims of trauma: The posttraumatic stress disorder-major depression connection. *Biological Psychiatry, 48,* 902-909.

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

Calfas, K.J., & Taylor, W.C. (1994). Effects of physical activity on psychological variables in adolescents. *Pediatric Exercise Science, 6,* 406–423.

Centers for Disease Control (1997). *Adverse Childhood Experiences Study*. Available from: 1

Centers for Disease Control (2008). The effectiveness of interventions to reduce psychological harm from traumatic events among children and adolescents: A systematic review. *American Journal of Preventative Medicine, 35,* 287-313.

Chytrova, G., Ying, Zhe, & Gomez-Pinilla, F. (2008). Exercise normalizes levels of MAG and Nogo-A growth inhibitors after brain trauma. *European Journal of Neuroscience, 27,* 1-11.

Clemmons, J.C., Walsh, K., DiLillo, D., and Messman-Moore, T.L. (2007). Unique and combined contributions of multiple child abuse types and abuse severity to adult trauma symptomatology. *Child Maltreatment, 12*, 172-181.

Cohen, J. A., Deblinger, E., & Mannarino, A. (2004). Trauma-focused cognitive-behavioral therapy for sexually abused children. *Psychiatric times, 21*.

Cohen, J. A., & Mannarino, A. P. (2008). Trauma-focused cognitive-behavioral therapy for children and parents. *Child and Adolescent Mental Health, 13,* 158-162.

Collishaw, S., Pickles, A., Messer, J., Rutter, M., Shearer, C., & Maughan, B. (2007). Resilience to adult psychopathology following childhood maltreatment: Evidence from a community sample. *Child Abuse and Neglect, 31,* 322-327.

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. *Trends in neurosciences, 6,* 295-301.

Cotman, C. W., & Berchtold, N. C. (2002). Exercise: A behavioral intervention to enhance brain health and plasticity. *Trends in Neuroscience, 25,* 295-301.

Craft, L.L. (1997). *The effect of exercise on clinical depression and depression resulting from mental illness: A meta-analysis.* Unpublished master's thesis, Arizona State University, Tempe.

Diaz, A. B., & Motta, R. W. (2008). The effects of an aerobic exercise program on posttraumatic stress disorder symptom severity in adolescents. *International Journal of Emergency Mental Health, 10,* 49-59.

Diener, E., Wirtz, D., Tov., W., Kim-Prieto, C., Choi, Dong-won, Oishi, S., & Biswas-Diener, R. (2010). New well-being measures: Short scales to assess flourishing and positive and negative feelings. *Social Indicators Research, 97,* 143-156.

Dilove, D., Steel., Z., McGorry, P., & Mohan, P. (2007). Trauma exposure, postmigration stressors, and symptoms of anxiety, depression, and post-traumatic stress in Tamil asylum-seekers: comparison with refugees and immigrants. *Acta Psychiatrica Scandinavica, 97,* 175-181.

Ding, Q., Vaynman, S., Akhavan, M., Ying, Z., & Gomez-Pinilla, F. (2006). Insulin-like growth factor I interfaces with brain-derived neurotrophic factor-mediated synaptic plasticity to modulate aspects of exercise-induced cognitive function. *Neuroscience, 140,* 823-833.

Doyne, E. J., Chambless, D. L., & Beutler, L. E. (1983). Aerobic exercise as a treatment for depression in women. *Behavior Therapy, 14*, 434-440.

Driscoll, R. (1976). Anxiety reduction using physical exertion and positive images. *The Psychological Record, 26*, 87-94.

Eker, C., Kitkis, O., Taneli, F., Eker, O. Z., Ozan, E., Yucel, K., Coburn, K., & Gonul, A. S. (2009). Correlation of serum BDNF levels with hippocampal volumes in first episode, medication-free depressed patients. *European Archives of Psychiatry and Clinical Neuroscience, 260,* 527-533.

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., Kim, J. S., Heo, S., Alves, H., White, S. M., Wojcicki, T. R., Mailey, E., Vieira, V. J., Martin, S. A., Pence, B. D., Woods, J. A., McAuley, E., & Kramer, A. F. (2010). Exercise training increases size of hippocampus and improves memory. *PNAS, 108*, 3017-3022.

Etherington, K. (2000). Supervising counselors who work with survivors of childhood sexual abuse. *Counselling Psychology Quarterly, 13*, 377-389.

Feiring, C., Simon, V., & Cleland, C. (2009). Childhood sexual abuse, stigmatization, internalizing symptoms, and the development of sexual difficulties and dating aggression. *Journal of Consulting and Clinical Psychology, 77*, 127-137.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., & Edwards V. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *American Journal of Preventative Medicine, 14,* 245-258.

Fitzpatrick, K. M., & Boldizar, J. P. (1993). The prevalence and consequences of exposure to

>   violence among African-American youth. *Journal of the American Academy of Child and*

>   *Adolescent Psychiatry, 32*, 424–430.

