

RELATIONSHIP BETWEEN EXERCISE AND PERSISTENT HYPERAROUSAL
SYMPTOMS OF PTSD

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ABSTRACT

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Post-Traumatic Stress Disorder is an anxiety disorder that is experienced by many individuals here in our nation and around the globe (Dimassi, Farhood, & Lehtinen, 2006; Kritz-Silverstein et al., 2009). The current U.S. PTSD prevalence rate is 7.8%, with estimates worldwide ranging widely from 1%-40% (Glynn, Marshall, Schell, & Shetty, 2006). Recently there has been a dramatic increase in PTSD symptoms and diagnosis in our country due in large part to the record number of military service members returning back from a two theatre war in the Middle-East (Cozza, 2005). Recently, hyperarousal symptomatology has been implicated as a key indicator in the diagnosis of PTSD when compared to other symptom clusters as listed in the DSM-IV-TR (Glynn et al., 2006; Schell, Jaycox, & Marshall, 2004) as well as strong predictor of subsequent expression and severity of PTSD symptomatology (Glynn et al., 2006). Efficacious treatments are needed that reduce symptoms of increased arousal quickly and with relatively few side effects.

This study investigated the relationship between exercise and hyperarousal symptoms in a sample of college students. The sample consisted of 65 undergraduate students from Humboldt State University. Participants completed the Hyperarousal Scale (Cartensen, Edell-Gustafsson, Regestein, Svanborg, & Swahn, 2006), which is a 26-item

self-report inventory that measures response to unexpected stimuli and other behaviors involved in human physiological arousal, and the Leisure Time Exercise Questionnaire (LTEQ; Godin & Shephard, 1985) which was used to assess the physical activity levels of individuals over a 7-day period. Participants also completed a scale that directly reflects the symptoms as listed in Category D of the PTSD section of the DSM-IV-TR (American Psychiatric Association [APA], 2000). It was hypothesized that there would be a negative correlation between an individual's weekly leisure-time exertion and reported hyperarousal symptoms as measured by the HAS and DSM-IV-TR criteria for hyperarousal (FSS) as well as group differences between reported frequency of exercise and hyperarousal as measured by the HAS and FSS. A negative relationship was found between individuals who self-reported greater levels of weekly leisure-time exertion and hyperarousal symptomatology as reported by both the HAS and FSS. Group differences were also found between individuals who self-reported exercising more often than individuals who reported sometimes or rarely/never.

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CHAPTER ONE

Introduction

Post-traumatic Stress Disorder (PTSD) is an anxiety disorder occurring in persons exposed to extreme stressors. These stressors fall under a wide umbrella ranging from natural and environmental disasters to interpersonal loss due to the death of a friend or loved one (Arida et al., 2008). Symptoms of PTSD include frightening dreams of re-experiencing the event, avoidance of certain triggering situations, emotional numbness, distancing from intimate relationships, and increased arousal. The DSM-IV-TR (American Psychiatric Association [APA], 2000) classifies PTSD symptoms into three groupings or clusters: (1) re-experiencing the trauma, (2) avoidance of usual activities, and (3) increased symptoms of physiological arousal, or hyperarousal. Though figures vary widely based on the methodology of the study, the National Institute of Mental Health (NIMH) reported in its National Comorbidity Survey-Replication study (NIMH, 2005) that approximately 7.7 million American adults 18 years or older, or 4% of the population, currently have PTSD. This percentage is significantly higher in military combat veterans or other at-risk populations such as victims of violence or natural disasters, or survivors of war or famine (Arida et al., 2008).

In the last decade, numerous studies have sought to determine if there are any predictable pathways that clearly signal the onset and progression of PTSD. Some studies (Glynn et al., 2006; Schell et al., 2004) have identified the hyperarousal symptoms of PTSD as strong predictors of later overall PTSD severity. Category D of the DSM-IV-TR (APA, 2000) specifies PTSD hyperarousal criteria as consisting of the following

symptoms: difficulty falling or staying asleep, irritability or outbursts of anger, difficulty concentrating, hypervigilance, and exaggerated startle response.

To this end, physical exercise may be an effective modality of treatment for PTSD, particularly in its targeting of hyperarousal symptoms. Several studies for example, provide evidence that aerobic exercise can decrease hyperarousal symptoms. One animal study (Ann et al., 2008) demonstrated a direct correlation between the amount of treadmill exercise and regulation of the HPA (hypothalamo-pituitary-adrenal) axis. The HPA axis is a major component of the neuroendocrine system in all mammals, and has been found to control reactions to stress as well as regulating many body processes including immune function, mood and emotions, and energy expenditure (Ann et al., 2008). Several large human population studies (Arida et al., 2008; Strohle, 2009) have also found evidence of the role of exercise in the mitigation of PTSD symptoms through its release of endogenous opioids and other biological precursors that decrease the release of stress related hormones, thereby decreasing hyperarousal symptoms. These animal and human studies demonstrate that aerobic exercise can play an important role in the proper balancing of the complicated biological systems responsible for the stress response in animal physiology.

Exercise has shown promise as a modality of treatment that effectively targets hyperarousal symptoms, key indicators of PTSD onset and progression. This study seeks to provide evidence that regular physical exercise correlates with hyperarousal symptoms in a college population. With record numbers of troops heading home from Iraq and Afghanistan adding to the millions of Americans that already suffer from the effects of

PTSD, it is imperative that treatments are found that are effective, beneficent, and can produce a wide range of positive treatment outcomes with minimal side effects.

CHAPTER 2

Literature Review

Overview of PTSD

Prevalence. The prevalence of PTSD varies all across the globe. According to the National Comorbidity Survey, the lifetime prevalence of PTSD for adults in the United States is 7.8 %, with women reporting prevalence rates at almost double those of men (10.4% vs. 5.1%) (Kritz-Silverstein et al., 2009). Worldwide, PTSD prevalence is not as well-known, with prevalence rates ranging from 1% to nearly 40%, depending on the population studied (NIMH, 2005). According to Dimassi, Farhood, and Lehtinen (2006) this is because the vast majority of PTSD research is conducted in countries that are not experiencing an armed conflict, a fact that greatly affects rates of PTSD in any population. These authors examined rates of PTSD in the conflict heavy societies of Algeria, Palestine, Cambodia, and Ethiopia, and found prevalence rates ranging from 15.8% to 37.4%, roughly two to four times the rate reported in the United States.

