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We recommend that the dissertation prepared under our direction by Scott Anderson entitled The Map Forward: Occupational Stress and Brain Arousal in Police Officers be accepted as fulfilling the research for the requirement for the degree of Doctor of Psychology.

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The Map Forward: Occupational Stress and Brain Arousal in Police Officers

A Dissertation
Presented to
the Faculty of Springfield College

In Partial Fulfillment
of the Requirements for the Degree
of Doctorate of Psychology

By
Scott H. Anderson, M.A., M.Ed.
August 2021

Dedication

I would like to dedicate this dissertation to the first responders around the world, your commitment to make our communities a safer place does not go unnoticed. Specific dedication goes to my brother, Mark Anderson; a paramedic and firefighter… you are my hero.

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I must first acknowledge the commitment of the Psy.D faculty at Springfield College who have offered their unwavering support throughout my academic journey. Specifically, I would like to thank Dr. Sally Hage and Dr. Sean DeMartino for their continued support, encouragement, and patience as I have completed this dissertation. Next, I would like to thank Dr. Mark Gapen for his continued mentorship and support. I am also incredibly grateful for the support and encouragement from Dr. Dan Smith. Your willingness to help out and get involved is greatly appreciated! Finally, I would also like to thank my parents, my partner, and my friends for their unconditional support, love, and encourage over the course of my academic career.

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Abstract

It is well known that occupation demands of police work exact a significant toll on police officers in terms of their physical and psychological well-being (Waters & Ussery, 2007). The purpose of this study was to investigate how occupation demands impact the brain arousal of police officers. A convenient sample of 55 police officers from several departments throughout a New England state participated by completing four questionnaires related to years of experience a patrol officer, hypervigilance, organizational police stress, and operational police stress. They then volunteered to have their electroencephalography (EEG) recorded for 2 minutes to derive the theta/beta ratio (TBR). The results of the study identified a moderate negative correlation between years of experience and TBR and a weak negative correlation between hypervigilance scores and TBR. Organizational police stress and operational police stress did not yield a significant relationship with the TBR.

Keywords: Police officers, occupational demands, electroencephalography, theta/beta ratio.

CHAPTER ONE

This study contributes to the existing first responder and electroencephalogram (EEG) literature by merging the two areas in a study of police officers and their brain arousal. Studying EEGs in police officers explores the relationship between the occupational demands of a police career and brain arousal. Brain arousal in this study is defined as an increase in alertness to stimuli, voluntary motor activity, and emotional reactivity (Pfaff, 2006). The findings of this study shed light on the relationship between the state of hypervigilance, years of experience as a patrol police officer, and occupational demands in relationship to brain arousal of police officers. This study utilized a community-based cross-sectional quantitative design. Participants included 55 police officers, all varying in the number of years on the police force.

The first chapter of this study addresses the background related to the demands of police officers, including but not limited to issues of mental health, occupational demands, the impact of police work on the brain/EEG, and hypervigilance. This chapter provides a framework for subsequent chapters. In addition, this chapter provides an overview of the research approach used in the current study, the researcher hypotheses about police officers and EEG, and definitions of key terms used throughout the study are provided. This chapter concludes with the rationale and significance of the study.

Background of the Problem

> At my worst, I could tell you what my pistol tasted like after firing a test round into the dirt. I truly believed without a shadow of a doubt that I was weak and going crazy. I thought that absolutely no one could begin to comprehend what I had seen. I thought I was alone, and because I was alone, I thought that asking someone, anyone, for help would be about as effective as yelling for help into a jet engine – Police Officer (Kirschman et al., 2014, p. 28)

Police work has been described as “civilian combat” because police officers who serve as patrol officers regularly experience exposure to traumatic events in their line of work (Violanti & Paton, 1999). The occupational demands of police work are well known, with one study suggesting that police work is among the top six jobs identified as being the most damaging to physical health and psychological well-being, and as having one of the lowest levels of job satisfaction (Johnson et al., 2005a). In 2017, 129 police officers were killed in the line of duty, in addition to 140 police suicides in the United States (Heyman et al., 2018). Furthermore, another study found that 7.8% of 193 active police officers in Midwestern states agreed with a statement suggesting the thought of taking their own life kept coming into their mind (Chopko et al., 2014). A national survey conducted in the United States by Kessler et al. (1999) reported the following statistics regarding suicide in the general population (N = 5,877, age range from 15 to 54 years old): 13.5% experience lifetime ideation, 3.9% have a plan, and 4.6% attempt suicide. However, the police officer lifetime prevalence rate of suicidal ideation is 25% in men and 23.1% in women (Violanti et al., 2009), which is approximately double the rate in the general population. Although exact numbers of police suicide attempts are difficult to find, it is well known that even low levels of suicide ideation significantly increase the risk of substantial ideation or a suicide attempt (Young et al., 1998)

Given the demanding nature of police duties and the effects of what Gilmartin (2002) calls the “hypervigilance biological rollercoaster” (p. 50), it is no surprise that police officers develop negative physical and mental health consequences. The “hypervigilance biological rollercoaster” suggests that patrol police officers are in a state of constant hypervigilance during their shift, which is adaptive in keeping the officer and

the public safe. However, in order to maintain a level of risk within normal limits, or what Gilmartin calls “biological homeostasis” (p. 44), a patrol police officer also encounters hypovigilance while off duty, or a state of drowsiness or inattentiveness. The results of the rollercoaster can strain relationships because of the high levels of alertness required of them while on duty and the indifference or withdrawal from activity at home (Gilmartin, 2002).

Literature cannot reliably predict the number of critical incidents a police officer may be exposed to over the course of their career; however, one can safely estimate that ample opportunity exists for frequent encounters with death and other critical events (Petr & Henry, 2004). In the general population, 60.7% of women and 51.2% of men will experience at least one potentially traumatic event in their lifetime (Javidi & Yadollahie, 2012). Of these potentially traumatic events in the general population, Lukaschek et al. (2013) suggest that full posttraumatic stress disorder (PTSD) occurs in only 1.7% of individuals impacted by trauma, and partial PTSD occurs in 8.8% of these individuals. However, the rate of chronic PTSD within police officers is much higher. Cone et al. (2015) suggest that chronic PTSD rates in police officers who did not report PTSD before 9/11 was 15.5% in women and 10.3% in men 10-11 years after 9/11. Therefore, these higher rates of PTSD suggest that the occupational demands of police work may be a leading cause of trauma induced health concerns. The importance of these statistics suggests that the men and women who are trained to protect our communities may be experiencing significant negative health consequences of their job, and it is the responsibility of researchers, clinicians, police departments, and the public to ensure the quality of their service and personal well-being.

Furthermore, police culture is a useful concept in understanding the many facets of policing. In the literature, positive aspects (e.g., collectivist culture that helps buffers the strains the officers face (Waddington, 1999)) of police culture are often understated while focus is placed on the negative connotations associated with police culture (Paoline, 2003). The negative aspects of police culture may impede a police officer's ability to seek assistance. Police officers often struggle silently with mental health concerns for several reasons. First, police officers who seek treatment fear losing their job or having their credibility/ fitness for duty called into question if they were to get labeled by a mental health diagnosis (Waters & Ussery, 2007). Second, police officers ignore symptoms of mental health concerns because these symptoms conflict with their image of what police officers should be, that is, the idea that only the weak suffer from stress related symptoms. They also may believe that they are a special population that has superhuman abilities without weaknesses and that trusting others is a sign of weakness (Waters & Ussery, 2007). Finally, police officers question the extent to which clinicians may be able to understand the pressures placed on law enforcement (Waters & Ussery, 2007). In sum, due to the combination of police culture, stigma surrounding mental health, and the necessity of hypervigilance maintaining officer safety, police officers are less likely to seek mental health services when compared to the general population.

Statement of the Problem

While several existing studies investigate first responder wellbeing (see Jones, 2017 for a comprehensive meta-analysis), no studies were found that specifically addressed the relationship between occupational demands of police work and brain arousal. Considering that police officers go through an intense selection protocol and are tested and screened both physically and mentally (Cone et al., 2015; Water & Ussery,

2007), evidence suggesting police officers experience physical and psychological deterioration over their career is surprising due to the effort put forth to identify healthy individuals fit to serve as police officers. Factors that may contribute to police officer deterioration include but are not limited exposure to job-derived trauma (which may result in acute stress disorder, adjustment disorders, or impairment of job performance) (Arnetz et al., 2009), physical ailment related to both cardiovascular and gastrointestinal systems (Neylan et al., 2002), and higher than average occupational stressors (e.g., pressure from supervisors, media, judges, inadequete resources, and autocratic leadership styles) (Loo, 2003; Neyland et al., 2002). Evidence also connects stress (both acute and chronic) with changes to neurochemical systems and specific changes within brain regions such as the amygdala, hippocampus, and medial prefrontal cortex, which results in long-term changes in the brains "circuits" and its reaction to stress (Bremner, 2006; Pitman et al., 2001). These factors result in potentially severe health consequences from police work (such as difficulties with sleep, nutrition, social interactions, physical fitness, etc.), which provides a rationale for the importance of determining how the demands of police work relate to brain arousal of patrol officers at a specific point during their career. Findings may inform the work of psychologists who treat first responders and may point the way to the development of preventative interventions to aid in the long-term health of police officers and emergency medical providers.

Purpose of the Study

The purpose of this study was to identify how police officers experience the demands of their job as measured by hypervigilance scores, years of experience as a patrol officer, occupational and organizational demands, and measures of brain arousal. Before this study, no EEG data had been gathered regarding brain arousal in police

officers. Finally, no studies have attempted to investigate the association between the occupational demands of police work and specific EEG patterns of arousal.

The study advances our knowledge base regarding first responders, and findings may inform preventative protocols that may aid in minimizing risk and building protective factors in police officers. Understanding the potential change in brain arousal in patrol police officers at one point in time, with varying years of experience provides a unique and previously unknown insight into the demands of the occupation. Finally, with police officers being exposed to daily risk of harm to themselves or others, understanding how brain arousal changes over a police officer's career may reduce long term suffering and as a result enhance the quality of crisis services to communities that police officers serve (Flannery, 2015). The police officers who dedicate their lives to protect our communities can benefit from this study, as understanding how their occupation may influence their brain arousal could motivate them to take preventative measures (such as reducing overtime, taking time off, or seeking help earlier) to ensure they engage in self-care to combat the difficult nature of police work.

Research Question

The overall research question for this study is: Are hypervigilance scores, years of experience as a patrol officer, and operational and organizational police stress predictors of brain arousal in patrol police officers? Furthermore, the author of the study hypothesizes that police officers who have higher scores of hypervigilance, years of experience, and operational and organizational police stress will display a higher level of over aroused EEG patterns than police officers who have lower scores and years of experience. Within the context of the hypervigilant biological rollercoaster, it is hypothesized that police officers get stuck in the pattern of over arousal during duty and

given a longer police career, their arousal level may become rigid and frozen in over aroused patterns even when off duty.

Research Design

This study has a community-based cross-sectional design. This quantitative design was chosen to determine if hypervigilance, years of experience, and occupational demands experienced as a patrol officer, might correlate with changes in brain arousal in officers. The independent variables in this study consisted of years of experience as a patrol officer (assessed with a demographic questionnaire, hypervigilant scores (assessed by the Hypervigilance Questionnaire (Kimble et al., 2009)), operational police stress (assessed by the Operational Police Stress Questionnaire (McCreary & Thompson, 2006)), and organizational police stress (assessed by the Organizational Police Stress Questionnaire (McCreary & Thompson, 2006)). The independent variables were independently analyzed to determine the degree by which they were able to predict the Theta/Beta Ratio (Monastra et al., 1999), a measure of brain arousal. A power analysis was conducted by the researcher and results revealed an appropriate sample size to achieve significance would consist of 55 participants. The researcher collected the data by meeting with each participant individually during a one-time session of approximately 20 to 25 minutes. Informed consent (see Appendix A) was obtained from each participant, but in order to ensure the confidentially and privacy of the participant the signed consent form was mailed by the participant to the Institutional Review Board (IRB) office at Springfield College. In addition, during data collection scores were manually inputted into a data collection sheet, which were given a random identification number. Hence, the names of participants were intentionally separated from the data,

which was deidentified. Descriptive and summary statistics were employed to analyze the data. Correlation and multiple regressions were used to identify associated factors.