Folkins, C. H. (1976). Effects of physical training on mood. *Journal of Clinical Psychology, 32,*

>   385-388.

Fordyce, D. E., & Wehner, J.M. (1993). Physical activity enhances spatial learning performance

>   with an associated alteration in hippocampal protein kinase C activity in C57BL/6 and

>   DBA/2 mice. *Brain Resilience, 619,* 111-119.

Fu-Sheng, B., Xu-Guang, G., Li-Li, H. et al. (2002). Effect of aerobic physical exercise on

>   amygdala-kindling development. *Journal of Apoplexy and Nervous Diseases*.

Gauvin, L. & Brawley, L. R. (1993). Alternative psychological models and methodologies for

>   the study of exercise and affect. In P. Seraganian (Ed.), *Exercise Psychology: The*

>   *influence of physical exercise on psychological processes* (pp. 146-171). New York:

>   John Wiley & Sons, Inc.

Gilbertson, M. W., Shenton, M. E., Ciszewski, A., Kasai, K., Lasko, N. B., Orr, S. P., & Pitman,

>   R. K. (2002). Smaller hippocampal volume predicts pathologic vulnerability to

>   psychological trauma. *Natural Neuroscience, 5,* 1242-1247.

Gobin, R.L. & Freyd, J.J. (2009). Betrayal and revictimization: Preliminary findings.

>   *Psychological Trauma: Theory, Research, Practice, and Policy, 1,* 242-257.

Gray, M. J., Litz, B. T., Hsu, J. L., & Lombardo, T. W. (2004). Psychometric properties of the

>   Life Events Checklist. *Assessment, 11*, 330 –341.

Greist, J. H., Klein, M. H., Eischens, R. R., Faris, J., Gurman, A. S., & Morgan, W. P. (1978).

>   Running through your mind. *Journal of Psychosomatic Research, 22,* 259-294.

Greist, J. H., Klein, M. H., Eischens, R. R., Faris, J., Gurman, A. S., & Morgan, W. P. (1979). Running as treatment for depression. *Comprehensive Psychiatry, 20,* 41-54.

Gruber, J. J. (1986). Physical activity and self-esteem development in children. In G.A. Stull & H.M. Eckert (Eds.), *Effects of physical activity and self-esteem development in children.* Champaign, IL: Human Kinetics Publishers.

Hanson, S. M., Francis, D. J., Vishnivetskiy, S. A., Kolobova, E. A., Hubbell, W. L., Klug, C. S., & Gurevich, V. V. (2006). Differential interaction of spil-labeled arrestin with inactive and active phosphordopsin. *Proceedings of the National Academy of Sciences, 103,* 4900-4905.

Hassmén, P., Koivula, N., & Uutela, A. (2002). Physical exercise and psychological well-being: A population study in Finland. *Preventive Medicine, 30,* 17-25.

Helm, C., & Nemeroff, C. B. (2001). The role of childhood trauma in the neurobiology of mood and anxiety disorders: Preclinical and clinical studies. *Biological Psychiatry, 49*, 1023-1039.

Howell, D. C. (2007). Statistical methods for psychology (6th ed.). Belmont, CA: Thomson Wadsworth.

Jacks, D. E., Sowash, J., Anning, J., McGloughlin, T., & Andres, F. (2002). Effect of exercise at three exercise intensities on salivary cortisol. *Journal of Strength & Conditioning Research, 16*.

Kalynchuk, L. E., & Meaney, M. J. (2003). Amygdala kindling increases fear responses and decreases glucocorticoid receptor mRNA expression in hippocampal regions. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 27,* 1125-1234.

Kavanagh, T., Shepard, R. J., Tuck, J.A., Qureshi, S. (1977). Depression following myocardial infarction: The effects of distance running. *Ann N Y Acad Sci.*, *301,* 1029-1038.

Korner, H., Winje, D., Ekeberg, O., Weisaeth, L., Kirkehei, I., Johansen, K. & Steiro, A. (2008). Early trauma-focused cognitive-behavioural therapy to prevent chronic post-traumatic stress disorder and related symptoms: A systematic review and meta-analysis.

Kramer, A.F., Hahn, S., Cohen, N.J., Banich, M.T., McAuley, E., Harrison, C.R., Chason, J., Vakil, E., Bardell, L., Boileau, R.A., & Colombe, A. (1999). Aging, fitness, and neurocognitive function. *Nature, 400,* 418-419.

Kubany, E. (2004). *Traumatic Life Events Questionnaire and PTSD Screening and Diagnostic Scale.* Los Angeles, CA: Western Psychological Services.

Kubany, E., Haynes, S., Leisen, M., Owens, J., Kaplan, A., Watson, S., et al. (2000). Development and preliminary validation of a brief broad-spectrum measure of trauma exposure: The Traumatic Life Events Questionnaire. *Psychological Assessment, 12*, 210-224.