Causes of PTSD. As stated earlier, there are many common causes of PTSD that bear some investigation. PTSD in the general population of the United States is often the result of catastrophe or natural disaster. A natural disaster can be defined as an effect of a natural hazard such as a flood, tornado, volcano, earthquake, or landslide. To be officially considered a natural disaster it must have severe impact upon humans in terms of environmental, human, or financial losses. According to Galea, Nandi, & Vlahov (2005) over 13 percent of the U.S. population has experienced a natural disaster of some

kind. PTSD is the most common psychological disorder found after a natural disaster and has been extensively studied in this context. A greater degree of exposure to any natural disaster is linked with an increased probability of experiencing PTSD symptoms, particularly in the development of the hyperarousal symptoms that impair concentration and increase an individual's vigilance (Galea, Nandi, & Vlahov, 2005).

Another common way to get PTSD in the United States is by becoming the victim of partner or child abuse. Partner abuse has been shown to have a many negative consequences that include anxiety, depression, and PTSD (Babcock, Green, Roseman, & Ross, 2008). The extent of the PTSD depends on many factors, including the type of partner abuse and whether physical violence was an integral part of it. Three broad categories of partner abuse are most widely recognized in the literature. These are physical, psychological, or a combination of the two. In their review of PTSD, Babcock et al., (2008) found that psychological abuse was more strongly related to the development of PTSD than just physical abuse on its own. Research has also noted clear associations between child abuse and PTSD among young adults. According to the Centers for Disease Control and Prevention (CDC; 2010) there were roughly 3.3 million reports of child abuse made in the United States in 2008. Capon, Cohen, Mannarino, and Zhitova (2003) found that the most recent population based studies all point to the fact that youths who self-report they have been a victim of abuse have a much higher than normal rate of PTSD than their peers. There is also evidence that PTSD resulting from prolonged child abuse is associated with structural brain abnormalities that can impair certain cognitive functions.

Another way a person can develop PTSD is to witness violence or become the victim of a physical or sexual assault (Babcock et al., 2008). A body of research has found that exposure to violence is a correlate of PTSD and extends itself into such areas as occupational functioning, social and interpersonal relationships and even physical health issues (Fitzgerald et al., 2008). According to the most recent National Survey, over 60 % of children who took the survey had been exposed to some type of violence in the last year. Almost one half of the children and adolescents in the survey had been assaulted, with one in ten actually being physically injured during the assault (Finkelhor, Hamby, Kracke, Ormrod, & Turner, 2009).

Since the end of World War II there have been numerous studies that have examined the relationship between military combat veterans and PTSD, the majority of them being done on soldiers that participated in combat operations in Vietnam (Cozza, 2005). One of the most exhaustive studies was done in 1983 by researchers participating in the National Vietnam Veterans Readjustment study that was conducted in response to a congressional mandate for an investigation of PTSD prevalence among Vietnam veterans (Kritz-Silverstein et al., 2009). This study compared the PTSD prevalence of men and women who served in theatre (15.2% and 8.5%) with the PTSD prevalence of those veterans who served out of theatre (2.5% and 1.1%) concluding that higher war zone stress exposure directly resulted in PTSD symptomatology (Cozza, 2005). Indeed, due to the United States involvement in sustained combat operations since the outbreak of the Iraq war in 2003, the issues of PTSD symptomatology and its associated mental health outcomes are being brought into sharp focus once again. According to Department

of Veterans Affairs researchers, Operation Enduring Freedom/Operation Iraqi Freedom Veterans are returning with a PTSD prevalence of close to 14%, with higher rates expected in combat arms military occupational specialties (Litz & Schlenger, 2009). For example, there is a direct connection between the number of combat exposures and the greater prevalence and intensity of PTSD symptomatology (Cozza, 2005). This connection is important since large numbers of troops are involved in the deployments to Iraq and Afghanistan. Since the start of the U.S. wars in the middle-east in October of 2003, over 1.8 million U.S. troops have served in Operation Iraqi Freedom and Operation Enduring Freedom, with 37% having deployed at least twice (Litz & Schlenger, 2009). Unique to other U.S. conflicts, large numbers of troops are returning home with Traumatic Brain Injuries (TBIs) that are due in large part to the repeated exposure to IEDs (Improvised Explosive Devices) and increased survivability of U.S. military personnel generally accredited to improved technologies that allow a soldier to survive on the battlefield (Bass, Goldberg, Golding, and Percy, 2009). This factor alone could dramatically raise the rate of PTSD in our service members returning home from combat operations. According to Bass, Goldberg, Golding, & Percy (2009) over 80 percent of TBIs are closed head injuries as opposed to penetrating head injuries, suggesting that many more of these types of injuries have gone undiagnosed since they are not always easily observable. One thing is for certain, the addition of tens of thousands of individuals returning from our decade of warfare in the Middle East will certainly raise the national rates of PTSD in this country to unprecedented levels, making the search for efficacious and beneficent treatment modalities one of our top priorities.

Importance of hyperarousal in PTSD. Finding efficacious and timely treatments for PTSD therefore must focus on clusters of symptoms that are easy to identify and have been shown to be good indicators of future diagnosis and progression of this anxiety disorder. Recently, hyperarousal has been shown as a key indicator in the diagnosis of PTSD when compared to other symptom clusters as listed in the DSM-IV-TR (Glynn et al., 2006; Schell et al., 2004). One longitudinal study by Schell et al., (2004) investigated the relationship of PTSD symptom clusters found in a population of several hundred young adults who received medical treatment at a level 1 trauma center for injuries that were the result of community violence. PTSD severity was measured within days of leaving the hospital and at 3 month and 12 month intervals. Factor analysis showed that the hyperarousal cluster of PTSD was the best predictor of almost every other symptom cluster and that hyperarousal was not influenced to any great degree by other symptoms clusters (Schell et al., 2004). Another longitudinal study done on survivors of orofacial injury demonstrated that hyperarousal was a strong predictor of subsequent expression of re-experiencing and avoidance symptom clusters while also demonstrating that re-experiencing and avoidance were not significantly related to any clusters other than themselves (Glynn et al., 2006). Both of these studies lend credence to the idea that different clusters of PTSD symptoms are not equally weighted when it comes to overall symptom expression and that hyperarousal may a good predictor of the manifestation of PTSD symptomatology.