Significance of the Study

The rationale for this study stemmed from a desire to better understand the occupational demands of police work and the effects of this work on the brain, while opening the door for future research that can aid in the identification of risk factors and the development of protective factors leading to the improvement of wellbeing and services for police officers. With the occupational fatality rate of police officers at nearly three times the national U.S. average (Maguire et al., 2002), and with an estimated 12% of officer deaths from 2008 to 2017 involving drug or alcohol use (National Law Enforcement Officers Memorial Fund, 2018a), the identification how police work impacts brain arousal is of critical importance. Furthermore, 22% percent of the total number of police officer deaths between 2008 and 2017 were attributed to job-related illness (National Law Enforcement Officers Memorial Fund, 2018a). As a result, the importance of understanding how patrol-related police duty impacts the individual is critical. The quantitative gathering and analysis of the participants' data sheds light on how brain arousal may change over a police career, which may help departments and practitioners tailor specific resiliency programs to better serve the men and women who dedicate their lives to protect our communities.

The Researcher

I conducted this research project as a dissertation requirement for graduation from a counseling psychology doctoral program. During the time the research was carried out, I was in my third year of doctoral studies. My dissertation committee was comprised of two licensed psychologists, one male and one female (both possessing a Ph.D.) and

another male committee member preparing for licensure (with a Psy.D.). In addition, the statistician committee member holds a Ph.D. The dissertation committee members have unique specializations and experience related to the study. Committee members have unique training and experience working with first responders and two committee members have expertise in clinical neurofeedback. The psychologist serving as chair for the study has expertise in trauma and resiliency and is an expert in prevention research.

The primary researcher was trained in and practiced clinical neurofeedback, while receiving weekly supervision from a licensed psychologist who is an expert in neurofeedback. The neurofeedback training provided the researcher with competencies in the interpretation of the EEG data. Neurofeedback has wide-reaching clinical utility that can provide clinicians and researchers with indicators of brain arousal measured by the theta/beta ratio (Monastra et al., 1999). The theta/beta ratio (TBR) is a measure of arousal that suggests that typical brain arousal is around 1.5; therefore, a ratio below 1.5 would show patterns of over arousal and a ratio above 1.5 would suggest under arousal. For the purposes of this study, the theta/beta ratio provides unique insight into the demands of police duty. Therefore, the EEG data collected from the police officers provides insightful data on how the brain may reorganize itself to meet the demands of police duty. In addition, the EEG is a less expensive option and is easier to collect than other measures of brain processes, such as Magnetic Resonance Imaging (MRI) or Functional Magnetic Resonance Imaging (fMRI), while still providing a precise measurement of brain arousal.

Some notable similarities exist between the participants and me, as researcher. According to the United States Bureau of Labor and Statistics (2018) 79.8% of patrol

police officers are White and 86.4% identify as male, which resembles my race and gender identity. These factors aided in my ability to gain buy-in and to recruit participants. However, as a civilian it was difficult to get patrol officers to trust me as their job is to be suspicious of individuals they do not know. Therefore, the researcher was sensitive to the hierarchical structure of the police department while considering their natural response to be untrusting of outsiders. The researcher worked hard to build rapport and discussed full disclosure and consent with police chiefs, captains, and patrol offers in order to invite participants to be involved in the study.

Definitions of Terms

Arousal. An aspect of an individual's general state that can vary along a continuum, corresponding at one end to deep sleep and at the other to extreme excitement (Duffy, 1951).

Electroencephalogram (EEG). A test providing a graphical representation of neuronal activity in the cerebrum (Demos, 2005).

Hypervigilance. A behavior that involves exaggerated or enhanced searching for environmental stimuli or scanning for threatening information (Rollman, 2009).

Hypovigilance. A state of diminished vigilance or anything that causes a decrease in paying close and continuous attention (Arun et al., 2011).

Multiple regression. A statistical procedure involving just one dependent variable but with two, three, or more independent variables (Huck, 2012).

Theta/beta ratio. A ratio derived by dividing the output of theta waves (4 to 8 Hz) by the output produced in beta waves (13 to 21 Hz) (Monastra et al., 1999).

Summary

Research suggests that increased rates of both suicide (Violanti et al., 2009) and PTSD (Cone et al., 2015) exist within the police officer population. Gilmartin (2002) also suggested that a unique aspect of police work is that police officers work to maintain biological homeostasis, which could have consequences on their work performance and home life. Attention within police departments is often given to training for job related skills or the need to update equipment; as a result, less concern is given to maintaining the physical and mental health of officers (Waters & Ussery, 2007). In addition, to date no research has sought an understanding of how the occupational demands of police work influence brain arousal of officers. Consequently, this study investigated whether or not occupation demands, hypervigilance scores, and years of experience as a patrol officer can predict brain arousal as measured by the EEG. The study provides unique physiological insight into how the number of years as a patrol officer impact the functioning of the brain.

Chapter Two of this dissertation provides a critical review of the empirical research on police officer health, occupational demands of police work, hypervigilance, and the relevance of the brain/EEG to healthy functioning. The overview of the literature further provides a foundation that builds and provides a holistic context and a rationale for the study.

CHAPTER TWO

Overview

In 2017, 93 police officers were killed in line-of-duty incidents in the United States (Federal Bureau of Investigation National Press Office, 2018). Of these 93 deaths, 46 officers died due to felonious acts (42 killed with firearms, three killed using a vehicle as a weapon, and one killed by a knife) and 47 officers died in accidents (the variety of

scenarios included automobile accidents, hit by a vehicle, drowning, and aircraft or boat accidents) (Federal Bureau of Investigation National Press Office, 2018). The important fact that these statistics illustrate is that police work is an inherently dangerous job and with over 750,000 police officers employed in the United States engaging in tens of millions of interactions with the public (Klinger, 2004), it may be surprising that death rates are not higher. Police work has been described as "civilian combat" in which police officers are almost certainly going to experience exposure to traumatic events as a result of responding to critical incidents (Violanti & Paton, 1999). A critical incident is defined as any event that is stressful enough to impact and overwhelm an individual's sense of control, connection, and meaning in their life (Pietrantoni & Prati, 2008). Examples of critical incidents include: handling of dead bodies, physical assault, witnessing violence and familial abuse, shootings, and disaster scenes such as Hurricane Katrine or 9/11 (Paton & Smith, 1996).

In addition to the physical harm to self that can occur in the line-of-duty, traumatic stress can also result in health concerns for police officers. Traumatic stress refers to the physiological and psychological reaction to stressors that threaten a person's life or bodily integrity and includes the subjective experience of extreme horror, fear, and helplessness due to being beyond the person's ordinary capacity to cope (Reyes et al., 2008). Published literature suggests that traumatic stress occurs in first responders 6 to 22% of the time when responding to a critical incident (Neria et al., 2011).

For several reasons, this study and the following literature review will focus specifically on police officers. First, due to the unique nature of law enforcement and exposure to critical incidents (e.g., threat of being shot at, ran over), police officers'

training is different when compared to paramedic or firefighter training as their training includes firearms and de-escalation (among other unique aspects), and job duties vary greatly from other first responders (Jones, 2017). Second, police departments have a different organization culture that includes unique policies and procedures when encountering a critical incident (Flannery, 2015). Police officers face multiple threats to their well-being and safety (Mumford et al., 2015), with occupational fatalities for police officers being nearly three times that of other U.S. workers (Maguire et al., 2002). Researchers within the United States contend that police officers experience more critical incidents when compared to emergency health service workers and military personnel (Liberman et al., 2002). Overall, police officers strive to ensure the safety of others; hence, researchers, clinicians, and the public have a duty to provide resources and to aid in taking care of the health and well-being of police officers (Stanley et al., 2016).

Police Officer Health

Police officers begin their careers in excellent physical and mental health (Alexander & Wells, 1999; Waters & Ussery, 2007). However, the number of officers who opt for early retirement or endure death from job related stress disorders demonstrates the cost of their occupational demands and the need for ongoing emotional readjustment (Waters & Ussery, 2007). A study conducted by the World Trade Center Health Registry examined continuing stress and posttraumatic stress disorder (PTSD) rates and found 8.3% of the sample of 4,017 police officers (582 women and 3,435 men) met full DSM-IV criteria for PTSD (Bowler et al., 2010). Flannery (2015) suggests that psychological trauma disrupts three domains related to good mental and physical health: caring attachment to others, reasonable mastery of one's environment, and an individual's ability to find a meaningful purpose in life that motivates them to invest

energy in the world each day to pursue a socially acceptable goal. The influence of psychological trauma on police officers is of critical importance when understanding unique elements of how police work influences their life and their ability to serve in the line of duty. For example, police work can influence a family in substantial ways, such as uprooting the family with temporary assignments, or postings and/or shift work disrupting all phases of a family's life including social life and possibly health (Loo, 2003). The next section looks at specific health concerns that police officers encounter.

Substance use

Former director of the National Institute of Drug Abuse, Alan Leschner, has stated on numerous occasions that the two primary reasons for consuming alcohol or taking drugs are to feel better and to feel good (Waters & Ussery, 2007). To "feel better" many first responders use substances to self-medicate the symptoms of untreated PTSD and trauma (Flannery, 2015). A biphasic nature has been identified with individuals suffering with PTSD (emotional flooding with painful affect and/or affective numbing); therefore, it is not surprising that substance use disorder (SUD) is a comorbid disorder (Khantzian, 2003). However, formal comorbidity rates are difficult to determine due to the wide range of trauma exposure (e.g., war, natural disaster, interpersonal violence) (Please see Bailey and Stewart, 2014 for descriptions of SUD rates and different types of traumatic exposure).

The self-medication hypothesis (SMH) (Khantzian, 1987) may provide insight into the nature of substance use. The SMH suggests two aspects of substance use that are important and disputed. First, the SMH suggests that drugs of abuse relieve psychological suffering. Second, the SMH proposes that a person's preference for specific substances

involves some degree of psychopharmacological specificity, meaning the drug of choice targets a neurobiological vulnerability in the user (Khantzian, 1997; Maté, 2010). Aspects of the SMH may be impacting the rates of substance use within the police population. Studies of police officers suggest that monthly binge drinking (defined as consumption over the past 30-day period of five or more drinks for men and four or more drinks for women) rates were 37.2% in males and 36.6% in females (Ballenger et al., 2010), which is higher than that of the general population (17.1%; Center for Disease Control and Prevention, 2012). The rate of alcohol misuse in a primary care population is one in four in females and one in three in males (Bradley et al., 2007). By comparison, in a police sample over half of both the female and male officers screened positive for alcohol misuse, further supporting the maladaptive use of alcohol as a coping strategy in response to stressors (Violanti et al., 1983). Alcohol use within the police community is so prevalent and normalized, Joseph Wambaugh, a former police officer and now a novelist, described the habit of gathering after a shift to drink and relax as "choir practice," with some retired police officers even purchasing police bars in order to remain connected to their peers (Waters & Ussery, 2007).

Divorce and domestic violence

Another way police officers' lives are impacted by stress in their work is in their intimate relationships. Divorce rates in some police departments can range from 50 to 80% and "almost appears to be a catching disease in police families" (Waters & Ussery, 2007, p. 178). High divorce rates have a significant relationship with domestic violence, with literature suggesting domestic violence in the general population is likely to occur three times more frequently in a divorce or separated situation (Waters & Ussery, 2007).

If domestic violence occurs at the same rate in police families as the general population, some 60,000 to 180,000 police families would be involved each year (Waters & Ussery, 2007). A study of 728 police officers reported that 40% had lost control and behaved violently towards their spouse (Johnson, 1991). Other police studies on domestic violence suggest rates of 22 to 41% (Neidig et al., 1992). Kirschman (2000, p. 139) states that domestic abuse is the "best kept secret shame of policing" and what is especially disturbing is that a woman has a higher chance of being attacked by their domestic partner than a police officer has of being assaulted during their shift and all too often the batterer is an officer (Waters & Ussery, 2007). It is important to note that literature has established a link between rates of PTSD and domestic violence in police officers, but gender differences were not specified in the review article (Dunnegan, 1997). Further concerns regarding the functioning of a police family in the research suggests between 40 to 70% of men who attack women will also attack the children (Waters & Ussery, 2007). Traditional gender roles may also lead to the increase in divorce and domestic violence within police families. The suggestion that men must provide for their families has police officers working night shifts and more than 50 hours a week. Consequently, fatigue caused by overworking is shown to have negative effects on self-control, while those suffering from sleep deprivation and "burnout" are frequently involved in domestic violence (Waters & Ussery, 2007).

Some evidence suggests that the effects of violent exposure on domestic violence is a mediated process. Johnson, Todd, and Subramanian (2005b) used a path model, which suggests that violent exposure is most significant if it leads to spousal violence through external burn out (a depersonalization of the individual) and authoritarian spill

over (an inability to leave the job at work by trying to evoke a sense of power and control within the family system). Another important factor of domestic violence is how gender roles influence the perpetration of violence. According to gender role theory (O'Neil, 1981), men who maintain a strong belief in masculine gender norms, specifically regarding providing for one's family, may be more likely to perpetrate violence if they believe these norms are being violated (Kwesiga et al., 2007). Additionally, men who are strongly committed to traditional views of masculine gender-role stress are more likely to turn to substance use as a means of managing insecurities regarding male role expectations, and as a result, they are more likely to engage in abusive behavior with intimate female partners (Copenhaver et al., 2000). Therefore, the perpetuation of strong male gender roles within police culture may lead to officers struggling with insecurities if coping strategies are overwhelmed.