Kugler, J., Seelback, H., & Krüskemper, G.M. (1994). Effects of rehabilitation exercise programmes on anxiety and depression in coronary patients: A meta-analysis. *British Journal of Clinical Psychology, 33,* 401–410.

Landers, D.M., & Petruzzello, S.J. (1994). Physical activity, fitness, and anxiety. In C. Bouchard, R.J. Shephard, & T. Stevens (Eds.), *Physical activity, fitness, and health.* Champaign, IL: Human Kinetics Publishers.

Lanius, R. A., Vermetten, E., Loewenstein, R. J., Brand, B., Schmahl, C., Bremner, J. D., Spiegel, D. (2010). Emotion regulation in PTSD: Clinical and neurobiological evidence for a dissociative subtype. *American Journal of Psychiatry, 167,* 640-647.

Laurin, D., Verreault, R., Lindsay, J., MacPherson, K., Rockwood, K. (2001). Physical activity and risk of cognitive impairment and dementia in elderly persons. *Archives of Neurology, 58,* 498-504.

Leveine, S. Z., Laufer, A., Hamama-Raz, Y., Stein, E., & Solomon, Z. (2008). Posttraumatic growth in adolescence: Examining its components and relationship with PTSD. *Journal of Traumatic Stress, 21,* 492-496.

Lewis, G. M., Cohen, H., & Schwartz (2008). Reducing post-traumatic anxiety by immunization. *Brain, Behavior, and Immunity, 22,* 1108-1114.

Lewitus, G. L., Cohen, H., & Schwartz, M. (2008). Reducing post-traumatic anxiety by immunization. *Brain, Behavior, and Immunity, 22,* 1108-1114.

Lichtman, S., & Poser, E. G. (1983). The effects of exercise on mood and cognitive functioning. *Journal of Psychosomatic Resilience, 27,* 43-52.

Liem, J. H., O'Tolle, J. G., & James, J. B. (1996). Themes of power and betrayal in sexual abuse survivors' characterizations of interpersonal relationships. *Journal of Traumatic Stress, 9,* 745-761.

Litz, B. T., Gray, M. J., Bryant, R. A., & Adler, A. B. (2006). Early intervention for trauma; Current status and future directions. *Clinical Psychology: Science and Practice, 9,* 112-134.

Long, B.C., & van Stavel, R. (1995). Effects of exercise training on anxiety: A meta-analysis. *Journal of Applied Sport Psychology, 7,* 167–189.

Maniam, J., & Morris, M. J. (2010). Voluntary exercise and palatable high-fat diet both improve behavioural profile and stress responses in male rats exposed to early life stress: Role of hippocampus. *Psychoneuroendocrinology, 35,* 1553-1564.

Mastorakos, G., Pavlatou, M., Diamanti-Kandarakis, E., & Chrousos, G. P. (2005). Exercise and the stress system. *Hormones, 4*, 73-89.

MacMillan, H.L., Fleming, J.E., Steiner, D.L., Lin, E., Boyle, M.H., Jamieson, E., et al. (2001). Childhood abuse and lifetime psychopathology in a community sample. *American Journal of Psychiatry, 158*(11), 1878-1883.

McAllister, T. W., & Stein, M. B. (2010). Effects of psychological and biomechanical trauma on brain and behavior. *Annals of the New York Academy of Sciences, 18,* 46-57.

McCauley, J., Kern D., E., Kolodner, K., Dill, L., Schroeder, A. F., & DeChant (1997). Clinical characteristics of women with a history of childhood abuse. *JAMA, 277*, pp. 1362–1368

McCutcheon, V. V., Sartor, C. E., Pommer, N. E., Bucholz, K. K., Nelson, E. C., Madden, P. A. F., & Heath, A. C. (2010). Age at trauma exposure and PTSD risk in young adult women. *Journal of Traumatic Stress, 23*, 811-814.

McDonald, D.G., & Hodgdon, J.A. (1991). *The psychological effects of aerobic fitness training: Research and theory.* New York: Springer-Verlag.

McGloin, J.M. & Widom, C.S. (2001). Resilience among abused and neglected children grown up. *Development and Psychopathology, 13,* 1021-1038.

McNally, R. J., Bryant, R. A., & Ehlers, A. (2003). Does early psychological intervention promote recovery from posttraumatic stress? *Psychological Science in the Public Interest, 4,* 45-79.

Medina, J. L., Vujanovic, A., A., Smits, J. A., Irons, J. G., Zvolensky, M. J., & Bonn-Miller, M. O. (2011). Exercise and coping-oriented alcohol use among a trauma-exposed sample. *Addictive Behaviors, 36,* 274-277.

Meyer, R. K., & Shipley, E. G. (1945). The production of shock in rats by the drum method. *Experimental Biology and Medicine, 60,* 334-337.

Milad, M. R., Orr, S. P., Pitman, R. K., & Rauch, S. L. (2005). Context modulation of memory for fear extinction in humans. *Psychophysiology, 42,* 456-464.