Treatments

There are many types of treatment modalities that have been found to be effective on the reduction of PTSD symptomatology. According to Grinage (2003) the most efficacious methods are those that take a multidimensional approach that include such facets as patient education, formation of social support, stress management techniques, and various psychopharmacological and psychotherapy interventions. One of the fastest growing and most controversial treatment modalities for PTSD can be found in the use of pharmaceutical agents that can be prescribed only by medical doctors (Albucher & Liberzon, 2002).

Pharmacotherapy can be defined as the treatment of diseases or mental disorders by administering drugs. Contrary to the popular opinion, pharmacotherapy is not a contemporary treatment but has existed for thousands of years across many cultures and traditions. Traditionally plants have been used as the source for these potent drugs, but modern science has evolved so that these compounds can be synthesized on demand in a chemically pure, known dosage format (Starcevic, 2005). There are many different classes of pharmaceuticals on the market that are prescribed for anxiety disorders. Perhaps the best known and most well studied are the SSRIs (selective serotonin reuptake inhibitors) which are currently considered to be the first-line pharmacotherapy treatment for PTSD (Chavez, 2006). There are numerous advantages of SSRIs over the traditional tricyclic antidepressants, including their ability to be well tolerated by a diverse population and their minimal withdrawal effects. Their most obvious limitations center around the length of time until they become effective (4-6 weeks on average) and their

high cost compared with other pharmacotherapies (Starcevic, 2005). Also significant, many individuals experience side effects such as nausea, drowsiness, insomnia, dry mouth, sexual dysfunction, and gastrointestinal distress.

Tricyclic antidepressants have also been used to treat the symptoms of PTSD. This class of drugs has typically been prescribed for depression in patients that showed little response to other forms of therapy. In one study, 46 veterans were given Amitriptyline and then compared to a placebo group over an eight week time frame, showing modest improvement in remission rates of up to 36% (Bystritsky et al., 2009). Research suggests that due to the broad side effect profile of these drugs they are not well tolerated as evidenced by high dropout rates in numerous clinical trials (Albucher & Liberzon, 2002). Side effects include blurry vision, lowered gastrointestinal motility or constipation, urinary retention, cognitive and/or memory impairment, anhedonia, dizziness, sexual dysfunction, hypotension, tachycardia, hallucinations, and accidental coma.

Another emerging drug treatment for PTSD symptoms is being found in a class of beta-adrenergic blocking agents called Beta-blockers. This medication was originally used in the management of cardiac arrhythmias, heart attacks, and hypertension, and works by partially negating the effects of adrenaline (epinephrine) and other stress response hormones (Chavez, 2006). These beta-blockers differ from SSRIs and tricyclic antidepressants in that they are used to prevent the trauma response in PTSD by blocking postsynaptic noradrenaline receptors, reducing adrenaline output thereby decreasing hyperarousal symptoms and hormone induced nightmares (Albucher & Liberzon, 2002).

Other types of drugs are occasionally prescribed as well. Atypical antipsychotics have recently been brought to bear in the quest for an effective pharmacotherapy for PTSD (Chavez, 2006). These drugs seem to decrease the frequency and intensity of nightmare and flashbacks symptom components of PTSD that typically did not respond to other pharmacotherapies. Unfortunately, the known side effects are extensive, including weight gain, hyperglycemia, increased cholesterol levels, and decreased libido (Chavez, 2006). Benzodiazepines also sometimes prescribed for PTSD but for the most part are avoided unless they are necessary to treat another comorbid disorder. Though this class of pharmaceuticals has a rapid onset of action and has been shown to reduce depression and anxiety, its chronic use can lead to chemical dependence (Albucher & Liberzon, 2002).

EMDR. Eye Movement Desensitization and Reprogramming (EMDR) is an evidence-based modality of treatment that was developed over 20 years ago by Dr. Francine Shapiro in Palo Alto, California. This treatment posits that trauma is stored in the human brain differently than other types of information and becomes “frozen in time” during times of extreme stress, along with the individual’s aroused physiological response. According to Ahari, Narimani and Rajabi, (2008) EMDR has a direct effect on the way the brain processes information, though the exact mechanism of how or why is still in dispute. Current theories suggest that EMDR allows an individual to re-experience many aspects of the original trauma in a low anxiety setting, therefore freeing the traumatic memories to be stored in less volatile area of the brain less likely to trigger a physiological response.

Since its inception, EMDR has been subjected to numerous controlled studies that have consistently shown it to be successful in the treatment of PTSD (Baardseth et al., 2010). EMDR has been shown to reduce symptoms such as anxiety, flashbacks, nightmares, and intrusive thoughts that are the hallmark of this anxiety disorder. In one study EMDR was administered to Iranian combatants that had been diagnosed with PTSD after an imposed war that included a mandatory draft (Ahari et al., 2008). Results showed a significant decrease in anxiety and depression for this population after only eight sessions of EMDR. It has been included in the Practice Guidelines of the American Psychiatric Association and the Departments of Defense and Veterans affairs. This is significant since this treatment is not without its skeptics. According to a meta-analysis done by Albright and Thyer (2010) which critically examined six experimental and three quasi-experimental studies of various methodological design, limited evidence was found for the effectiveness of EMDR for the reduction of PTSD in combat veterans. It is commonly believed by detractors of this modality that the placebo effect is mostly responsible for the effects of this treatment, as well as overlap of other therapy modalities while administering EMDR (Baardseth et al., 2010).

CBT and Trauma-Focused CBT. Perhaps the best known treatment modality for anxiety disorders resides in the realm of Cognitive Behavioral Therapy (CBT) and its derivatives. CBT is a modality that is designed to target the core features of a disorder as opposed to tackling the root causes and subsequent symptom expression of that disorder. The main components of this treatment include a framework based upon the concepts of collaboration, skill-building, and goal-orientation while at the same time being cognizant

of time constraints of the everyday individual (Cisler, Deacon, & Olatunji, 2010).