Sleep

Considering the unique demands of shift work, sleep is critical for police officer to be at their best. Performing police duties while fatigued/impaired poses significant personal risk to both the general public and the officers (Vila, 2000). For example, Neylan et al. (2002) identified that the majority of police vehicle accidents occur in the early morning hours when the graveyard shift officers are particularly vulnerable to the consequences of sleep deprivation. General psychopathology and posttraumatic stress symptoms were found to be strongly associated with sleep disturbances in police officers, which may have a ripple effect in other areas of functioning such as occupational performance and health implications (Neylan et al., 2002).

Sleep quality is negatively influenced by many common stressors within police work including chronic exposure to critical incidents, rotating shift work, and occupational and organizational stressors (Neylan et al., 2002). Therefore, police officers who are exposed to such stressors may experience the effects in multiple domains of their sleep, such as sleep initiation, sleep maintenance, and nightmares (Neylan et al., 2002). However, police officers are often motivated by unique benefits that make them more likely to risk greater sleep debt. Some of these motivations may include overtime pay, college education reimbursement, and secondary employment, all of which could result in the police officer having remarkably insufficient or poor rest (Senjo, 2011). The negative consequences of a combination of reduced sleep and excess work could compromise public safety, increase risk of the officer getting injured, and increase the likelihood of civil liability for avoidable accidents (Senjo, 2011).

Mental Health

> I grew up in the church. Suicide was never an option. But after a while, I got tired. Tired of fighting, tired of the symptoms, tired of trying. The unthinkable began to be thinkable. Suicide started to make sense
> – Police Officer (Kirschman et al., 2014, p. 145)

Suicide

The Center for Disease Control and Prevention (2016) suggests that the overall rate of suicide in the general population is 13.0 per 100,000 people and, while rates of suicide are difficult to calculate accurately due to stigma and inaccurate reporting, evidence suggests police suicide occurs at higher rates. A meta-analysis of 30 published studies since 1950 suggest a police suicide rate of 18.1 per 100,000, which is considerably higher than that of the general public (Aamodt & Stalnaker, 2006). Suicide ideation rates within police officers have also been shown to be higher than that of the

public. Lifetime suicide ideation within male police officers was found to be 25% and 23% in female officers, whereas the rate of public suicidal ideation is 13.5% (Kessler et al., 1999; Violanti et al., 2009). The high frequency of police suicide is also supported within police suicide literature that suggests that police officers are more likely to die by suicide than by homicide or accidents (Violanti et al., 1996).

When considering suicide in police officer populations, it is important to consider and include occupational considerations. First, police officers protect civilians from deadly bullets, which may lower their fear surrounding death and may increase their risk for suicidality (Van Orden et al., 2010). Second, police officers have access to and have been trained in how to use firearms, which is a highly lethal means of completing suicide (e.g., patrol issued firearm; Stanley et al., 2016). Third, police officers are predominantly White males (United States Bureau of Labor and Statistics, 2018), which is the same demographic that is at the highest risk for suicide (Curtin et al., 2016). In addition, sleep disturbances caused by shift work can disrupt the family and impact social support, which increases the risk for suicide (Vallieres et al., 2014; Van Orden et al., 2010). The size of the department can also influence suicide rates. Violanti et al. (2012b) noted that higher rates of suicide may occur in smaller departments rather than larger departments, perhaps due to fewer resources and fewer mental health professionals per capita available to assist them. Finally, the risk for suicide is strongly correlated with SUD (Cavanagh et al., 2003). Psychological autopsy studies suggest 19 % to 63 % of all people who completed suicide suffered from SUD (Schneider, 2009).

Posttraumatic stress disorder (PTSD)

PTSD is a widely known mental health disorder however, it is complex and multifaceted, especially when it is related to police officers. Cumulative exposure to traumatic events was found to be significantly associated with PTSD in the general population when measured globally (Karam et al., 2014). While professional training appears to mitigate the risk of an adverse response to a critical event (Perrin et al., 2007), first responders still present with considerable rates of PTSD (Geronazzo-Alman et al., 2017). With police officers potentially experiencing a wide range of critical events that would be classified as traumatic or severely stressful over their career, it is not shocking that PTSD in officers is experienced at higher rates (Mumford et al., 2015). Police officers are shown to report significant somatization and PTSD symptomatology. A study consisting of 100 male police officers ranging in age from 20 to 60 years old all assigned to street patrol, shown a significant correlation between duty-related stress, somatization, and symptoms of PTSD; with 13% of the sample meeting diagnostic criteria for PTSD (Robin et al., 1997). When comparing the rates of PTSD of the general populations to rates of PTSD in police officers, the differences are staggering. PTSD occurs at a rate of 1.7% (full PTSD) and 8.8% (partial PTSD) in the general population (Lukaschek et al., 2013). In contrast, chronic rates of PTSD in police officers who did not report PTSD pre-9/11 was 15.5% in women and 10.3% in men, ten to eleven years after 9/11 (Cone et al., 2015). In addition, literature suggests that trait anger is a risk factor for PTSD symptoms, and PTSD symptoms are also associated with an increase of state anger (Meffert et al., 2008). Specifically, the study displays the complexity of PTSD illustrating the “nature-nurture” relationship by demonstrating that trait anger predicts vulnerability to PTSD symptoms, and trauma exposure and PTSD symptoms are associated with a further

intensification of anger (Meffert et al., 2008). Therefore, the potential consequences for police officers living with PTSD are great considering that they are responsible for maintaining peace and serving the public (Arnetz et al., 2009).

Physical health

The link between psychological trauma and physical health concerns in police officers is now becoming known. The symptoms of psychological trauma have been shown to cause dysregulation of cortisol patterns, which may impact future health outcomes in police officers (Violanti et al., 2007). Therefore, health problems are common in police officers (Brown & Campbell, 1994). The psychological stress that police officers face puts them at significantly higher risk than the general population for mental health and long-term physical health problems (Violanti et al., 2006). Hartley et al. (2011) used data from The Buffalo Cardio-Metabolic Occupational Police Stress Study (BCOP; Violanti et al., 2006) and conducted a comprehensive follow up investigation comparing health disparities in police officers to the general population. Hartley et al., (2011) accessed data from 464 officers using medical and laboratory tests, questionnaires, sleep data, and work history found some alarming results. First, 18.7% of the United States employed population (adults holding a full-time job) are at risk for acquiring metabolic syndromes, which places them at risk for coronary artery disease, type 2 diabetes, and stroke (Hartley et al., 2011). This statistic can be compared to more than 27 % of the officers in the study who were found to be at risk for acquiring the same metabolic syndromes. Finally, police officers were nearly four times more likely to sleep less than six hours per 24-hour period than the general population to which they were compared (33% vs. 8%; Hartley et al., 2011).

Further physical health concerns reported in police officers suggest that they are at increased risk for experiencing gastrointestinal and cardiovascular disorders (Neylan et al., 2002). Conversely, the prevalence of obesity in police officers (26.6%) has been found to be lower than the general population (34.9%; Ogden et al., 2013). Nevertheless, a study of 184 police officers from 11 different agencies reported that 92% had good health in the past year, compared to the general population (89.7%); but, only half as many officers reported excellent health on the Medical Outcomes Study Short Form-36 (Ware & Sherbourne, 1992) (16.9%) compared to the general population (32.7%; Mumford et al., 2015; O'Hara & Caswell, 2012). In another study examining the physiology of police officers (N = 355) in a United States city, Charles and co-authors (2014) investigated the association between insulin and heart rate variability. The results suggest that higher levels of insulin were significantly associated with lower (i.e., worse) levels of heart rate variability, especially in those with lower levels of physical activity and higher rates of obesity (Charles et al., 2014). Although ample support exists to show the connection between police officer stress and physiological concerns, no published studies were found that investigate the connection between the stress police officers face and their brain arousal.

Age

Age is another factor to consider when studying police officers, as it can have consequences for how stress impacts the individual. For example, one study suggests that the prevalence of depression increased from zero percent for police officers younger than 40 years-old to 24% in officer aged 40 to 49 years-old (Darensburg et al., 2006). In a study examining aging police officers (N = 105, mean age= 53 years), Gershon et al.

(2002) found that police officers in the study reported high levels of perceived stress based upon specific outcome variables, such as PTSD (53%), burnout (73%), and depression (75.6%). In the same study, older police officers indicated high levels of perceived stress related to chronic back pain (62.8%), foot problems (48.8%), and high blood pressure (36.4%; Gershon et al., 2002). This study sheds light on how brain arousal may change at different points throughout a patrol police officer's career and may be related to the degree of occupational stress patrol officers experience.

Occupational Demands

Few occupations demand employees to face as many stressful and dangerous situations as police officers experience on a daily basis (Queirós et al., 2013). Police officers are constantly under pressure and exposed to multiple stressors and uncertainty (Blum, 2000). Concerns regarding the high incidence of stress-related illnesses among police officers within the United States has reached such high proportions that an International Law Enforcement Stress Association has been formed and even publishes a quarterly journal called *Police Stress* (Cooper et al., 1982). Violanti and Aron's (1995) study of New York state police officers (N = 103) developed a hierarchy of stressors experienced by police. The top five-ranked stressors were: 1) killing someone in the line of duty, 2) fellow officer killed, 3) physical attack, 4) battered child, and 5) high speed chases (Violanti & Aron, 1995). In studying stress in police officers, McCreary and Thompson (2006) found supporting evidence that police officers naturally organize their stressors into the two general categories that were initially proposed by Symonds in 1970: *organizational* (i.e., stressors associated with the culture and organization within which they are performing their job) and *operational* (i.e., stressors associated with doing the job).

Organizational stress

Organizational stressors are typically organized into two categories: task content and role properties (Kahn & Byosiere, 1992). Task content stressors are physical aspects of an occupation that characterize the task at hand while considering its complexity, simplicity, or monotony and the physical conditions in which it must be carried out. Examples include excessive noise, extreme temperatures, or inadequacies in equipment (Shane, 2010). Role properties include the psychosocial aspects of the occupation that are characterized by the social nature of the work. Examples include role overload, role ambiguity, role conflict, and interpersonal relations between superior officers and subordinate personnel (Shane, 2010). The most stressful organizational factors for police officers, according to McCreary et al. (2017), consist of: 1) bureaucratic red tape, 2) staff shortages, 3) inconsistent leadership, 4) different rules applying to different personnel, and 5) always feeling the need to prove yourself to the organization. Researchers who have focused specifically on organizational stress in police officers have found that higher levels of organizational stress are positively associated with decreases in work performance (Shane, 2010) and higher levels of job-related burnout (Louw & Viviers, 2010). With the demands and consequences of police work being high, factoring how organizational stressors may impact police officers is of critical importance when studying this population.

Operational stress

Operational stressors are specific to job characteristics of police work and may include shift work, job related injuries (Violanti et al., 2012a), and the experience of traumatic events (Shucard et al., 2012). The most stressful operational factors for police

officers consisted of: 1) fatigue, 2) finding time to stay in good physical condition, 3) shift work, 4) occupation-related health issues such as pain, and 5) a tie between not having enough time available to spend with friends and family and paperwork (McCreary et al., 2017). The results of the Gutshall et al. (2017) study of police officers (n = 30) found that operational stress negatively affects processing information, learning, cognitive functioning, and working memory. Evidence linking the high operational demands of police work to physical health concerns also exists. For example, Nixon et al. (2011) found an association between non-traumatic workplace stressors and physical health concerns, which include sleep disturbance, gastrointestinal problems, and fatigue. A meta-analytic study (n = 336) of occupational stress revealed that an inability to keep up with work demands (perhaps due to poor health) may increase one's workload, which was associated with lower levels of physical health (e.g., indicated by global health and physical symptoms) and poorer psychological well-being (e.g., depression, burnout, distress, fatigue, and general well-being) (Bowling et al., 2015).

The most salient connection between the importance of understanding how occupational demands influence police performance is highlighted in Queirós et al. (2013) paper, which focused on burnout in police officers as a predictor of aggressivity. The findings from this study showed that burnout in police officers predicted 13 to 22% of aggressivity and highlights the need to develop effective stress prevention strategies aimed at reducing burnout as a result of occupational chronic stress and decreasing the risk of developing aggressivity among police officers (Queirós et al., 2013). Aggressivity within the Queirós et al. (2013) study being defined as an emotional state elicited by

stressful situations, leading the person to evaluate the situation as more threatening than it really is (Griffin & Bernard, 2003)

Arousal, Performance, and Vigilance

In performance domains there is a common misbelief that high levels of arousal are detrimental in facilitating a successful performance. For example, Drive Theory (Hull, 1943) suggests that performance is a function of arousal and habit strength; however, sport settings demonstrate that Drive Theory (Hull, 1943) does not occur and the theory has been identified as having methodological problems (Martens, 1971; Raglin, 1992). In addition, another theory of arousal and performance studied mice using a maze discrimination task where electrical shocks of varying intensities served as the stimulation (Yerkes & Dodson, 1908). The high-intensity shock would slow learning in the mice, suggesting that moderate stimulation was best for performance conditions which has been called the Yerkes-Dodson law. However, these results have been generalized to a variety of constructs and most associated with arousal (Teigen, 1994).