Maercker, A., Beauducel, A., & Schutzwohl, M. (2000). Trauma severity and initial reactions as precipitating factors for posttraumatic stress symptoms and chronic dissociation in former political prisoners. *Journal of Traumatic Stress, 13,* 651-660.

Molteni, R., Ying, Z., & Gómez-Pinilla (2002). Differential effects of acute and chronic exercise on plasticity-related genes in rat hippocampus revealed by microarray. *European Journal of Neuroscience, 16,* 1107-1116.

Morgan, W. P. (1979). Negative addiction in runners. *The Physician and Sportmedicine, 7,* 57-71.

Morgan, M. and LeDoux, J. (1995). Differential contribution of dorsal and ventral medial prefrontal cortex to the acquisition and extinction of conditioned fear in rats. *Behavioral Neuroscience, 109,* 681-688.

Mullen, P. E., Martin, J., L., Anderson, J. C., Romans, S. E., & Herbison, G. P. (1996). The long-term impact of the physical, emotional, and sexual abuse of children: A community study. *Child Abuse and Neglect, 20,* 7-21.

Nemeroff, C. B. (2004). Neurobiological consequences of childhood trauma. *Journal of Clinical Psychiatry, 65*, 18-28.

Newman, C. L., & Motta, R. W. (2007). The effects of aerobic exercise on childhood PTSD, anxiety, and depression. *International Journal of Emergency Mental Health, 9,* 133-158.

North, T.C., McCullagh, P., & Tran, Z.V. (1990). Effect of exercise on depression. *Exercise and Sport Science Reviews, 18,* 379–415.

O'Connor, P. J., Morgan, W. P., Raglin, J. S., Barksdale, C. M., & Kalin, N. H. (2000). Mood state and salivary cortisol levels following overtraining in female swimmers. *Psychoneuroendocrinology, 14,* 303-310.

O'Donnell, M. L., Creamer, M., Pattison, P. (2004). Posttraumatic stress disorder and depression following trauma: Understanding comorbidity. *American Journal of Psychiatry, 161,* 1390-1396.

Petruzzello, S.J., Landers, D.M., Hatfield, B.D., Kubitz, K.A., & Salazar, W. (1991). A meta-analysis on the anxiety-reducing effects of acute and chronic exercise. *Sports Medicine, 11(3),* 143–182.

Phelps, E.A., LeDoux, J.E. (2005). Contributions of the Amygdala to Emotion Processing: From Animal Models to Human Behavior. Neuron, 48, 175–187.

Preacher, K. J., Curran, P. J., & Bauer, D. J. (2006). Computational tools for probing interaction effects in multiple linear regression, multilevel modeling, and latent curve analysis. *Journal of Educational and Behavioral Statistics, 31*, 437-448.

Physical activity and risk of cognitive impairment and dementia in elderly persons. *Arch Neurol 58,* 498–504.

Quirk, G. J., & Beer, J. S. (2006). Prefrontal involvement in the regulation of emotion: convergence of rat and human studies. *Curr Opin Neurobiol, 16,* 723-727.

Rasmussen, A., Aber, M. S., & Bhana, A. (2004). Adolescent coping and neighborhood violence: Perceptions, exposure, and urban youths' efforts to deal with danger. *American Journal of Community Psychology, 33,* 61-75.

Roberts, L., & Lie, G. Y. (1989). A group therapy approach to the treatment of incest. *Social Work with Groups, 12,* 77-90.

Rose, S., & Bisson, J. (1998). Brief early psychological interventions following trauma: A systemic review of the literature. *Journal of Traumatic Stress, 11,* 697-710.

Rubin, D.B. (1987) Multiple Imputation for Nonresponse in Surveys. J. Wiley & Sons, New York.

Savitz, J., van der Merwe, L., Stein, D. J., Solms, M., & Ramesar, R. (2007). Genotype and childhood sexual trauma moderate neurocognitive performance: A possible role for brain-derived neurotrophic factor and apolipoprotein E variants. *Biological Psychiatry, 62,* 391-399.

Shalev, A. Y., Freedman, S., Peri, T., Brandes, D., Sahar, T., Orr, S. P., & Pitman, R. K. (1998). Prospective study of posttraumatic stress disorder and depression following trauma. *American Journal of Psychiatry, 155,* 630-637.

Schindler, R. T. (2010). *Relations among exercise patterns, life satisfaction, and PTSD related symptoms.* Unpublished doctoral dissertation, Yeshiva University, New York.

Silove, D., Steel, Z., McGorry, P., & Mohan, P. (2007). Trauma exposure, postmigration stressors, and symptoms of anxiety, depression, and post-traumatic stress in Tamil asylum-seekers: Comparison with refugees and immigrants. *Acta Psychiatrica Scandinavica, 97*, 175-181.