Though many meta-analytic studies of cognitive and behavioral treatments have been done, the weight of current research has shown that the combination of cognitive and behavioral treatments rolled into one modality is more efficacious than that of either treatment alone (Baardseth et al., 2010). Recent meta-analytical studies support the efficacy of CBT in the treatment of anxiety disorders including PTSD. In a review of empirically supported CBT treatments that included diagnosis as an outcome measure for PTSD, Hollon and Ponniah (2009) found that between 40% and 100% of individuals no longer met diagnostic criteria for PTSD after treatment and that gains were maintained in a one year follow-up. These treatment groups included such diverse population as combat veterans, natural disaster survivors, abuse or assault victims, and mixed trauma patients.

Even though CBT is considered by many to be the “Gold Standard” of PTSD treatments, it is not without its issues and its critics. As Cisler et al. (2010) state, there is a high relapse rate among patients who underwent CBT for anxiety disorders (27%) over a 2 year follow up period. This finding and others question the durability of CBT for treating anxiety disorders and has encouraged clinicians and researchers to augment CBT with other approaches to increase its longevity. One of the most promising augmentations to CBT is found in the Trauma-Focused CBT modalities that have been making an impact over the last decade.

Trauma-focused CBT is a relatively new evidence-based derivative of CBT shown to help children, adolescents, and their adult caretakers overcome trauma-related difficulties. It is also gaining attention in its use with adults suffering from anxiety

disorders (Baardseth et al., 2010). Its main focus is in the reduction of negative emotional and behavioral reactions immediately after a traumatic experience by teaching coping skills that are effective and appropriate. This therapeutic tool focuses almost exclusively on the specifics of the trauma that was experienced by the individual and attempts to create interventions that deal with this issue head on.

Over the last decade, the efficacy of TF-CBT has been explored in many studies and summarized in several meta-analyses. The first, done by Bison et al. (2005), compared TF-CBT treatments against non-trauma focused treatments such as stress management and EMDR. TF-CBT groups had the lowest risk for retaining a PTSD diagnosis at the end of treatment as well as showing effect sizes of 0.99 versus the control group. Another meta-analysis by Kornor et al., (2008) included a comparative study of TF-CBT modalities on patients experiencing symptoms of PTSD. Results showed the risk for being diagnosed with PTSD at 3 to 6 months, 9 months, and 36 to 48 months as being 0.49, 1.09, and 0.73 respectively. Furthermore, Trauma-Focused CBT techniques have been shown to outperform both wait-list controls and supportive counseling controls in a variety of clinical settings, pointing to its incremental efficacy and effectiveness (Cisler et al., 2010). However, it is interesting to note that Hollon and Ponniah (2009) recognized in their meta-analysis of TF-CBT studies that the sample sizes were always less than 30 patients, severely limiting the conclusions that could be drawn about its treatment efficacy.

Physical Exercise

Effects on anxiety and depression. It is a commonly held belief that cardiovascular exercise has some degree of positive effect on anxiety and depression levels in most individuals. This belief has been tested in numerous research projects and studies over the last twenty years. The abundance of evidence to date points to the idea that regular, light to medium exercise decreases depression and anxiety related disorders in a wide array of populations and cultures (Strohle, 2009). One large scale population study in the United States showed that regular exercise negatively correlated with the likelihood of being diagnosed with a clinical disorder such as anxiety or depression (Kendall-Tackett, 2009). As Blumenthal et al., (2007) point out, exercise has also been shown to be equally effective as the popular anti-depressant Zoloft for the treatment of anxiety and depressive disorders. These population studies are important in understanding the relationship between exercise and anxiety symptoms.

Exercise as self-medication. Exercise in itself might be thought of as form of self-medication pharmacotherapy in that it is fairly common knowledge that exercise releases a whole host of beneficial biochemicals, the most well-known being endogenous morphine derivatives, or endorphins. This opioid peptide is produced by the pituitary gland and hypothalamus in vertebrates during prolonged physical activity and is has been shown to create feelings of analgesia, well-being, and even exhilaration (Berry et al., 2006). The critical difference in these medication strategies lies in the fact that regular physical exercise seems to have very few side effects, especially when compared with the vast array of physical and emotional side-effects reported by makers and consumers of

human engineered pharmaceuticals. Research done on anxiety disorders by Strohle (2009) compared the efficacies of a popular pharmacotherapy, clomipramine (a tricyclic antidepressant) against that of an exercise group using a control group in randomized controlled study. After 10 weeks of treatment, regular physical exercise was found to be as effective as clomipramine on all measures of primary outcome with no reportable side-effects. The minimal side-effect profile of regular aerobic exercise as a treatment modality is well worth investigating more thoroughly, but there are also other benefits being teased out by research as well that point to exercise being an important factor in improved mental health and overall quality of life.

Exercise effects on mental health and quality of life. Though a review of the literature of the last decade extols physical exercise as important in the biological homeostasis and mental health of an individual, much less is known about its relationship as it relates directly to a person's overall health and quality of life issues (Dudgeon et al., 1998). Numerous population-based studies have shown an association between aerobic exercise and improved mental health, including one by Hassmen et al., (2000) that showed that individuals who exercised two or three times weekly experienced fewer symptoms of depression, anger, stress, and anxiety than those who did not exercise at all. One of the most intriguing facets of exercise being used as a tool to relieve anxiety symptoms is that there are other well-known health benefits that have a positive effect on the individual as well. Regular physical exercise has repeatedly been shown to protect individuals against the onset of a host of medical issues including somatic complaints, diabetes, heart disease, hypertension, and numerous forms of cancer (Kendall-Tackett,

2009). There has also been attention focused on the use of physical exercise as a mechanism for building resistance to the negative effects of psychosocial stressors. In one study, a group of Australian Vietnam Veterans diagnosed with PTSD was polled and self-reported that they no longer participated in physical activities they used to enjoy, exacerbating symptoms of anxiety and depression and their own perceived ability to cope with stress (Arida et al., 2008). There has been a large body of research that also demonstrated that physical exercise not only decreases mortality rates but decreases an individual's morbidity as well, leading to an overall improved sense of well-being and better perceived quality of life (Kendall-Tackett, 2009). This is important since according to Arida et al., (2008) the overall quality of life self-reported by individuals is negatively correlated with PTSD symptomatology.