Arousal has also been connected to vigilance and dates back to 1915. In 1915, Cannon proposed the concept of energy mobilization in relation to the study of bodily changes in pain, hunger, fear, and rage. However, little attention was given to the specific concept of "energy mobilization," which was later defined as the "release of potential energy, stored in the tissues of the organism, for the use in activity or response" (Duffy, 1951, p. 32). Early literature on energy mobilization appears to take a physiological perspective. However, it is acknowledged that energy mobilization exists on a continuum that ranges from low during a deep sleep to high during frantic effort or excitement (Duffy, 1951). Therefore, energy mobilization appears to be a precurser for what the field of psychology now describes as arousal.

Energy mobilization or arousal is shown to be directly controlled by the autonomic nervous system (Duffy, 1951). Within the autonomic nervous system, a more global network exists, called the salience network (Uddin, 2017). The function of the salience network is to respond to novel stimuli across different modalities; specifically, the salience network works to determine what stimuli are important (or salient) within the environment that requires attention and what stimuli can be safely ignored (Uddin, 2017). Therefore, arousal and vigilance are co-occuring states within the same branch of the autonomic nervous system, designed to mobilize and ensure the survival of the individual.

Vigilance is defined as a readiness to detect and respond to certain specified small changes in the environment, occurring at irregular time intervals (Mackworth, 1968). Hence, police officers experience high levels of arousal when dealing with occupational demands that result in beta waves being prevalent in their EEG. The hypervigilant biological rollercoaster proposed by Gilmartin (2002) supports this concept of police officers experiencing hypervigilance related to occupational demands.

Hypervigilance is defined as a behavior that involves exaggerated or enhanced searching for environmental stimuli or scanning for threatening information (Rollman, 2009). A police specific definition of hypervigilance states it is “the necessary manner of viewing the world from a threat-based perspective, having the mindset to see the events unfolding as potentially hazardous” (Gilmartin, 2002, p. 35). Several specific elements make up hypervigilance, including: a high degree of monitoring of internal and external events, greater sensitivity to stimuli, maladaptive coping in dealing with elevated anxiety about bodily signs, attribution of bodily signs to physiological causes rather than

psychological or environmental factors, and a biological predisposition to respond to negative experiences through localized or widespread muscle tension (Rollman, 2009). Police officers have been identified as working in a high risk occupation where exposure to critical incidents and the need for constant hypervigilance results in "a phantom assailant" or the perceived idea that a threat could be behind the next door (Waters & Ussery, 2007).

According to Flannery (2015) the mindset of a first responder during a critical incident should be detached, and able to make quick assessments and self-directed, immediate decisions. After a critical incident, the mindset should be one that is relaxed in order to be more receptive to interventions that are designed to aid in a first responders recovery from a critical incident (Flannery, 2015); however, very little training is dedicated to teaching police officers how to relax post-critical incident. Furthermore, internationally renowned trauma researcher, Dr. Bessel van der Kolk (1987), suggests that traumatized people often have a poor tolerance for physiological or psychological arousal. If brain arousal was further understood in police officers, specific training protocols could be developed to aid in their psychological flexibility and ability to obtain treatment benefits post-critical incident.

During and after a traumatic or critical incident experience, the resulting fear is thought to activate the brain systems including the hypothalamic-pituitary-adrenal axis and the amygdala, which both play a role in triggering and regulating physiological activation (Yehuda, 2002). Such intense activation or over arousal appears to contribute to the behavioral, psychophysiological, and cognitive abnormalities associated with PTSD (Pole, 2007). Furthermore, the potential consequences of living with PTSD prior to

seeking treatment has the potential to decrease effectiveness within the police population because they must serve the public (Arnetz et al., 2009).

To determine arousal states of an individual's brain, neurofeedback protocols have used a CZ assessment to derive a benchmark recording by placing a sensor at the vertex or center of an individual's scalp (Demos, 2005). From this position a theta/beta ratio can be collected. The theta and beta brain waves are measured in hertz (Hz) which is the derived unit of frequency which measures electromagnetic waves and is defined as one cycle per second (Hertz, 1992) A theta/beta ratio is determined by dividing the electrophysiological output of the frequency band of theta (4 to 8 Hz) by the frequency band of beta (13 to 30 Hz; Monastra et al., 1999). In order to determine whether or not an individual's brain physiology is aroused (Monastra et al., 1999), cutoffs scores have been determined as a general index of theta/beta elevations. The cutoffs that are relevant to the study of police officers are 1.5 Hz. Therefore, a theta/beta ratio under 1.5 indicates patterns of over arousal and a ratio over 1.5 indicates a pattern of under arousal. Ultimately, conducting a CZ assessment to obtain a TBR allows an individual to identify the arousal profile of the brain. The arousal profile of the brain is important because there is evidence suggesting a link between hypervigilant states and physiological arousal (Conoscenti et al., 2009).

Electroencephalogram (EEG) and the Brain

When conceptualizing the TBR it is important to discuss the development of the EEG while providing information regarding the fundamental brain wave patterns. The first evidence that the brain generates electricity was produced by an English physician named Richard Caton in the 1870s and 1880s (Robbins, 2008). Hans Berger published

the first human electroencephalogram (EEG) from an intact skull of a living human in 1924 (Robbins, 2008). Previous methods of gathering EEG data had researchers cut a hole in the animal's skull where sensors made direct contact with the brain. An EEG is a record of the specific oscillations of the brain's electric potential, which is recorded from electrodes on the human scalp (Nunez & Srinivasan, 2006). An EEG is typically used to record continuous brain activity that is produced by millions of neurons (Barriga-Paulino et al., 2011) and EEG frequencies have been found to correlate with arousal levels (Sanei, 2013). Specifically, when a subject rests quietly, but alert, the EEG pattern is usually one of alpha waves or low arousal; however, when a stimulus is presented, the alpha waves are replaced by low-amplitude desynchronized fast rhythm waves (beta waves) that are characteristic of arousal (Mackworth, 1968).

Recordings of brain activity are on a millisecond time scale and allow the temporal dynamics of how the brain is functioning to be analyzed (Laufs et al., 2003). An EEG identifies four fundamental rhythms that the brain produces spontaneously: delta, theta, alpha, and beta (Barriga-Paulino et al., 2011; Niedermeyer & Lopes da Silva, 1999). The four fundamental rhythms all exist at different frequencies. Delta rhythms are frequencies lower than 4 Hz (associated with deep sleep), theta rhythms exist between 4 Hz and 8 Hz (associated with drowsiness), alpha rhythms are between 8 and 12 Hz (associated with relaxed awareness), and beta rhythms are from 13 to 30 Hz (associated with active thinking or active attention) (Salek-Haddadi et al., 2003; Sanei, 2013). Scientific and clinical practice use scalp EEG to obtain both pathophysiological and physiological recordings of brain activity (Laufs et al., 2003). The main pillar for which scalp EEG is used is the monitoring of sleep stages, vigilance, and arousal states. A

detailed understanding of the EEG and the corresponding brain wave rhythms is relevant as the study identified a correlation between the TBR and years of experience as a police patrol officer.

Conclusion and Summary of Findings

Exposure to disaster and traumatic events emphasizes the need to further investigate the health impact these events have on police officers (Violanti et al., 2007). Our protectors deserve our protection within all domains ranging from mental to physical health (Stanley et al., 2016). The implications of solid research on the relationship between occupational demands of police work and brain arousal of police officers can aid in their ability to protect and serve, which can increase the quality of crisis services provided and therefore benefit the community.

Further understanding the mental and physical symptomology of how police work impacts the officers is of critical importance, as it can aid in informing how intervention strategies and training are designed and delivered. Resilience training for police officers has shown to be effective and has resulted in significantly less negative moods, less heart rate reactivity, and better policing (Arnetz et al., 2009). While most police academies focus on officer safety in order to keep the officers safe when performing their duties, they fail to both train and teach the police officers' brains how to effectively cope with the high demands of the work. The relationship between occupational demands of police work and brain arousal may provide a rationale for further exploration of preventative interventions such as brain training.

This study examined self-report measures of police work and how they predicted brain arousal. The study accomplished this goal by providing empirically validated and

police specific measures on hypervigilance, operation police stress, organizational police stress, together with years of patrol officer experience to determine whether these factors can predict brain arousal in patrol police officers, as measured by the officer's theta/beta ratio. The study furthered the body of research on police officers by providing data on how the high-risk occupation influences brain arousal, which has never been accomplished before with police officers.

CHAPTER THREE

Overview

The primary goal of this study was to investigate the relationship between police stress, years of experience as a patrol officer, hypervigilance scores, and the brain arousal of police officers, as measured by the theta/beta ratio. The hypothesis of this study is that as the independent variables (years of experience, hypervigilance scores, organizational stress measure, and occupational stress measure) increase, the dependent variable (the theta/beta ratio) will decrease; in other words, the dependent and independent variables will share an inverse relationship. No data existed that investigated brain wave patterns of police officers, nor were studies found that investigated the potential relationship between the occupation demands of a police career and brain arousal. The premise of this study was that by better understanding the physiological effects of a police career on the brain, law enforcement officials and helping professionals who serve first responders may be able to develop policies and preventative measures to aid in the longevity of police officers' careers and personal wellbeing. For the purpose of this study on police officers, arousal is considered a proxy to represent vigilance and is described further within the literature review.

Hypothesis

This study addressed the following hypothesis: 1) there is no significant relationship between years of experience, hypervigilance scores, organizational police stress, and operational police stress and the TBR. 2) no significant inverse relationship exists between the independent variables and the dependent variable. 3) years of experience does not moderate the relationship between the IVs and the DV.

Participants

Selection of sites

To collect a sample size large enough to conduct a multiple regression with this data, the researcher of this project needed to recruit from more than one police department throughout a New England state. The researcher contacted one police chief who agreed to participate in the study. In order to recruit participants from additional police departments, the researcher used a snowball sampling technique. The initial police chief introduced the researcher at a meeting of the state board of police chiefs. During the meeting, the researcher described the research to the state police chiefs and answered any questions they had about the study. The researcher then left his student cards with his contact information with the state board of police chiefs while also collecting business cards of those police chiefs who were interested in having their department participate. The rationale for this format of site recruitment is that the researcher would have better buy in from other police chiefs if the study has already been conducted with one police department and the initial police chief could vouch for the researcher and the process of participating in the study. Once the researcher described the study to the state board of police chiefs, site recruitment consisted of a convenience sampling procedure.

Selection of participants

After a police chief expressed interest, the researcher reached out to the chief and sent him or her both the recruitment flyer (see Appendix B) and the police officer recruitment letter (see Appendix C). The recruitment flyer was displayed throughout the department and the police officer recruitment letter was sent to patrol officers within the department in the hopes of recruiting individual patrol officers. Officers who were interested in participating had two options regarding how they could participate: walk-in data collection or scheduled data collection. First, walk-in data collection consisted of the researcher working along-side the police chief to determine which days and times worked within the department for the researcher to collect data. During this time, the researcher was given a quiet room to collect data and any patrol police officer who wished to participate in the study were invited to walk-in and participate in the study. The researcher then used the roll call script (see Appendix D) to brief the police officers during their pre-shift roll call about the purpose of the study and where to find him if they were interested in participating. Second, when the researcher confirmed a few days and times he was going to be in the police department, willing patrol officers were invited to schedule a specific time (in 20 to 25-minute blocks) to participate in the study as part of a scheduled data collection. During the data collection phase, all police officers chose the walk-in style of participation with no officers scheduling a formal time to participate. Officers were informed that participation was voluntary; participating officers were given a written consent form and following a review of this form with the researcher, the participants signed the informed consent document and s/he mailed it back to Springfield College IRB in the envelope provided by the researcher. After the campus IRB director reviewed the form, it was destroyed to protect the confidentiality of participants. Hence,

the only identifying information collected was the signed form because upon completion of data collection the data for each individual participant was assigned a random number. Informed consent forms were mailed to Springfield College IRB by the participating officer to ensure the informed consent form was never associated with the collected data. Participants were also provided contact information of the researcher. Finally, at any point during data collection if a call was to be received requesting the officer, data collection stopped immediately to allow the officer to respond to the call. The police officer then had the ability to participate in the study later if they so choose.