Silva de Lacerda, A. F., Janjoppi, L., Scorza, F. A., Lima, E., Amado, D., Cavalheiro, E. A., & Arida, R. M. (2007). Physical exercise program reverts the effects of pinealectomy on the amygdala kindling development, *Brain Res Bull, 74,* 216-220.

Shirley, L. & Rosén, L. A. (2010). *The childhood maltreatment questionnaire: A measure of abuse and neglect.* Unpublished master's thesis, Colorado State University, Fort Collins.

Shirley, L. & Rosén, L. A. (2010). *The college adjustment questionnaire: A measure of student's academic, social, and emotional adjustment to the college environment.* Unpublished master's thesis, Colorado State University, Fort Collins.

Solomon, E. P., & Heide, K. M. (2005). The biology of trauma: Implications for treatment. *Journal of Interpersonal Violence, 20,* 51-60.

Sonstroem, R. J., & Morgan, W. P. (1989). Exercise and self-esteem: Rational and model. *Medicine & Science in Sports and Exercise, 21,* 329-337.

Sothmann, M. S., Buckworth, J., CLaytor, R. P., Cox, R. H., White-Whelkley, J. E., & Dishman, R. K. (1996). Exercise training and the cross-stressor adaptation hypothesis. *Exercise and Sport Sciences Reviews, 24,* 267-288.

Spano, L. (2001). The relationship between exercise and anxiety, obsessive-compulsiveness, and narcissism. *Personality and Individual Differences, 30,* 87-93.

Spauwen, J., Krabbendam, L., Lieb, R., Wittchen, H., & van Os, J. (2006). Impact of psychological trauma on the development of psychotic symptoms: relationship with psychosis proneness. *The British Journal of Psychiatry, 188*, 527-533.

Spence, J. C., Poon, P., & Dyck, P. (1997). The effect of physical-activity participation on self-concept: A meta-analysis (Abstract). *Journal of Sport and Exercise Psychology, 19,* S109.

Stephens, T. (1988). Physical activity and mental health in the United States and Canada: Evidence from four population surveys. *Preventive Medicine, 17,* 35-47.

Szabo, Z., Ying, Z., Radak, Z., & Gomez-Pinilla, F. (2010). Voluntary exercise may engage

    proteasome function to benefit the brain after trauma. *Brain Resilience, 23,* 25-31.

Tabachnick, B. G., & Fidell, L. S. (2007). Using multivariate statistics (5th ed.). Boston: Allyn

    and Bacon.

Trejo, J. L., Carro, E., & Torres-Aleman, I. (2001). Circulating insulin-like growth factor I

    mediates exercise-induced increases in the number of new neurons in the adult

    hippocampus. *The Journal of Neuroscience, 21*, 1628-1634.

Tedeschi, R. G., & Calhoun, L. G. (1996). The posttraumatic growth inventory: Measuring the

    positive legacy of trauma. *Journal of Traumatic Stress, 9,* 455-471.

U.S. Department of Health and Human Services, Administration for Children and Families,

    Administration on Children, Youth and Families, Children's Bureau. (2010). *Child*

    Maltreatment 2009. Available from

    http://www.acf.hhs.gove/programs/cb/stats_research/index.htm#can.

Van der Kolk, B. A. (1987). *Psychological Trauma*. Washington, DC: American Psychiatric

    Press.

Van Praag, H., Shubert, T., Zhao, C., & Gage, F. H. (1999). Exercise enhances learning and

    hippocampal neurogenesis in aged mice. *The Journal of Neuroscience, 21,* 8680-8685.

Weathers, F. W., & Keane, T. M. (2007). The Criterion A problem revisited: Controversies and

    challenges in defining and measuring psychological trauma. *Journal of Traumatic Stress,*

    20, 107–121.

Yehuda, R., & LeDoux, J. (2007). Response variation following trauma: A translational

    neuroscience approach to understanding PTSD. *Neuron Review, 56,* 19-32.

Zung, W. W. K. (1971). A rating instrument for anxiety disorders. *Psychosomatics, 12,* 371-379

Appendix A

Demographic Questionnaire:

1. What is your age? ___ years old

2. What is your gender? (please choose one)
   ___ Male
   ___ Female
   ___ Transgender
   ___ I prefer not to answer

3. What race/ethnicity do you identify with the most? (please choose one)
   ___ African American/Black
   ___ Alaska Native
   ___ American Indian/Native American
   ___ Asian American
   ___ Caucasian/White
   ___ Hawaiian/Pacific Islander
   ___ Latino or Hispanic
   ___ Middle Eastern American
   ___ Other (Please specify: _____)

4. What is your current employment status? (please choose one)
   ___Employed full-time
   ___Employed part-time
   ___Unemployed

5. Please indicate the highest level of education achieved by your father:
   ___Some high school
   ___High school graduate or GED recipient
   ___Some college
   ___College graduate
   ___Graduate degree (e.g., M.S., M.A.)
   ___Doctoral degree (e.g., Ph.D., M.D.)