Exercise as a treatment modality. More recently, meta-analyses of exercise interventions on clinical populations suffering from anxiety disorders determined that there was significant therapeutic benefit to an exercise modality as part of a multi-modal treatment program (Berry et al., 2006). A recent meta-analysis of 11 treatment outcome studies found a large combined effect size that indicated the advantage of exercise versus control groups who did not exercise (Berry et al., 2006).

Effects of exercise on hyperarousal in animals. Physical exercise has also been shown to have an effect specifically on the hyperarousal symptoms of PTSD, key indicators in the diagnosis and predicted course of PTSD in an individual. It has been shown that the stress response in animals activates the HPA(hypothalamic–pituitary–adrenal) axis, a complex of organs that work together to release the hormones necessary

for the successful startup of the chemical cascade that creates an animal's "fight or flight" mechanism (Kendall-Tackett, 2009). In one animal model experiment, twelve male Sprague–Dawley rats were injected once daily over a 19 day period with 40mg/kg of Corticosterone, a steroid released by the adrenal glands during stress and the main hormone responsible for dysregulation of the HPA axis in mammals (Ann et al., 2008). Another six rats were used as a control and were injected once daily with the same dosage of saline solution. Regular aerobic treadmill exercise was administered once daily to 6 of the original 12 experimental group rats. The rats who exercised adjusted the imbalance of corticosterone in their system at a much faster rate than the rats who did not exercise, providing strong evidence that treadmill exercise may speed up the recovery of hypoactivated HPA axis dysregulation, one of the main biological roots in psychological disorders like PTSD (Strohle, 2009).

Effects of Exercise on human hyperarousal. One large scale population study done in Finland suggests that those individuals who exercise on a regular basis (2-3 times weekly) will experience less symptoms commonly associated with anxiety disorders, PTSD, and depression (Berry et al., 2006). Other biological correlates of PTSD have to do with the antidepressant effects of exercise. It is known that exercise is responsible for the release of endogenous opioids. These are peptides produced naturally within the body that are known for their ability to produce feelings of euphoria by binding to opioid receptors in the central and peripheral nervous system. These endogenous opioids provide an antidepressant effect and make an individual more likely to be calmer, decreasing overall hyperarousal levels in mammals (Ann et al., 2008). It is also well known that

individuals who have a diagnosis of PTSD possess lower ambient cortisol levels, attributed to chronic adrenal exhaustion due to inhibition of the HPA axis by persistent and severe anxiety (Grinage, 2003). All of this points to the body's innate capacity to rebalance itself through its own complex biochemical processes, the body's own form of pharmacotherapy that is catalyzed by a steady routine of aerobic exercise.

CHAPTER 3

Statement of Purpose and Hypotheses

There has been previous research that found a positive correlation between exercise and overall mental health, as well as an abundance of literature reporting that aerobic exercise mitigates the effects of anxiety and depression (Kendall-Tackett, 2009). Animal studies have shown (e.g. Ann et al., 2008) that exercise can decrease hyperarousal symptoms in animal models, and human studies suggest exercise could have similar effects in human hyperarousal (Kendall-Tackett, 2009). Recent publications on anxiety disorders (Glynn et al., 2006; Schell et al., 2004) such as PTSD have shown that consistent symptoms of hyperarousal as outlined in Category D of the DSM-IV-TR are the key indicators of whether an individual will be diagnosed with PTSD and whether they continue to express these symptoms in the future. To date there have been no studies conducted that investigate the association of regular exercising and hyperarousal symptoms. This research seeks to build upon that idea by exploring the relation of aerobic exercise and hyperarousal symptoms in a sample of college students. This study hopes to advance the understanding of exercise and human hyperarousal, a first step in investigating its potential usefulness as a standard treatment for PTSD.

Hypotheses

1. It is hypothesized that an individual's total weekly leisure-time exertion will correlate negatively with an individual's self-reported level of trait hyperarousal. This is substantiated by research that suggests exercise is an effective mode for reducing anxiety

disorder related symptoms such as hypervigilance, difficulty concentrating, trouble sleeping, irritability/outbursts of anger, and an exaggerated startle response (Berry et al, 2006).

2. It is hypothesized that an individual's total weekly leisure-time exertion will correlate negatively with an individual's self-reported current hyperarousal symptoms as defined by Category D of PTSD in the DSM-IV-TR (APA, 2000).

3. It is hypothesized that there will be a group difference between self-reported frequency of exercise and an individual's self-reported level of trait hyperarousal, with more frequent exercisers tending to report lower trait hyperarousal.

4. It is hypothesized that there will be a group difference between self-reported frequency of exercise and an individual's self-reported level of current hyperarousal symptoms as defined by Category D of PTSD in the DSM-IV-TR (APA, 2000), with more frequent exercisers tending to report lower current hyperarousal symptoms.

Research Questions:

1. Is there a relationship between gender and trait hyperarousal symptoms?
2. Is there a relationship between gender and total weekly leisure-time exertion?
3. Is there a relationship between gender and frequency of exercise?

CHAPTER 4

Methods

Participants

Participants were recruited from 4 separate undergraduate courses at Humboldt State University. These courses included business, biology, and philosophy students. HSU is a medium sized, four year, public university located in Northern California. Participation in the study was entirely voluntary, with no consequences for participants who decide to withdraw from the study at any point. The sample size goal was 46 participants, which would have provided 80% power to detect a medium effect size of .40, although more participants were recruited in order to increase the power to detect a smaller effect.

Procedure

Permission was obtained from the class instructor to conduct this study with their class. A questionnaire containing demographic questions and the measures described below was administered to volunteers in four classrooms.

Measurements

Demographic questions

Information about participant's gender and age was collected (see Appendix A).

Hyperarousal Scale (HAS)

Participants completed the Hyperarousal Scale (Cartensen et al., 2006). The HAS is a 26 item self-report inventory that assesses trait hyperarousal, including tendencies to

introspect, respond to unexpected stimuli, and other measures of arousal. The responses to each scale item are graded from 0 to 3, where 0= Not At All, 1= A little, 2= Quite a bit, and 3= Extremely. Cartensen et al. (2006) reported psychometric data for the HAS in a sample of 402 women and 391 men. Internal consistency was good ($\alpha=.84$) and 21- day test-retest reliability on 273 subjects was reported as $r=.80$. Validity evidence for this scale is that it has a Pearson's correlation coefficient of similar strength and expected direction when compared to the Zung Self-Depression Scale, the Vicious cycle of Sleeplessness Behavior Scale, and the Short Form 36 Health Survey Questionnaire Scale with scores at 0.49, 0.54, and -.54 respectively (Cartensen et al., 2006).