Description of participants

The number of patrol police officers needed for the study was established from a power analysis. Participants consisted of 56 patrol police officers drawn from three police departments across a New England state. Exclusion criteria was applied to the participants if they had consumed an abnormal about of caffeine (compared to their daily average) or if they were currently taking stimulant medication (see demographic questionnaire, Appendix E). Both exclusion criteria were assessed using the demographic information survey. Additional exclusion criteria included a high impedance level (over 25) which suggested the electrodes of the neurofeedback software did not have a strong connection to the scalp of the participant. Inclusion criteria for the study provided that the participant had to have at least one-year of experience as a patrol police officer and they must be employed as a police officer. The researcher quickly reviewed the inclusion criteria before proceeding with the brain mapping and reviewed the impedance level post brain mapping. Police officers who had previous experience as a patrol officer and had

since moved into supervision roles were still included in the study. All participants were obtained from three different urban towns in a New England state.

Sampling procedures

The study used convenience sampling to recruit participants. Obtaining a convenient sample from several different police departments throughout the region strengthened the study (rather than relying on one police department) because patrol officers stationed at a busy urban department could experience a different level of occupational demands with a higher frequency of critical incidents than an officer who is stationed at a smaller rural police department. Sampling from different police departments ensured that patrol police officers had a wide breadth of experience working the streets, which aided in the generalizability of the results from this study. In order to provide meaningful direction and insight when designing and implementing training and prevention programs, the study aimed to capture the perceived occupational demands and brain physiology of patrol police officers at one point within their career in order to see the larger picture of how police officers' brains are influenced by the occupational demands of police work. Sampling procedures accomplished this goal by obtaining a community based cross-sectional sample of police officers.

Instrumentation

Demographic questionnaire

A demographic questionnaire (see Appendix E) was developed by the researcher to collect demographic information about the participants. Information obtained included gender, age, number of years of experience as a patrol officer, caffeine intake for the day, average caffeine intake, and whether the patrol officer was currently taking any psychiatric medication. Collecting this data aided in the researcher's ability to determine

whether the participant's caffeine intake or medications would skew the results of the brain mapping. Finally, the researcher was able to use the number of years as a patrol officer within the multiple regression to determine whether years of experience (among the other measures) predicts brain arousal in police officers.

Operational Police Stress Questionnaire (PSQ-Op)

The Operational Police Stress Questionnaire **(**PSQ-Op; see Appendix F) (McCreary & Thompson, 2006) measures stressors associated with the police officer's ability to manage their work-life balance and to make time for family and friends. The measure consisted of 20 self-report items and included questions about the extent to which the following items were perceived as stressful: shift work, over-time demands, fatigue, making friends outside the job, and negative comments from the public. Responses for each question were recorded on a seven-point Likert scale that ranged from 1 (No Stress at All) to 7 (A Lot of Stress) with a middle of 4 (Moderate Stress). Scores for the PSQ-Op were designed to produce a single summary score, which was the average (mean) of all 20 items (McCreary et al., 2017). The Cronbach alpha for the PSQ-Op was reported as .92 and corrected item-total correlations ranged from .39 to .70 (McCreary & Thompson, 2006). The Cronbach alpha of .92 for the PSQ-Op demonstrates excellent internal reliability, suggesting that the items within the measure were closely related.

Organizational Police Stress Questionnaire (PSQ-Org)

The Organizational Police Stress Questionnaire **(**PSQ-Org; see Appendix G) (McCreary & Thompson, 2006) was developed to measure organizational stress of police officers (McCreary & Thompson, 2006). Items consist of questions about different

aspects of being a police officer that have the potential to cause stress (e.g., bureaucratic red tape, inadequate equipment, staff shortages, inconsistent leadership) (McCreary & Thompson, 2006). The PSQ-Org consists of 20 self-report items that are measured on a seven-point Likert scale. The response options within the PSQ-Org range from: 1 which indicated "No Stress at All," 4 "Moderate Stress," to 7 stating "A Lot of Stress." The Cronbach alpha for the PSQ-Org was reported as .92 with corrected item-total correlations ranging from .43 to .71 (McCreary & Thompson, 2006). The PSQ-Org also loads onto one singular score, which is the average of all 20 items (McCreary et al., 2017). Cutoff scores for both the PSQ-Op and the PSQ-Org were not presented within this study due to the collection of continuous data for this study but can be found in McCreary et al. (2017). The PSQ-Org is a relatively new scale and has not been used extensively in research thus far.

The correlation between the PSQ-Op and the PSQ-Org is reported as .72, which suggests that the overlap of the assessments is 52% (McCreary & Thompson, 2006). Therefore, the discriminant validity of the PSQ-Op and the PSQ-Org was impacted within reliability and validity studies (McCreary & Thompson, 2006). McCreary and Thompson (2006) studied the correlation of PSQ-Op and the PSQ-Org against measures of general stress. The PSQ-Op and the PSQ-Org were correlated to the following general measures of stress: Perceived Stress Scale (Cohen et al., 1983), The Daily Hassles Scale (Kanner et al., 1981), and the Negative Life Events Scale (Hammen et al., 1985). Results showed that the PSQ-Op shares between 12 to 30 % of its variance with the three general measures of stress, whereas the PSQ-Org shares between 7 to 22 % of its variance with the same three measures (McCreary & Thompson, 2006). These findings suggest that

although there is some overlap in what the PSQ-Op and the PSQ-Org measure, they are still measuring separate and distinct constructs from the three more general measures (McCreary & Thompson, 2006).

Hypervigilance Questionnaire (HVQ)

The Hypervigilance Questionnaire **(**HVQ; see Appendix H) is an 11-item self-report scale that loads onto a single factor (Kimble et al., 2009). Items are scored on a five-point Likert scale ranging from 1 "Not at All True," to 5 "Extremely True" with total scores ranging from 11 to 55 (Kimble et al., 2013). The Cronbach's alpha for the HVQ is reported by Kimble et al (2012) to be .92 with a split half reliability of .89. The HVQ was shown to have good convergent and divergent validity (Kimble et al., 2013) and to have high correlation with the PTSD Symptoms Scale Self-Report (PSS- SR; Foa et al., 1993).

Theta/beta ratio (TBR)

The theta/beta ratio (TBR) was first introduced by Monastra et al. (1999) to measure attention deficit hyperactive disorder in children. The purpose of this assessment was to obtain the brain arousal of the participant measured through arousal. The TBR was derived by dividing the electrical output of theta brain waves (4 to 8 Hz), by the electrical output of beta brain waves (12 to 18 Hz). The TBR was measured using the EEGer neurofeedback system (Version 4; EEG Store, 2014) in which the researcher has been certified. The TBR is asymptotic, which means the ratio never hits zero and has no upper limit. When measuring theta and beta, one can always rely on the brain to be producing some level of both brain waves; therefore, determining a TBR is always possible (M. Gapen, personal communication, February 22, 2019). Literature on the TBR suggest

typical ratios in healthy brains are 1.5, with over arousal measured at less than 1.5 and under arousal measured at greater than 1.5 (Monastra et al., 1999).

When measuring the TBR, sensors were attached to the midline of the participant's skull with the help of conducting gel. After the sensors were registering brain waves, the researcher ensured the impedance level (or amount of electrical interference) is below the threshold to obtain accurate measurements (below 10 K) for brain mapping. Brain mapping took place at one location on the participants scalp (CZ) for two minutes. The CZ placement was derived from the 10-20 international system (Malmivuo & Plonsey, 1995). The 10-20 international system (Malmivuo & Plonsey, 1995) is a recognized method to describe and apply electrodes to the scalp in the application of EEG. The researcher conducting the brain mapping took one, two-minute recording at one location (CZ) to determine the TBR.

Validity of the TBR can be found in the relationship between arousal and the EEG. EEG is known to capture the arousal fluctuations of the sleep-wakefulness cycle and has displayed promise for identifying subtler differences of mental activation and individual differences (Stenberg, 1992). Furthermore, Eysenck's theory of extraversion (Eysenck, 1967) suggests that higher levels of arousal are found in introverts than in extroverts. Sternberg (1992) results suggest that highly impulsive individuals display EEG patterns of lower arousal over lower impulsive behaviors. Therefore, validity for the TBR is established in the relationship between EEG as a measurement of arousal.

The reliability of the TBR was difficult to determine as no specific research had been previously conducted. However, further examination of studies that measure specific brain waves and their relationship to vigilance provided a pattern that was used

for the purpose of reliability for the study. In tasks of attention and performance, researchers have used EEG measurements to determine states of vigilance. These researchers concluded that an increase in theta brain waves results in a decrease in the physiological state of vigilance (Ballard, 1996; Corsi-Cabrera et al., 1996). Further evidence suggests that in tests of sustained attention, an increase in theta results in a decrease in an individual's performance on a vigilance task where they had to withhold a response if a specific number appeared (Smit, 2004). The theta evidence provides a connection between the level of theta activity in the brain and a decrease level of vigilance and task performance. Therefore, a connection within the scientific literature exists suggesting that an increase in theta decreases vigilance and performance on attention tasks.

Studies investigating attention and vigilance show that as beta increases in the brain, vigilance also increases (Coull, 1998). Within sustained attention tests, a higher beta level did result in better performance (Smit, 2004). However, in sustained mental task performance increases in beta have also led to feelings of anxiety (Knott et al., 1996). These results suggest a beta threshold wherein an increase in beta activity may aid in vigilance and attention performance; however, too much beta may result in feelings of anxiety. Therefore, the connection between beta waves and an increase in vigilance suggests that an excessive amount of beta may lead to feelings of anxiety.

In sum, the cited studies suggest that by dividing theta waves by beta waves, the resulting number provides a general understanding of the arousal an individual may be experiencing at any point in time. In combination with the Monastra et al.'s (1999) TBR explanation above, the TBR should be considered valid due to the evidence suggesting

EEG is a measurement of arousal (Sternberg, 1992). Additionally, several studies suggest that EEG is inter-rater reliable due to similar results connecting theta brain waves to a decrease in vigilance and beta waves to an increase in vigilance and if excessive, to anxiety (Ballard, 1996; Corsi-Cabrera, et al., 1996; Coull, 1998; Knott et al., 1996).

Data Collection Procedures

When a patrol officer decided to participate in the study, they were contacted (see police officer recruitment letter in Appendix C) and given days and times during which the researcher was at the police department. The patrol officer was given the option to sign up for a scheduled time. The researcher had both the questionnaires and the brain mapping equipment set up prior to the participant entering the room. The patrol officer reported to a quiet room within the police department to complete data collection. Prior to the data collection period, the researcher had reviewed informed consent information Next, the researcher gave the officer an addressed, stamped envelope, so the participant could mail the signed informed consent to the IRB office. Once the IRB office received the mailed form and confirmed consent, the document was destroyed. At no point was the signed consent document associated with the data. After the researcher answered any questions posed by the officer, the officer was asked to complete the demographic form, the HVQ (Kimble et al., 2009), the PSQ-Op (McCreary & Thompson, 2006), and the PSQ-Org (McCreary & Thompson, 2006).

Next, the officer was hooked up to the neurofeedback equipment with a sensor on each ear and one on top of their head. When the sensors are in place, data was collected by the researcher for two minutes with the officer's eyes open. Upon completion of the brain recording, the conducting gel was removed from the officer and the data collection period was complete. The entire data collection period lasted approximately 20 to 25

minutes and if a police call came in during the collection of data, data collection was immediately stopped to ensure the officer could respond to the call.

Data Analysis

The statistical test that was used for the analysis of the data being collected was a multiple regression. Multiple regressions are used when there are two or more independent variables and the analysis for this study was a predictive multiple regression due to the focus on the dependent variable. The independent variables within the study included the number of years as a patrol officer, hypervigilance, as measured by the HVQ (Kimble et al., 2009), and the level of organizational stress of police officers, as measured by PSQ-Op (McCreary & Thompson, 2006), and PSQ-Org (McCreary & Thompson, 2006). The independent variables were used on a continuous scale and therefore cut-off scores were not necessary. The dependent variable consisted of the theta/beta brain wave ratio gathered from the brain mapping procedure, using the EEGer neurofeedback system (Version 4; EEG Store, 2014). The multiple regression was conducted at a statistical significance level of p= .05 and the researcher used Statistical Package for the Social Sciences (SPSS Version 24.0.0; IBM Corporation, 2016) statistical software for the analysis. The high correlation between the PSQ-Op and the PSQ-Org was considered when evaluating the data to ensure the data analysis is not impacted by the overlap between the PSQ-Op and the PSQ-Org.