6. Please indicate the highest level of education achieved by your mother:
   ___Some high school
   ___High school graduate or GED recipient
   ___Some college
   ___College graduate
   ___Graduate degree (e.g., M.S., M.A.)
   ___Doctoral degree (e.g., Ph.D., M.D.)

7. Are you religiously affiliated?
   ___ No
   ___ Yes

Appendix B

Childhood Maltreatment Questionnaires - Abuse (CMQ-A)

Listed below are statements that describe experiences with maltreatment that people may have had when they were growing up. Some of the experiences can be very common and others not as common. **Please indicate how often each of the following occurred while you were a child**. So that you can describe your experiences in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully, and then circle the number that best describes your experience.

Response Options

1: Never

2: Rarely

3: Sometimes

4: Often

5: Very Often

When I was a child:	Never				Very Often
1. I was hit hard enough by a parent/guardian to have to receive medical care.	1	2	3	4	5
2. I was touched in a sexual way by a person older than me.	1	2	3	4	5
3. I felt cared for by my parents/guardians.	1	2	3	4	5
4. One of my caregivers said degrading things to me.	1	2	3	4	5
5. I was physically hurt by a parent/guardian.	1	2	3	4	5
6. I felt safe with all of my caregivers.	1	2	3	4	5
7. I was emotionally maltreated by a parent/guardian.	1	2	3	4	5

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8. I was hit hard enough by a parent/guardian to leave

    marks on my skin.   1   2   3   4   5

9. I was sexually molested by a person older than me.   1   2   3   4   5

10. I could trust that none of my caregivers would

    intentionally hurt me.   1   2   3   4   5

11. I was sexually abused as a child.   1   2   3   4   5

12. A caregiver said things that indicated they cared very

    little for my wellbeing.   1   2   3   4   5

13. One of my caregivers physically abused me.   1   2   3   4   5

14. A person older than me made me show them my genitals for

    their sexual gratification.   1   2   3   4   5

15. I felt supported by all of my caregivers.   1   2   3   4   5

16. A parent/guardian emotionally abused me.   1   2   3   4   5

17. I experienced non-accidental physical injury from a

    parent/guardian.   1   2   3   4   5

18. I was coerced into unwanted sexual behavior.   1   2   3   4   5

19. All of my caregivers were "there for me" when I was

    growing up.   1   2   3   4   5

Appendix C

Childhood Maltreatment Questionnaires – Neglect (CMQ-N)

Listed below are statements that describe experiences with maltreatment that people may have had when they were growing up. Some of the experiences can be very common and others not as common. **Please indicate how often each of the following occurred while you were a child.** So that you can describe your experiences in an honest manner, your responses will be kept in absolute confidence. Please read each statement carefully, and then circle the number that best describes your experience.

Response Options

1: Never

2: Rarely

3: Sometimes

4: Often

5: Very Often

When I was a child:	Never				Very Often
1. I was left alone and unsupervised for significant periods of time as a young child.	1	2	3	4	5
2. One of my caregivers did not bathe me, even when I was clearly dirty.	1	2	3	4	5
3. One of my caregivers failed to provide adequate emotional care for me.	1	2	3	4	5
4. I felt cared for by my parents/guardians.	1	2	3	4	5
5. My physical care was neglected by a parent/guardian.	1	2	3	4	5

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6. A parent/guardian refused or failed to provide the

    affection I needed.   1   2   3   4   5

7. I felt safe with all of my caregivers.   1   2   3   4   5

8. My emotional needs were not met by a parent/guardian.   1   2   3   4   5

9. I had to fend for myself because there was no one around

    to supervise me.   1   2   3   4   5

10. I went hungry because a parent/guardian did not feed me. 1   2   3   4   5

11. I felt supported by all of my caregivers.   1   2   3   4   5

12. A parent/guardian left me by myself even though there

    should have been someone watching me.   1   2   3   4   5

13. All of my caregivers were "there for me" when I was

    growing up.   1   2   3   4   5

14. I was emotionally neglected by a parent/guardian.   1   2   3   4   5

15. A caregiver did not dress me appropriately for the

    weather.   1   2   3   4   5

16. I could trust that none of my caregivers would

    intentionally hurt me.   1   2   3   4   5

Appendix D

Trauma History Survey

Have you ever experienced any of the following events? (Check all that apply)

1) Death of a close loved one

- If yes, rate the severity of this event in terms of personal distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

2) Very serious medical problem _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was the most recent experience of this event (month/year)? _____

3) Close friend, significant other, or family member experience a serious medical condition

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

4) Accident that led to serious injury to yourself or someone close to you _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

5) Place of residence being damaged by fire or other natural causes _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

6) Endured a divorce _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

7) Physically or sexually assaulted _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

8) Victim of a crime such as robbery or mugging _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this? _____

- When was your most recent experience of this event (month/year)? _____

9) Being stalked _____

- If yes, rate the severity of this event in terms of levels of distress (circle number).