Leisure Time Exercise Questionnaire (LTEQ)

Participants also completed the Leisure Time Exercise Questionnaire (Godin & Shephard, 1985). The LTEQ is a questionnaire designed to assess frequency and exertion of leisure time physical activity over a 7-day period. This contains two questions that provide separate measures of leisure-time physical activity. A total weekly leisure-time exertion score is calculated by averaging the weighted product of the response to each question as follows: (mild x 3) + (moderate x 5) + (strenuous x 9). The second question measures self-reported frequency of sweat-inducing exercise by asking subjects how often per week they engage in regular activity long enough to work up a sweat. The total weekly leisure-time exertion score was found to have a two week test-retest reliability of $r=.74$ for adults. The total weekly leisure-time exertion question had a test-retest reliability of $r=.80$ for the same time interval and population (Godin & Shephard, 1985). Validity was demonstrated for the total exercise score through comparisons to other

measures of fitness such as accelerometer motion scores ($r = .32$), VO_2 (volume of oxygen) maximum measured by graded treadmill exercise ($r = .56$) and percentage of body fat ($r = -.43$) (Godin & Shephard, 1985; Jacobs et al., 1993).

Five Symptom Scale (FSS)

This short questionnaire measures hyperarousal symptoms by asking questions that directly capture the essence of the five symptoms listed in Category D of the PTSD section of the DSM-IV-TR (APA, 2000).

Statistical Analysis

The mean scores and standard deviations for the HAS and FSS were reported. Pearson product-moment correlations were calculated for each of the hyperarousal scales in relation to weekly leisure-time exertion and frequency of exercise. Internal consistencies for the HAS and FSS scales were calculated using Cronbach's alpha. An ANOVA was done to determine any possible group differences for the frequency of exercise question, which is composed of three different levels of reported leisure time frequency (often, sometimes, rarely/never).

CHAPTER 5

Results

Undergraduate students ($N=65$) completed the questionnaire in person while participating in summer classes at Humboldt State University. This questionnaire consisted of a demographic section, the Hyperarousal Scale (HAS), the Leisure Time Exercise scale (LTEQ), and the Five Symptom scale (FSS). The mean age of participants was 25.37 years with 53.8% of participants reporting their gender as female ($n = 35$, $SD = 10.25$) and 46.2% of participants reporting their gender as male ($n = 30$, $SD = 10.45$). Means, standard deviations, and score ranges were calculated for each test and can be found in Table 1. Reliability coefficients for the HAS and the FSS were calculated using Cronbach's alpha. The internal consistency of the HAS was $\alpha = .85$, consistent with the reliability ($\alpha = .84$) reported by Cartensen et al. (2006), while the internal consistency value for the FSS was $\alpha = .68$. For the purposes of this study the reliability levels for the HAS and FSS are considered acceptable.

A bivariate correlation analysis was used to investigate hypothesis #1, the relationship between total weekly leisure-time exertion and trait hyperarousal as measured by the HAS. The results from this test show a significant negative relationship, $r(65) = -.38$, $p = .002$, indicating that people who exert more energy exercising report lower levels of trait hyperarousal. This directly supports hypothesis #1 which states that an individual's total weekly leisure-time exertion is negatively related to an individual's self-reported level of trait hyperarousal. A bivariate correlational analysis was also used to investigate hypothesis #2, the relationship between total weekly leisure-time exertion

and hyperarousal as measured by the FSS. These results also showed a significant relationship in the negative direction $r(65) = -.36$, $p = .004$. This also directly supports hypothesis #2 which states that an individual's total weekly leisure-time exertion correlates negatively with an individual's self-reported level of current hyperarousal symptoms as defined by Category D of PTSD in the DSM-IV-TR (APA, 2000).

Hypothesis #3, which looked at the relationship between self-reported frequency of exercise and trait hyperarousal, was investigated using an analysis of variance (ANOVA). This test was used to examine group differences in trait hyperarousal across three different levels of weekly self-reported frequency of exercise (often, sometimes, rarely/never). The initial ANOVA results revealed that mean trait hyperarousal differed across these groups $F(2, 62) = 5.26$, $p = .008$, $\eta^2 = .145$. These results indicated that a significant difference exists somewhere between the groups. A Tukey test was performed to determine what specific groups significantly differed. The Tukey test demonstrated that people who reported engaging "often" in leisure time activity reported lower levels of trait hyperarousal than people who reported sometimes or rarely/never (See Table 2). This directly supports hypothesis #3 which states that individuals who report higher frequency of leisure-time exercise will tend to report lower trait hyperarousal. The same type of analysis investigated hypothesis #4, which examined the relationship between frequency of leisure-time exercise and current hyperarousal symptoms as defined by the FSS. The initial ANOVA results showed that levels of hyperarousal differed depending on frequency of sweat-induced leisure time activity $F(2,62) = 4.62$, $p = .013$, $\eta^2 = .130$. Again, these results were followed up with a Tukey test and demonstrated that people

who engage in weekly leisure-time exercise often report lower levels of hyperarousal than people who report sometimes or rarely/never (See Table 2). This directly supports hypothesis #4 which states that individuals who report higher frequency of leisure-time exercise will tend to report fewer current hyperarousal symptoms as defined by Category D of PTSD in the DSM-IV-TR (APA, 2000).

To investigate gender differences, independent samples *t*-tests were conducted for the HAS, FSS, and the LTEQ score. For all *t*-tests equal variances were assumed and all data were distributed normally. For the HAS, the *t*-test indicated that males ($M = 37.5$, $SD = 10.45$) and females ($M = 40.8$, $SD = 10.24$) did not differ significantly $t(63) = -1.28$, $p = .20$, $d = -0.32$. For total weekly leisure-time exertion (the LTEQ), results indicated the males ($M = 46.0$, $SD = 29.14$) and females ($M = 44.11$, $SD = 26.75$) also did not differ significantly in their reported levels of weekly leisure time exertion $t(61) = 0.27$, $p = .79$, $d = 0.07$. Lastly, Category D of PTSD in the DSM-IV-TR (APA, 2000) (the FSS) indicated that males ($M = 6.43$, $SD = 2.98$) and females ($M = 7.83$, $SD = 3.78$) did not differ significantly $t(63) = -1.63$, $p = .11$, $d = -0.41$.