The data analysis was designed to answer the following research question: Are years of experience as a patrol officer, level of hypervigilance, and levels of police stress predictors of brain arousal in patrol police officers? The hypothesis that was addressed within the research question states that as the years of experience as a patrol officer, HVQ (Kimble et al., 2009) scores, PSQ-Op (McCreary & Thompson, 2006) and PSQ-Org

(McCreary & Thompson, 2006) scores increase, the TBR will decrease, indicating higher levels of over arousal.

Ethical Considerations

The Springfield College Institutional Review Board approved the study before formal contact was made with participants. The study also adhered to the research procedures of The American Psychological Association *Ethical Principles of Psychologists and Code of Conduct* (2017). The purpose of the ethical code is to prevent harm from occurring to participants of the research study. The study implemented informed consent procedures that protect the confidentiality of the participants even in the event the data was subpoenaed.

The informed consent process provided to participants included an explanation of the purpose of the study. The process also informed the participants about the kinds of data that were collected, potential risks and benefits from participating in the study, information regarding voluntary withdrawal of consent and participation from the study, information related to how confidentiality was maintained, and how collected data was stored.

The researcher ensured that participants clearly understood that they were able to withdraw from the study at any point with no penalty or repercussion from the police department, or Springfield College. Discussing the right to withdraw with the participants was an important part of informed consent as patrol officers could have believed that the study may influence their standing within the department or how their supervisors view them. They were informed about the different types of questionnaires they were asked to fill out and informed about the brain mapping.

During informed consent, the researcher also clearly stated how the collected data was stored. All the questionnaires and brain mapping data was stored on an encrypted flash drive, thus preventing any unauthorized users from accessing the data. Furthermore, upon completing data collection with a participant, the data was assigned a number, so no names were attached to the data set.

Limitations

The study has several limitations. First, the findings from the study could not be generalized to all police officers, as the occupational demands vary greatly within a police department. For example, an undercover officer and an analyst would have different levels of hypervigilance and exposure to critical incidents than would a patrol officer. Second, data collection was limited to on site collection, which would suggest that police officers had already been conditioned to be vigilant within the police department context. Third, interpretations of the finding were made with the understanding that much was still unknown about the human brain suggesting that "if the brain were so simple we could understand it, we would be too simple to do so" (Robbins, 2008, p. 28-29). Fourth, temporal resolution of the EEG was excellent; however, its spatial resolution was limited (Dale & Sereno, 1993). Fifth, the sample was not random but rather recruited volunteers which may have resulted in a bias sample of the police officer who choice to participate. Finally, a methodology limitation existed in using the TBR as test-retest reliability is still unknown.

Delimitations

The delimitations utilized within the research in the study were determined by a desire to gain a better understanding of how well occupational demands as a patrol officer influence police officer brain arousal. To obtain the data, the research only recruited

patrol officers. Limiting the sample to patrol officers in this study allowed the researcher to gain the views of other police officers with different occupational demands. A second delimitation included the researcher's schedule regarding data collection. Conducting brain maps from patrol officers during the night shift may have resulted in different data when compared to brain maps collected during the daytime. A third delimitation is that the researcher only collected data from one New England state, which may therefore have impeded the generalizability of the findings. Finally, an environmental delimitation of this study was that data was only be collected while the patrol officers were on duty, which would suggest they could already be conditioned to be hypervigilant and therefore could impact the brain mapping conducted by the researcher (see hypervigilant biological rollercoaster in chapter two).

Summary

This chapter presented the purpose of the study, the research question, hypotheses, and the research design. The participants were chosen through convenient sampling from three police departments throughout the Northeastern United States and consisted of approximately 55 patrol police officers. Police work is known to be dangerous, with exposure to traumatic events and dangerous situations resulting in Violanti and Paton (1999) describing it as "civilian combat" (p. 1). As a result, research suggests health problems were common in police officers (Brown & Campbell, 1994), and the psychological cost of the job remained high (Geronazzo-Alman et al., 2017). However, no studies had investigated the relationship between occupational demands of police work and brain arousal. This study sought to explore and understand how the occupational demands of patrol officers influenced their brain arousal as a measure of

arousal. Focus on brain arousal may inform researchers, clinicians, and police departments as to how to create more effective training protocols and treatment plans to better assist police officers. By understanding how the brain is impacted by the demands of police work, research may be able to contribute to an increase in the psychological flexibility of police officers, which would benefit them in all domains of their life.

CHAPTER FOUR

The purpose of this study was to identify whether years of experience, hypervigilance scores, operational police stress, and organizational police stress were predictors of brain arousal in patrol police officers. Prior to data analysis, data was first screened for accuracy, missing values, outliers, and normality. Subjects missing more than two values in the demographic or questionnaires were removed. The mean impedance for the data set (n = 55) was 6.13, suggesting an overall strong connection between the surface of the participants scalp and the neurofeedback software. Overall, one subject was deleted due to high impedance (40) with this being the only extreme outlier detected. This section is organized into two parts: first, descriptive statistics and second, the correlation and regression analysis.

Descriptive statistics

The mean age of participants fell within the 41-45-year-old category and 92.7% (n = 51) of the participants identified as White. Officers who identified as male represented 87% (n = 48) of the sample with only 13% (n = 7) identifying as female. Of the participants, 65% (n = 36) reported the majority of their occupational tasks were patrol duties while only 35% (n = 19) reported supervisor duties. The mean number of years of experience was 12.95 (see Table 1 for additional descriptive statistics). No participant reported using stimulant medication. Finally, all the independent variables

displayed symmetrical skewness (-0.5 to 0.5) except hypervigilance (-0.644) which displayed a moderately skewed distribution. The dependent variable also displayed symmetrical skewness (-0.151).

Correlations

First, the data was analyzed using bivariate correlations examining each independent variable's relationship with the TBR. The correlation between years of experience and the TBR resulted in a strong negative relationship (r = -.442, p = .001). Hypervigilance scores displayed a weak negative relationship with the TBR (r = -.266, p = .050). Finally, no relationship was identified between organizational stress (r = -0.008, p = .956) or operational stress (r = -.104, p = .452) and the TBR. See Table 2 for correlational data.

Multiple regression

Next, the data was analyzed using a multiple linear regression to understand the relationship between all the independent variables and the TBR. The results indicated that collectively the variables had a moderate degree of relationship with the TBR and predicted 26.7 % of the variability in TBR (p = 0.03) (please see Table 3 for the model summary). The unstandardized regression coefficient for years of experience was significant; b = -.020, p = .001. This can be interpreted as the slope of the relationship between years of experience and TBR, such that a .2 unit decrease in TBR would be predicted per 10 years of experience as a police officer. In addition, the unstandardized regression coefficient for hypervigilance was significant; b= -.011, p= .050. These results suggest a decrease in TBR of .011 for every unit increase in hypervigilance scores. Finally, there was no significant unstandardized regression coefficient for organizational

police stress or operational police stress; *b*= -.002, *p*= .956 and *b*= -.027, *p*= .452, respectively. Please see Table 4 for the coefficient data.

To examine years of experience as a possible moderator of the relationship between each of the other independent variables and TBR, all variables were rescaled by transforming the data into standardized z scores. These were used to conduct three subsequent regression analyses on the main effects and interaction effect of the independent variables on TBR. Years of experience was used as a moderating variable within the interaction effects. In each of these analyses, there was no significant moderating effect (p = .126, .182, and .624 for the interactions of years of experience with hypervigilance, organizational police stress, and operational police stress, respectively). Years of experience displayed a significant main effect (p = .001) in the regression analyses including hypervigilance and organizational stress and a significant main effect (p = .002) in the regression analysis including operational stress. The main effect of hypervigilance was significant (p = .036). The main effect of organizational police stress was not significant (p = .267). Finally, the main effect of operational police stress was not significant (p = .906). More details of the multiple regression results are provided in Table 5. In addition to the data showing that years of experience as a patrol police officer indeed change biomarkers of arousal in their brain, it is important to discuss the implication for practice and the limitations of the study.

CHAPTER FIVE

Discussion and Summary

> If a 747 airliner with approximately 300 passengers on board crashed each year, the Federal Aviation Administration would ground 747s until the problem was discovered and corrected, yet we lose 300 police officers every year to suicide and we think that is just the cost of doing business. Robert Douglas, National P.O.L.I.C.E Suicide Foundation Officer (Gilmartin, 2002, p. 14)

Occupational demands of police work are well documented with one study suggesting that police work is among the top six most damaging jobs to physical health and psychological well-being (Johnson et al., 2005b). In 2017, 129 police officers were killed in the line of duty, in addition to 140 police suicides in the United States (Heyman et al., 2018). With rates of PTSD and other physical ailments related to the job higher in a police population than the general population (Cone et al., 2015; Lukaschek et al., 2013; Neylan et al., 2002), the toll being placed on police officers who dedicate their lives to protecting their communities is of concern. In addition, given intense selection protocols to screen both physical and mental qualities of healthy individuals (Cone et al., 2015; Water & Ussery, 2007) within police candidates, it is surprising police officers experience physical and psychological deterioration over their career. Fortunately, police culture does provide a connected culture. Specifically, social integration (the role one assumes in an organization and frequency of contact with other members) can act as a moderator for (or buffer to) police officers' reaction to stress (Schwarzer et al., 2014).

Stress can be measured in many different ways; for example, it can be measured using skin temperature, salivary cortisol levels, heart rate variability, and blood pressure (Ashton et al., 1972). In addition, changes in stress can also be effectively represented by electroencephalography (EEG) signal (Seo & Lee, 2010). An EEG is a record of the specific oscillations of the brain's electric potential, which is recorded from electrodes on the human scalp (Nunez & Srinivasan, 2006). However, to date, no research was found that looked at the EGG patterns in officers at different points along a career as a patrol police officer.

This study explored the relationship between the theta-beta ratio (TBR; the TBR is derived by dividing the electrical output of theta brain waves (4 to 8 Hz), by the electrical output of beta brain waves (12 to 18 Hz) and is a measure of arousal in the brain) and years of experience as a police patrol officer, hypervigilance, organizational police stress, and operational police stress. In addition, years of experience was used as a moderating variable to identify subsequent main and interaction effects. The following section provides more details on existing literature related to police officer health, occupational demands of police work, and finally the brain and the EEG. The purpose of this study was to identify how police officers experience the demands of their job as measured by hypervigilance scores, years of experience as a patrol officer, occupational and organizational demands, and measures of brain arousal.

Review of Literature

In 2017, 93 police officers were killed in line-of-duty incidents in the United States (Federal Bureau of Investigation National Press Officer, 2018). These states illustrate that police work is inherently dangerous and, with over 750,000 police officers employed in the United States engaging in tens of millions of interactions with the public (Klinger, 2004), it may be surprising that death rates are not higher. Police officers are almost certainly going to experience exposure to traumatic events as a result of responding to critical incidents (Violanti & Paton, 1999). A critical incident is defined as any event that is stressful enough to impact and overwhelm an individual's sense of control, connection, and meaning in their life (Pietrantoni & Prati, 2008). Critical incidents can include physical assault, shootings, handling of dead bodies, witnessing

violence and familial abuse, or responding to disaster scenes such as Hurricane Katrine or 9/11 (Paton & Smith, 1996).

In addition to the physical harm to self that can occur in the line-of-duty, traumatic stress can also result in mental health concerns for police officers. Traumatic stress refers to the physiological and psychological reactions to stressors that threaten a person's life or bodily integrity and includes the subjective experience of extreme horror, fear, and helplessness due to being beyond the person's ordinary capacity to cope (Reyes et al., 2008). Published literature suggests that traumatic stress occurs in first responders 5.9% to 22% of the time when responding to a critical incident (Neria et al., 2011).

Police Officer Health

Police officers begin their careers in excellent physical and mental health (Alexander & Wells, 1999; Waters & Ussery, 2007). However, the number of officers who opt for early retirement or endure death from job related stress disorders demonstrates the cost of their occupational demands and the need for ongoing emotional readjustment (Waters & Ussery, 2007). When police officers respond to critical incidents, psychological trauma can disrupt good mental and physical health in the following three ways. First, it can impact caring attachments to others; second, traumatic stress can result in a decrease in an individual's perception of mastery in their environment; and finally, traumatic stress can interrupt an individual's ability to find a meaningful purpose in life that motivates them to invest energy in the world each day to pursue socially acceptable goals (Flannery, 2015). The following paragraphs will present significant bodies of literature on police officer health.

Alcohol. Alcohol use within the police community is prevalent and normalized (Water & Ussery, 2007). The self-medication hypothesis (SMH) (Khantzian, 1987) may provide insight into the nature of substance use. The SMH suggests two aspects that are important and disputed. First, the SMH suggests that drugs of abuse relieve psychological suffering. Second, the SMH suggest that a person's preference for specific substances involves some degree of psychopharmacological specificity (Khantzian, 1997); meaning, that an individual's nervous system will be attracted to specific types of substances in order to gain the most relief. These two aspects of the SMH may be impacting the rates of substance use within the police population. Studies of police officers suggest that monthly binge drinking rates are 22%, which is slightly higher than that of the general population (17.1%; Kanny et al., 2012). Alcohol misuse (defined as meeting diagnostic criteria for an alcohol use disorder within the past year or drinking above recommended limits based on National Institute on Alcohol Abuse and Alcoholism criteria) suggest a primary care population has an at risk rate of one in four in females and one in three in males (Bradley et al., 2007). By comparison, in one study of a police sample over half of both the female and male officers screened positive for alcohol misuse, further supporting the maladaptive coping strategy in response to stressors (Violanti et al., 1983).