1 – *Not at all*   **2**– *Very small*   **3** – *Small*   **4** – *Moderate*   **5**- *Extreme*

- If yes, how many times have you experienced this?   _____

- When was your most recent experience of this event (month/year)?   _____

Appendix E

Seven-Day Physical Activity Recall Questionnaire

This questionnaire is called the Seven-Day Physical Activity Recall. The information from it will be used to estimate the number of calories you burn up through physical activity. For questions regarding the number of hours you spend engaging in various activities, **please round to the nearest half-hour.**

1. On average, how many hours did you sleep each night during the last five weekday nights, Sunday through Thursday? ____

2. On average, how many hours did you sleep each night last Friday and Saturday nights? ____

Now you will be asked questions about your physical activity during the past seven days; that is, the last five weekdays and last weekend, Saturday and Sunday, even if this was not a typical week for you.

3. What moderate physical activities (i.e., walking, stretching, gardening, playing golf, etc.) did you do during the last five weekdays? Please list below:

_____
_____
_____

How many hours did you spend during the last five weekdays doing these moderate activities or others like them? ____

4. What moderate activities did you do last Saturday and Sunday? Please list below:

_____
_____
_____

How many hours did you spend last Saturday and Sunday doing these moderate activities? ____

5. Now let's look at hard activities. What *hard* physical activities (i.e., light jogging, yoga, lifting weights, etc.) did you do during the last five weekdays? Please list below:

_____
_____
_____

How many hours did you spend during the last five weekdays doing these hard activities or others like them? ____

6. What hard activities did you do last Saturday and Sunday? Please list below:

_____
_____
_____

How many hours did you spend last Saturday and Sunday doing these activities? ____

7. Now let's look at very hard activities. What *very hard* activities (i.e., strenuous running, competitive sports, vigorous bike-riding, etc.) did you do during the last five weekdays? Please list below:

_____
_____
_____

How many hours did you spend during the last five weekdays doing these very hard activities or others like them? ____

8. What very hard activities did you do last Saturday and Sunday? Please list below:

_____
_____
_____

How many hours did you spend last Saturday and Sunday doing these very hard activities? ____

9. Were you gainfully employed, that is, did you earn money for doing work during the last seven days?

___Yes

___No

If no, proceed to question 10

If yes, how many days?

      How many hours per day? ____

      How many of these hours per day were spent doing moderate activities? ____

      How many of these hours per day were spent doing hard activities? ____

      How many of these hours per day were spent doing very hard activities? ____

10. Compared to your physical activity over the past three months, was last week's physical activity more, less, or about the same?

___More

___Less

___About the same

11. Compared to your physical activity during *high school*, was last week's physical activity more, less, or about the same?

___More

___Less

___About the same

12. Compared to your physical activity during *middle school and/or junior high school*, was last week's physical activity more, less, or about the same?

___More

___Less

___About the same

13. Compared to your physical activity during *elementary school*, was last week's physical activity more, less, or about the same?

___More

___Less

___About the same

FLOURISHING SCALE

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Below are 8 statements with which you may agree or disagree. Using the 1–7 scale below, indicate your agreement with each item by indicating that response for each statement.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

_____ I lead a purposeful and meaningful life

_____ My social relationships are supportive and rewarding

_____ I am engaged and interested in my daily activities

_____ I actively contribute to the happiness and well-being of others

_____ I am competent and capable in the activities that are important to me

_____ I am a good person and live a good life

_____ I am optimistic about my future

_____ People respect me

Zung Self-Rating Depression Scale (SDS)

For each item below, please place a check mark (✓) in the column which best describes how often you felt or behaved this way during the past several days

Place check mark (✓) in correct column.	A little of the time	Some of the time	Good part of the time	Most of the time
1. I feel down-hearted and blue.				
2. Morning is when I feel the best.				
3. I have crying spells or feel like it.				
4. I have trouble sleeping at night.				
5. I eat as much as I used to.				
6. I still enjoy sex.				
7. I notice that I am losing weight.				
8. I have trouble with constipation.				
9. My heart beats faster than usual.				
10. I get tired for no reason.				
11. My mind is as clear as it used to be.				
12. I find it easy to do the things I used to.				
13. I am restless and can't keep still.				
14. I feel hopeful about the future.				
15. I am more irritable than usual.				
16. I find it easy to make decisions.				
17. I feel that I am useful and needed.				
18. My life is pretty full.				
19. I feel that others would be better off if I were dead.				
20. I still enjoy the things I used to do.				

Zung Self-Rating Anxiety Scale (SAS)

For each item below, please place a check mark (✓) in the column which best describes how often you felt or behaved this way during the past several days. Bring the completed form with you to the office for scoring and assessment during your office visit.