Table 1

Means, Standard Deviations and Ranges for the LTEQ, HAS, and FSS

	Mean	SD	Score Range
LTEQ	44.95	27.62	00.00 - 127.00
HAS	39.12	10.25	19.00 - 64.00
FSS	7.21	3.39	1.00 – 16.00

Table 2

Means and Standard Deviations for Hyperarousal Measures for Group Exercise

	Often	Sometimes	Rarely/Never
HAS	33.82 (9.51) _a	41.73 (8.37) _b	42.85 (12.86) _b
FSS	5.52 (3.38) _a	7.85 (2.99) _b	8.61 (3.82) _b

*Means with differing subscripts are significantly different, $p < .05$.

CHAPTER 6

Discussion

The purpose of this study was to investigate the relationship between physical exercise and hyperarousal symptomatology. More specifically, this study sought to determine if there was a relationship between levels of weekly physical exertion and frequency of exercise, and the hyperarousal symptoms as listed in Category D of the PTSD section of the DSM-IV-TR (APA, 2000) as well as trait hyperarousal. It was hypothesized that individuals who exercise more frequently would show lower levels of hyperarousal symptomatology on the HAS and FSS scales. It was also hypothesized that individuals who report higher levels of exertion during their leisure-time exercise would also report lower levels of hyperarousal as reported by these same scales. The goal of this research was to contribute to the current literature on physical exercise treatment modalities as a step toward further investigating the efficacy of physical exercise as a treatment for PTSD. Three research questions were also investigated, exploring possible relationships between gender, hyperarousal, and exercise.

All of the study's four hypotheses were supported. Specifically, a significant negative correlation was found between the variables of weekly leisure-time exertion and reported hyperarousal on the HAS and FSS scales (hypotheses #1,#2). Simply put, the level of physical exertion that was produced by individuals during weekly leisure-time exercise was related to their self-reported hyperarousal as measured by the HAS and FSS. The greater the reported levels of weekly leisure-time exertion, the less reported

hyperarousal symptomatology an individual was likely to report. Further investigation would be needed to deduce exactly why individuals who report greater weekly physical exertion reported fewer hyperarousal symptoms.

For the frequency of exercise hypotheses (hypotheses #3,#4), an analysis of variance (ANOVA) was used to examine group differences between trait hyperarousal and current symptoms of hyperarousal and three different levels of reported leisure time frequency (often, sometimes, rarely/never). The results showed a strong relationship between reported frequency of exercise and reported hyperarousal symptomatology for both the HAS and FSS scales. This is consistent with Berry et al. (2006), who found that individuals who exercise on a regular basis (2-3 times weekly) will experience less symptoms commonly associated with anxiety disorders, PTSD, and depression than individuals who do not exercise at all. These results are also consistent with two large human population studies (Arida et al., 2008; Strohle, 2009) that found evidence of the role of exercise in the mitigation of PTSD symptoms through its release of endogenous opioids and other biological precursors that decrease the release of stress related hormones, thereby decreasing hyperarousal symptoms.

There were no significant differences found between gender and hyperarousal symptomatology on the basis of self-reported frequency of exercise or self-reported weekly leisure-time exertion level. One explanation for this lies in the nature of the study questions. Since the self-reported frequency of exercise between males and females was shown to be similar, it would hold that hyperarousal symptomatology would also be very similar. This might be especially true in a highly structured university setting where unit

load, work hours, and daily responsibilities are probably comparable. Therefore, no significant differences were found between gender, exercise, and hyperarousal symptomatology.

Strengths and limitations. One of the strengths of the present study was that it used previously published measures for hyperarousal as well as creating its own scale devised from the DSM-IV-TR (APA, 2000) criteria for PTSD. This allowed us to compare two different types of hyperarousal measures, one for trait hyperarousal and the other for symptoms of hyperarousal. Another strength of this study was that it managed to maintain a narrow focus, examining only hyperarousal symptomatology and physical exercise. Category D of the DSM-IV-TR is often characterized by mental health practitioners as being the “physical” symptoms of PTSD while exercise in itself is classified as a purely physical endeavor.

The present study also has several limitations. To begin with, our sample consisted exclusively of undergraduates who were enrolled during summer classes at Humboldt State University. Therefore our sample was not only limited by the fact that it was a sample of convenience but by the limited age of the sample participants. Another possible limitation of the present study is that possible moderating variables such as race, ethnicity, or previous physical conditioning were not examined. Another limitation of this study centers on the issue of trauma itself. We did not ask which individuals had suffered a trauma that could result in them expressing increased hyperarousal symptomatology. It is assumed that individuals who experience trauma or traumas would have an overall increased expression of PTSD symptoms, including hyperarousal. It would have been

helpful to identify those individuals who reported having experienced a trauma so that their data could be compared with that of a normal college population. Lastly, the alpha level for the FSS scale was reported as being .68. This is more than likely due to the small item number of the scale (five questions). Typically, scales that use small numbers of questions report lower alpha levels when compared to larger scales with more questions. However, the low reliability suggests that results from analyses using the FSS scale should be interpreted with caution.

Clinical implications. Though this study has several inherent limitations, the findings are significant and can be applied to clinical settings in a variety of ways. The lower hyperarousal for individuals who self-reported more frequent leisure-time exercise is consistent with human population studies done in Finland that suggests that those individuals who exercise on a regular basis (2-3 times weekly) experience less symptoms commonly associated with anxiety disorders, PTSD, and depression (Berry et al., 2006). This result adds another piece of evidence to the growing body of research on the effects of regular exercise on hyperarousal symptomatology, and allows clinicians to suggest exercise interventions that are more appropriate and effective.

The correlation found between weekly leisure-time exertion and hyperarousal symptomatology could encourage individuals to break a sweat more often, rather than just sometimes or rarely. This could potentially increase the number of times the average person exercises, increasing not only physical health but mental health parameters as well. This study adds yet another piece of evidence to the body of research that suggests that physical exercise is an efficacious treatment for anxiety disorders such as PTSD.