Domestic Violence. Rate of divorce within police departments range from 50% to 80% (Waters & Ussery, 2007), whereas domestic violence rates within police communities range from 22% to 41% (Neidig et al., 1992). Johnson et al. (2005b) used a path model that suggests that violent exposure is most significant if it leads to spousal violence through external burnout (a depersonalization of the individual) and

authoritarian spill over (an inability to leave the job at work by trying to evoke a sense of power and control within the family system).

Gender Roles. Another important factor of domestic violence is how gender roles influence the perpetration of violence. According to gender role theory (O'Neil, 1981), men who maintain a strong belief in masculine gender norms, specifically regarding providing for one's family, may be more likely to perpetrate violence if they believe these norms are being violated (Kwesiga et al., 2007). Additionally, men who are strongly committed to traditional views of masculine gender-role stress are more likely to turn to substance use as a means of managing insecurities regarding male role expectations, and as a result, they are more likely to engage in abusive behavior with intimate female partners (Copenhaver et al., 2000). Applying gender role theory may provide additional insight into the complexity of domestic violence within the police force.

Sleep. Sleep is critical to any job performance. Research suggests that fatigued-impaired police officers pose significant personal risk to both the general public and to other officers (Vila, 2000). For example, Neylan et al. (2002) identified that the majority of police vehicle accidents occur in the early morning hours when the graveyard shift officers are particularly vulnerable to the consequences of sleep deprivation. General psychopathology and posttraumatic stress symptoms were found to be strongly associated with sleep disturbances in police officers, which may have a ripple effect to other areas of functioning such as occupational performance and health implications (Neylan et al., 2002). Sleep quality is negatively influenced by many common stressors within police

work, including chronic exposure to critical incidents, rotating shift work, and occupational and organizational stressors (Neylan et al., 2002).

Mental Health

Suicide is an important topic within police literature. A meta-analysis of 30 published studies since 1950 suggest a police suicide rate of 18.1 per 100,000, which is considerably higher (52%) than that of the general public (Aamodt & Stalnaker, 2006). Occupational demands must be considered when discussing suicide within a police population. First, police officers protect community members from violent acts and deadly bullets, which may lower their fear surrounding death resulting in a potential increase in suicidality (Van Orden et al., 2010). Second, police officers have received training related to the use of firearms, which is a highly lethal means of completing suicide (Stanley et al., 2016). Third, the dominant demographic of police officers (White males) (United States Bureau of Labor and Statistics, 2018) is at the highest risk for suicide (Curtin et al., 2016). Finally, disturbance in sleep caused by shift work can impact social support and disrupt family relationships, which are risk factors for suicide (Vallieres et al., 2014).

While professional training has been shown to mitigate the risk of an adverse response to a critical event (Perrin et al., 2017), first responders still present with considerable rates of PTSD (Geronazzo-Alman et al., 2007). With police officers encountering a wide range of critical incidents that would be classified as traumatic or severely stressful over their career, it is not surprising that the experience of PTSD is higher in police officers than the general population (Mumford et al., 2015). A study conducted eleven years after 9/11 found that 15.5% of female officers and 10.3% of

male officers experience chronic PTSD (Cone et al., 2015), whereas in the general population rates of full PTSD occur at a rate of 1.7% and partial PTSD occurs at a rate of 8.8%. Consequences for police officers living with PTSD are important to consider due to the police officers' responsibility for maintaining the peace and serving the public (Arnetz et al., 2009).

Organizational and Operational Stress

Occupational demands for police officers are unique due to the number of dangerous and stressful situations they often experience on a daily basis (Queirós et al., 2013). For example, a study of New York state police officers (n = 103) developed a hierarchy of stressors experienced by police officers, from most to least stressful, that includes: 1) killing someone in the line of duty, 2) fellow officer killed, 3) physical attack, 4) battered child, and 5) high speed chases (Violanti & Aron, 1995).

Organizational stress (stressors associated with the culture and organization; Symonds, 1970) may be broken down into two categories. First, task content stressors are physical aspects of an occupation that characterize the task at hand while considering its simplicity, complexity, or monotony, and the physical conditions (Kahn & Byosiere, 1992). Examples of an organizational stressor include but are not limited too excessive noise, inadequacies in equipment, or extreme temperatures (Shane, 2010). The second type of organizational stress is role properties, which includes the psychological aspects of the occupation that are characterized by the social nature of the work. Examples include but are not limited to role ambiguity, role conflict, role overload, and interpersonal relations between superior officers and subordinate personnel (Shane, 2010). McCreary et al. (2017) suggest that the more stressful organizational factors

include: 1) bureaucratic red tape, 2) staff shortages, 3) inconsistent leadership style, 4) different rules applying to different personnel, and 5) always feeling the need to prove yourself to the organization.

Operational stress refers to specific stressors associated with doing the job (Symonds, 1970). These operational stressors are specific to the job characteristics of police work and may include job related injuries, shift work (Violanti et al., 2012a), and the experience of traumatic events (Shucard et al., 2012). Additional operational stressors within police work may include fatigue, overtime demands, managing a social life, negative comments from the public, and paperwork (McCreary et al., 2017). Operational stressors have been shown to negatively affect the speed of processing information, learning, cognitive functioning, and working memory (Gutshall et al., 2017). High operational demands of police work are also linked to physical health concerns. Nixon et al. (2011) found an association between non-traumatic workplace stressors and physical health concerns, which include sleep disturbance, gastrointestinal problems, and fatigue.

Arousal, Performance, and Vigilance

Early theories of arousal suggested that optimun performance conditions are based upon moderate stimulation and that successful performance is a function of the varying level of stimulation (Yerkes & Dodson, 1908). Around this time, arousal was also being understood from a physiological perspective. Arousal has been connected to vigilance and dates back to 1915. In 1915, Cannon proposed the concept of energy mobilization in relation to the study of bodily changes in pain, hunger, fear, and rage. However, little attention was given to the specific concept of "energy mobilization," which was later defined as the "release of potential energy, stored in the tissues of the organism, for the use in activity or response" (Duffy, 1951, p. 32). Early literature on

energy mobilization appears to take a physiological perspective. However, it is acknowledged that energy mobilization exists on a continuum that ranges from low during a deep sleep to high during frantic effort or excitement (Duffy, 1951). Therefore, energy mobilization appears to be a precurser for what the field of psychology now describes as arousal.

Energy mobilization or arousal is shown to be directly controlled by the autonomic nervous system (Duffy, 1951). Within the autonomic nervous system, a more global network exists, called the salience network (Uddin, 2017). The function of the salience network is to respond to novel stimuli across different modalities; specifically, the salience network works to determine what stimuli are important (or salient) within the environment that requires attention and what stimuli can be safely ignored (Uddin, 2017). Therefore, arousal and vigilance are co-occuring states within the same branch of the autonomic nervous system, designed to mobilize and ensure the survival of the individual.

Vigilance is defined as a readiness to detect and respond to certain specified small changes in the environment, occurring at irregular time intervals (Mackworth, 1968). Hence, police officers experience high levels of arousal when dealing with occupational demands that result in beta waves being prevalent in their EEG. The hypervigilant biological rollercoaster proposed by Gilmartin (2002) supports this concept of police officers experiencing hypervigilance related to occupational demands.

Hypervigilance is defined as a behavior that involves exaggerated or enhanced searching for environmental stimuli or scanning for threatening information (Rollman, 2009). A police specific definition of hypervigilance states that hypervigilance is “ the

necessary manner of viewing the world from a threat-based perspective, having the mindset to see the events unfolding as potentially hazardous" (Gilmartin, 2002, p. 35). Hypervigilance is comprised of several different elements, including a high degree of monitoring of internal and external events, maladaptive coping in dealing with elevated anxiety about bodily signs, greater sensitivity to stimuli, attribution of bodily signs to physiological causes rather than psychological or environmental factors, and a biological predisposition to respond to negative experiences through localized or widespread musle tension (Rollman, 2009).

Arousal states of an individuals brain can be determined using neurofeedback protocols. A CZ assesssment is used to obtain a benchmark recording of an individuals arousal state by placing a sensor at the vertex or center of an individual's scalp (Demos, 2005) and two sensor clips on each ear. The CZ recording can than be used to calculate a theta/beta ratio (TBR). The TBR is dertermined by dividing the electrophysiological output of the frequency band theta (4 to 8 Hz) by the frequency band of beta (13 to 30 Hz; Monastra et al., 1999). Cutoff scores were determined as a general index of theta/beta elevations (Monastra et al., 1999). The cutoff score that is relevant to the study of police officers was 1.5. Therefore, a theta/beta ratio under 1.5 indicates patterns of over arousal and a ratio over 1.5 indicates a pattern of under arousal. The arousal profile of the police officer brain is important because there is evidence suggesting a link between hypervigilant states and physiological arousal (Conoscenti et al., 2009). Understanding hypervigilant states is important to determine the functioning of an indivdiual's nervous system. Specifically, the cue-utilization hypothesis (Easterbrook, 1959) suggests that when an indivdiual experiences increased arousal, their perceptual range reduces, and

attention focuses in on the source of arousal. Increased arousal and a reduction in a police officer's perceptual range may become problematic as they respond to ciritical incidents. Another issue that may arise from the consequences of increased arousal may be the completeness of memory (Hulse & Memon, 2006). Within a criminal case where police officers may only focus on details that have significant emotional importance at the time of the event may result in missing forensically important details giving a partial picture of the event (Hulse & Memon, 2006)

Electroencephalogram (EEG) and the Brain

Evidence that the brain generates electricity was produced by an English physician name Richard Caton in the 1870s and 1880s (Robbins, 2008). The first electroencephalogram (EEG) study with an intact skull of a living human was published in 1924 (Robbins, 2008). An EEG is a record of the specific oscillations of the brain's electric potential, which is recorded from electrodes on the human scalp (Nunez & Srinivasan, 2006). An EEG is typically used to record continuous brain activity that is produced by milllions of neurons (Barriga-Paulino et al., 2011), and EEG frequencies have been found to correlate with arousal levels (Duffy, 1951; Sanei, 2013). The EEG pattern of an indivdiual who is resting quietly, but alert, is usually one of alpha waves or low arousal; however, when a stimulus is presented, the alpha waves are replaced by low-amplitude desynchronized fast rhythem waves (beta waves) that are characteristic of arousal (Mackworth, 1968). Recordings of the brain activity are on a millisecond time scale and allow the temoral dynamics of how the brain is functioning to be analyzed (Laufs et al., 2003). An EEG identifies four fundamental rhythms that the brain produces (the four rhythms of the brain are delta, theata, alpha, and beta) spontaneously, which can

be read about more in literature by Barriga-Paulino and co-authors (2011) and Niedermeyer and Lopes da Silva (1999).

In summary, a gap exists in the research investigating EEG patterns of arousal in police officers. Previous studes have focused on occupational demands of police officeres and many dynamic aspects of police officer health; however, none of these studies, to date, have explored arousal patterns in the brain. Police departments, psychologists, and other health service providers need to better understand how occupational demands of police work may impact the EEG and arousal patterns of police officers. This study sought to open a new channel within police research on EEG patterns and police officers. In addition to identifying the relationship between occupation demands of police work and EEG patterns, the findings of the research may be helpful in informing training, intervention, and treatment programs for police officers. The findings of this study offer useful information and insight into how occupational demands and years of experience as a police patrol officer impact the officer's brain arousal. Finally, departments and practitioners may become better informed about how best to support these officers.

Method

This study utilized a community-based cross-sectional quantitative design to investigate the relationship between police stress, years of experience as a patrol officer, hypervigilance scores, and the brain arousal of police officers, as measured by the theta/beta ratio. Most of the research that exists discusses the various impacts of police work from both a physical and mental health perspective. However, no research to date was found that investigated the relationship between police stress, years of experience as a patrol officer, hypervigilance scores, and brain arousal. The findings of this study offer

insightful information about how police stress, years of experience, and hypervigilance scores impact the brain arousal of police officers.

Hypothesis

This study addressed the following research question: Are years of experience, hypervigilance scores, and operational and organizational police stress predictors of brain arousal in patrol police officers? Furthermore, the study hypothesized that as years of experience, hypervigilance scores, and operational and organizational police stress increase, the theta/beta ratio scores would decrease, indicating increased over arousal. Therefore, the hypothesis suggested an inverse relationship between the independent variables and the dependent variable.