Place check mark (✓) in correct column.	A little of the time	Some of the time	Good part of the time	Most of the time
1 I feel more nervous and anxious than usual.				
2 I feel afraid for no reason at all.				
3 I get upset easily or feel panicky.				
4 I feel like I'm falling apart and going to pieces.				
5 I feel that everything is all right and nothing bad will happen.				
6 My arms and legs shake and tremble.				
7 I am bothered by headaches neck and back pain.				
8 I feel weak and get tired easily.				
9 I feel calm and can sit still easily.				
10 I can feel my heart beating fast.				
11 I am bothered by dizzy spells.				
12 I have fainting spells or feel like it.				
13 I can breathe in and out easily.				
14 I get feelings of numbness and tingling in my fingers & toes.				
15 I am bothered by stomach aches or indigestion.				
16 I have to empty my bladder often.				
17 My hands are usually dry and warm.				
18 My face gets hot and blushes.				
19 I fall asleep easily and get a good night's rest.				
20 I have nightmares.				

Source: William W.K. Zung. A rating instrument for anxiety disorders. Psychosomatics. 1971

College Adjustment Questionnaire (CAQ)

Listed below are some statements that describe how college students might be feeling about their experience with college. **Please use the rating scale below to indicate how accurately each statement describes you** *at this point in time.* Please read each statement carefully, and then circle the number that corresponds to how accurately the statement describes you.

Response Options
1: Very Inaccurate
2: Moderately Inaccurate
3: Neither Inaccurate nor Accurate
4: Moderately Accurate
5: Very Accurate

	Very Inaccurate				Very Accurate
Right now:					
(Academic Adjustment)					
1. I am succeeding academically	1	2	3	4	5
5. I am doing well in my classes	1	2	3	4	5
7. I am happy with the grades I am earning in my classes	1	2	3	4	5
10. I am meeting my academic goals	1	2	3	4	5
13. I have performed poorly in my classes since starting college	1	2	3	4	5
(Social Adjustment)					
2. I don't have as much of a social life as I would like	1	2	3	4	5
4. I am happy with my social life at college	1	2	3	4	5
9. I have had a hard time making friends since coming to college	1	2	3	4	5
11. I am as socially engaged as I would like to be	1	2	3	4	5
14. I am satisfied with my social relationships	1	2	3	4	5
(Emotional Adjustment)					
3. I feel that I am doing well emotionally since coming to college	1	2	3	4	5
6. I am happy with how things have been going in college	1	2	3	4	5
8. I feel that I am emotionally falling apart in college	1	2	3	4	5
12. I have felt the need to seek emotional counseling since coming to college	1	2	3	4	5

Appendix J

Informed Consent

Thank you for agreeing to participate in my study. This form is designed to explain the purpose and procedures of the study and is an agreement for the protection of your rights as a human participant involved in psychological research. This project was reviewed by the Internal Review Board at Colorado State University and has been deemed ethical and risk free.

My name is Julian Nolen, and I am conducting this study in affiliation with Colorado State University in fulfillment of my thesis project. Dr. Lee Rosén is supervising this study. This study was designed to examine the relationships between traumatic life experiences, exercise habits, and adult psychological functioning. The surveys included in this study should take you approximately 15-30 minutes to complete. Please respond to all of the questions in this study, and with as much accuracy as possible. Your honesty is greatly appreciated.

You will not be required to record your name on any of the included surveys, nor will your name be attached to any data. Your signature is required on this form in order to verify that you have read and understand the nature of my study, but will not be associated with your individual test scores. No other identifying information will be required at any other point in this study, and all information will remain confidential. Your scores will be kept in a private, secure place, and they will not be shared with anyone. Because this analysis will focus on collective results, your individual responses will not be accessible to others.

Please note that your participation in this study is entirely voluntary. You are free to withdraw from this study at any time and for any reason.

If you have any further questions or wish to receive the results of this study you can reach me through email at Julian.Nolen@Colostate.edu

Researcher signature_____ **Date**_____

Participant signature_____ **Date**_____

Appendix K

Debriefing Information

<u>Objective of Research</u>
This study is concerned with the interaction between exposure to negative events, exercise habits, and current psychological functioning. Previous studies have suggested that exercise might help some people to recover from the negative effects traumatic life experiences. The present study will expand upon existing research by also examining whether physical activity might help to *prevent* the consequences of these experiences.

<u>General Information</u>
Your participation is greatly appreciated and will help psychologists to better understand the relationship between traumatic experiences, exercise habits, and psychological functioning. If you would like to receive a report of this research when it is completed (or a summary of the findings), please contact Julian Nolen at Julian.Nolen@colostate.edu. If your participation in this study has caused you concerns, anxiety, or otherwise distressed you, you may contact the CSU Counseling Center at 970-491-6053.

<u>Confidentiality</u>
All information collected in today's study will be confidential, and there will be no way of identifying your responses in the data archive. Identifying the responses of individual participants is not important. Instead, this research will be focused on examining general patterns that emerge when the data are aggregated together.

Please do not disclose research procedures and hypotheses to anyone who might participate in this study between now and the end of data collection, as this could affect the results of the study.

Thank you for your participation!