The abundance of physical exercise programs and techniques leaves mental health practitioners with an almost unlimited number of physical exercise interventions that can be used with individuals that are presenting with hyperarousal symptomatology.

The physical exercise modality of treatment also has been shown to provide other benefits other than a decrease in hyperarousal symptomatology such as the creation and maintenance of biological homeostasis and improved overall mental health of an individual (Dudgeon et al., 1998). It has also been shown to protect individuals against the onset of a host of medical issue including somatic complaints, diabetes, heart disease, hypertension, and numerous forms of cancer (Kendall-Tackett, 2009) This all points to physical exercise as a truly multi-modal form of therapy that not only focuses on the hyperarousal component of anxiety disorders like PTSD but as an efficacious and beneficent treatment that is “drug free” and possesses very few known side effects. Though not as quick as taking modern oral medications, physical exercise can be performed during relatively small periods of free time (15 minutes or more) and within a variety of locations and spatial limitations. In this modern age where time and space always seems like they are at a premium, mental health practitioners could use a tool as flexible, timely, and effective as physical exercise therapy.

Directions for future research. For the future, studies should attempt to replicate the present study using data collected from a broader population. This could expose possible racial, cultural, and ethnic differences dealing with hyperarousal and physical exercise. This broader sample would allow future researchers to draw conclusions that were applicable to different age groups and generations. It would also be interesting to

investigate whether various types of physical exercise (swimming, jogging, tai chi, etc.; aerobic vs. anaerobic; etc.) correlate differently with trait hyperarousal or current hyperarousal symptoms. This would open up even more possibilities for physical exercise and possibly help determine a hierarchy of effective physical modalities for treatment.

It would also be interesting to study the moderator of the PTSD diagnosis itself, examining any possible relationship between physical exercise and hyperarousal symptomatology in individuals already diagnosed with PTSD. In this same vein, exploring any relationship between physical exercise and individuals who experienced trauma, whether or not they had a PTSD diagnosis, also seems like the next logical step in this research process. Lastly, researching any relationship between physical exercise and hyperarousal/PTSD as it relates to an individual's current physical conditioning also seems like it would be worth investigating. Do healthy, extremely physically fit individuals benefit more or less in a reduction of hyperarousal symptoms than more typical representatives from the sample population? Would there be a greater reduction in reported hyperarousal/PTSD symptomatology from an individual who does not exercise regularly versus someone who does? These questions easily segue into future areas of research on the efficacy of physical exercise modalities, specifically in the treatment of anxiety disorders such as PTSD.

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Appendix B

Hyperarousal Scale

Please read the following statements and circle the response that best describes your typical behavior and feelings the **last 6 months**. Your answers will range from Not at all (0) to Extremely (3).

Please mark every item. If you are unsure of a response give your best estimate.

	(Not At all)	(A Little)	(Quite A Bit)	(Extremely)
Item Rating	0	1	2	3
1. I am well organized	0	1	2	3
2. I am slow to awaken mornings	0	1	2	3
3. I am a very careful worker	0	1	2	3
4. My mind is always going	0	1	2	3
5. I think a lot about feelings	0	1	2	3
6. Bright lights, crowds/noise, or traffic bother me	0	1	2	3
7. Evenings are my best time	0	1	2	3
8. I cannot take naps, even if I try	0	1	2	3
9. I tend to anticipate problems	0	1	2	3
10. My bedroom is a mess	0	1	2	3
11. I take things personally	0	1	2	3
12. I get rattled when a lot happens at once	0	1	2	3
13. I am good at details	0	1	2	3

14. I have trouble falling asleep	0	1	2	3
15. I am a cautious person	0	1	2	3
16. In bed at night, my thoughts keep going	0	1	2	3
17. A sudden, loud noise would cause me a prolonged reaction	0	1	2	3
18. I am overly conscientious	0	1	2	3
19. Caffeine affects me strongly	0	1	2	3
20. When things go wrong, I tend to get depressed	0	1	2	3
21. My routine is predictable	0	1	2	3
22. Some thoughts return to often	0	1	2	3
23. I take a long time to make decisions	0	1	2	3
24. Alcohol makes me sleepy	0	1	2	3
25. I get tearful easily	0	1	2	3
26. I keep thinking about the same things long after they happened	0	1	2	3

Appendix C

Leisure Time Exercise Questionnaire (LTEQ)

1. During a typical **7-Day period** (a week), how many times on average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the approximate number).

a) Strenuous Exercise (Heart Beats Rapidly)	Times Per Week
(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)	-----

b) Moderate Exercise (Not Exhausting) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)	-----
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c) Mild Exercise (Minimal Effort) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)	-----
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2. During a typical 7- day period (a week), in your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

Often	Sometimes	Never/Rarely
1. <input type="checkbox"/>	2. <input type="checkbox"/>	3. <input type="checkbox"/>

Appendix D
Five Symptom Scale (FSS)

Please circle one response for each question:

1. Do you have difficulty falling or staying asleep? 0-----1-----2-----3-----4
2. Do you consider yourself irritable or find that you are prone to outbursts of anger? 0---
--1-----2-----3-----4
3. Do you have difficulty concentrating? 0-----1-----2-----3-----4
4. Would you consider yourself hypervigilant?(state of increased anxiety/constantly
scanning of the environment for threats) 0-----1-----2-----3-----4
5. Do you feel like you startle easily? 0----1-----2-----3-----4

Please remove or print this page and take it with you

We wish to thank you for volunteering in our study. We recognize that some of the questionnaires touch upon several questions that are of a personal nature. As such we also recognize that some of the questions asked may be potential areas of concern for you. People sometimes, while completing the questionnaires, become aware of behaviors and thoughts that may suggest the need to talk to a professional or seek out further information.

If, after completing the questionnaires, you recognize that there may be some issues or feelings that are a potential problem for you, we strongly urge you to contact a professional to talk to about your concerns or to answer questions that you may have.

The following agencies and resources are available for you to contact:

HSU Counseling & Psychological Services	(707)826-3236
HSU Community Counseling Clinic	(707)826-3921
Open Door Clinic	(707)441-1624
Humboldt County Mental Health	(707)445-7715

Once again, we thank you for your participation in this research project.