Definition of Key Terminology

Arousal. An aspect of an individual's general state that can vary along a continuum, corresponding at one end to deep sleep and at the other to extreme excitement (Duffy, 1962).

Electroencephalogram (EEG). A test providing a graphical representation of neuronal activity in the cerebrum (Demos, 2005).

Hypervigilance. A behavior that involves exaggerated or enhanced searching for environmental stimuli or scanning for threatening information (Rollman, 2009).

Hypovigilance. A state of diminished vigilance or anything that causes a decrease in paying close and continuous attention (Arun et al., 2011).

Multiple regression. A statistical procedure involving just one dependent variable but with two, three, or more independent variables (Huck, 2012).

Theta/beta ratio. A ratio derived by dividing the output of theta waves (4 to 8 Hz) by the output produced in beta waves (13 to 21 Hz) (Monastra et al., 1999).

Positionality

There are notable similarities that exist between the participants and the primary researcher. According to the United States Bureau of Labor and Statistics (2018), 79.8% of patrol police officers are White and 86.4% identify as male, which resembles the primary researcher's race and gender identity. These factors may have aided the researcher in his ability to gain buy-in and to recruit participants. However, it is important to note that the researcher is a civilian and there may be in-group/out-group bias from the police officers as their job requires them to be suspicious of individuals they do not know. Therefore, the researcher acknowledges the hierarchical structure of the police department while considering their natural response to be distrustful of outsiders. The researcher worked hard to build rapport with the police officers and discussed full disclosure and consent with the police chiefs, police captains, and patrol officers in order to invite participants to be invovled in the study.

Research Design

The community-based cross-sectional study design included a quantitative design to determine if exposure to stress and traumatic events, experienced as a patrol officer, might correlate with changes in brain arousal in officers with varying levels of experience. The demographic questionnaire collected information related to the officers' age range, race, occupational tasks, time line of patrol officer experience, number of years as a patrol police officer, gender, caffinee intake/caffinee intake in the last 24 hours, tobacco use, and stimulant medication. However, the independent variables in this study consisted of the number of years as a patrol police officer, the Hypervigilance Questionnaire (HVQ; Kimble et al., 2009), Operational Police Stress Questionnaire (PSQ-Op; McCreary & Thompson, 2006), and the Organizational Police Stress

Questionnaire (PSQ-Org; McCreary & Thompson, 2006). The independent variables were independently analyzed to determine the degree to which they were able to predict the TBR.

A power analysis was conducted and revealed an appropriate sample size would consist of a minimum of 55 participants. The researcher collected the data by meeting with each participant individually during a single session of approximately 20 to 25 minutes. To ensure the confidentially and privacy of the participant, informed consent (see Appendix A) was obtained from each participant but at no point was the consent form and data associated with one another. The signed consent form was mailed to the Institutional Review Board (IRB) office at Springfield College to be confirmed, at which point the consent forms were destroyed. During data collection scores were manually entered into a data collection sheet, which were given a random identification number. Descriptive and summary statistics were employed to analyze the data. Correlational analysis and a multiple linear regression were used to identify associated factors.

Selection of Sites

In order to gain a sample size large enough to conduct a multiple regression, the researcher needed to recruit from more than one police department throughout a New England state. The research contacted one police chief who agreed to participate in the study. In order to recruit from additional police departments, the researcher used snowball sampling techniques. The initial police chief introduced the research to several other police chiefs throughout the state who were willing to participate in the study. The rationale for this format of site recruitment is that the researcher would have better buy-in from other police chiefs if the study has already been conducted with one police

department and the initial police chief could vouch for the researcher and the process of participating in the study.

Participants

Selection of Participants

Once a police chief expressed interest in having the department participate in the study, the recruitment flyer (see Appendix B) and the police officer recruitment letter (see Appendix C) were sent to be distributed to the police officers. The recruitment flyers were displayed throughout the police department in order develop interest and recruit participants. Officers who were interested in participating had two options regarding how they could participate: walk-in data collection or scheduled data collection. First, walk-in data collection consisted of the researcher working along-side the police chief to determine which days and times worked within the department for the researcher to collect data. During this time, the researcher was given a quiet room to collect data and any patrol police officer who wished to participate in the study was able to walk-in and participate in the study. The researcher then used the roll call script (see Appendix D) to brief the police officers during their pre-shift role call about the purpose of the study and where to find him if they were interested in participating. Second, when the researcher confirmed a few days and times he was going to be in the police department, willing patrol officers were invited to schedule a specific time (in 20 to 25-minute blocks) to participate in the study as part of a scheduled data collection. During the data collection phase, no police officer scheduled a formal time to participate in the study; all of the data was collected during walk-in times. Participating police officers were given a written consent form as all participation was voluntary; the participant signed the informed consent document and s/he mailed it back to Springfield College IRB in the envelope

provided by the researcher. After the IRB reviewed the form it was destroyed to protect the confidentiality of participants. The data was assigned a number to ensure the data was never associated with the informed consent forms. Participants were also provided contact information of the researcher. Finally, at any point during data collection if a call was received requesting the officer, data collection stopped immediately to allow the officer to respond to the call. The police officer then had the ability to participate in the study later if they so choose.

Description of Participants

Participants consisted of 56 patrol police officers drawn from three police departments across a New England state. Exclusion criteria was applied to the participants if they had consumed an abnormal amount of caffeine (compared to their daily average), if they were currently taking stimulant medication (see demographic questionnaire, Appendix E), or if brain mapping displayed an impedance level over 25 as measured by the neurofeedback software. Both exclusion criteria were assessed using the demographic questionnaire; only one police officer was excluded from the study. Inclusion criteria stated that the participant must be employed as a police officer and have at least one year of fulltime experience. The researcher quickly reviewed the inclusion criteria before proceeding with the brain mapping. Police officers who had previous experience as a patrol officer and had since moved into supervision roles were still included in the study.

Sampling Procedures

The study used convenience sampling to recruit participants. Obtaining a convenient sample from several different police departments throughout the region strengthened the study (rather than relying on one police department), because different

police department experience different emergency call volumes that result in a different level of occupation demands and different frequency of critical incidents. Therefore, an urban department will have higher exposure rates when compared to a rural department. Sampling from different departments ensured that the patrol police officers had a wide breadth of experience working the streets, which adds to the generalizability of the results. In order to provide meaningful insight from the results, the study aimed to capture the perceived occupational demands and brain physiology of the police officers at one point within their career to better understand the larger picture of how police officers' brains are influenced by police work. Sampling procedures accomplished this goal by obtaining a community based cross-sectional sample of police officers.

Instrumentation

Demographic Questionnaire

A demographic questionnaire (see Appendix E) was developed by the researcher to collect demographic information about the participants. Information obtained included gender, age, number of years of experience as a patrol officer, coffee caffeine intake for the day, average caffeine intake, and whether the patrol officer was currently taking any psychiatric medication. Collecting this data aided the researcher in preventing the participant's caffeine intake or medications from skewing the results of the brain mapping. Finally, the researcher was able to use the number of years as a patrol officer within the multiple regression to determine whether years of experience (among the other measures) predicts brain arousal in police officers.

Operational Police Stress Questionnaire (PSQ-Op)

The Operational Police Stress Questionnaire **(**PSQ-Op; see Appendix F) (McCreary & Thompson, 2006) measured stressors associated with the police officer's

ability to manage their work-life balance and to make time for family and friends. The measure consisted of 20 self-report items and included questions about the extent to which the following items were perceived as stressful: shift work, over-time demands, fatigue, making friends outside the job, and negative comments from the public. Response for each question were recorded on a seven-point Likert scale that ranged from 1 (No Stress at All) to 7 (A Lot of Stress) with a middle of 4 (Moderate Stress). Scores for the PSQ-Op were designed to produce a single summary score, which was the average (mean) of all 20 items (McCreary et al., 2017). The Cronbach alpha for the PSQ-Op of .92 and corrected item-total correlations ranged from .39 to .70 (McCreary & Thompson, 2006). The Cronbach alpha of .92 for the PSQ-Op was excellent internal reliability, suggesting that the items within the measure were closely related.

Organizational Police Stress Questionnaire (PSQ-Org)

The Organizational Police Stress Questionnaire **(**PSQ-Org; see Appendix G) (McCreary & Thompson, 2006) was developed to measure organizational stress of police officers (McCreary & Thompson, 2006). Items consisted of questions about different aspects of being a police officer that had the potential to cause stress (e.g., bureaucratic red tape, inadequate equipment, staff shortages, inconsistent leadership) (McCreary & Thompson, 2006). The PSQ-Org consisted of 20 self-report items that were measured on a seven-point Likert scale. The response options within the PSQ-Org ranged from: 1 which indicated “No Stress at All,” 4 “Moderate Stress,” to 7 stating “A Lot of Stress.” The Cronbach alpha for the PSQ-Org was .92 with corrected item-total correlations ranging from .43 to .71 (McCreary & Thompson, 2006). The PSQ-Org also loaded onto one singular score, which was the average of all 20 items (McCreary et al., 2017). Cutoff scores for both the PSQ-Op and the PSQ-Org were not presented within this study due to

the collection of continuous data for this study but can be found in McCreary et al. (2017). The PSQ-Org is a relatively new scale and has not been used extensively in research thus far. However, the PSQ-Org was selected because it specifically measured the perceptions of police officers in a relatively short questionnaire (20 items) providing the most information in the least amount of time.

The correlation between the PSQ-Op and the PSQ-Org was .72, which suggested the assessments overlap by about 52 percent. Therefore, the discriminant validity of the PSQ-Op and the PSQ-Org was impacted. The high correlation between the PSQ-Op and the PSQ-Org was considered when evaluating the data to ensure the data analysis is not impacted by the overlap between the PSQ-Op and the PSQ-Org. McCreary and Thompson (2006) studied the correlation of PSQ-Op and the PSQ-Org against measures of general stress. The PSQ-Op and the PSQ-Org were correlated to the following general measures of stress: Perceived Stress Scale (PPS; Cohen et al., 1983), The Daily Hassles Scale (DHS; Kanner et al., 1981), and the Negative Life Events Scale (NLE; Hammen et al., 1985). Results showed that the PSQ-Op shares between 12 to 30 percent of its variance with the three general measures of stress, whereas the PSQ-Org shares between 7 to 22 percent of its variance with the same three measures (McCreary & Thompson, 2006). These findings suggest that although there is some overlap in what the PSQ-Op and the PSQ-Org measure, they are still measuring separate and distinct constructs from the three more general measures (McCreary & Thompson, 2006).

Hypervigilance Questionnaire (HVQ)

The Hypervigilance Questionnaire **(**HVQ; see Appendix H) is an 11- item self-report scale that loads onto a single factor (Kimble et al., 2009). Items were scored on a five-point Likert scale ranging from 1 “Not at All True,” to 5 “Extremely True” with total

scores ranging from 11 to 55 (Kimble et al., 2013). The Cronbach's alpha for the HVQ is .92 with a split half reliability of .89. The HVQ was shown to have good convergent and divergent validity and to have high correlation with the PTSD Symptoms Scale Self-Report (PSS - SR; Foa et al., 1993).

Theta/beta ratio (TBR)

The theta/beta ratio (TBR) was first introduced by Monastra et al. (1999) to measure attention deficit hyperactive disorder in children. The purpose of this assessment was to obtain the brain arousal of the participant measured through arousal. The TBR was derived by dividing the electrical output of theta brain waves (4 to 8 Hz), by the electrical output of beta brain waves (12 to 18 Hz). The TBR was measured using the EEGer neurofeedback system (Version 4; EEG Store, 2014) in which the researcher has been certified. The TBR is asymptotic, which means the ratio never hits zero and has no upper limit. When measuring theta and beta, one can always rely on the brain to be producing some level of both brain waves; therefore, determining a TBR is always possible (M. Gapen, personal communication, February 22, 2019). Literature on the TBR suggest typical ratios in healthy brains are 1.5, with over arousal measured at less than 1.5 and under arousal measured at greater than 1.5 (Monastra et al., 1999).

When measuring the TBR, sensors were attached to the midline of the participant's skull with the help of conducting gel. After the sensors were registering brain waves, the researcher ensured the impedance level (or amount of electrical interference) is below the threshold to obtain accurate measurements (below 10 K) for brain mapping. Brain mapping took place at one location on the participants scalp (CZ) for two minutes. The CZ placement was derived from the 10-20 international system (Malmivuo & Plonsey, 1995). The 10-20 international system (Malmivuo & Plonsey,

1995) is a recognized method to describe and apply electrodes to the scalp in the application of EEG. The researcher conducting the brain mapping took one, two-minute recording at one location (CZ) to determine the TBR.

Validity of the TBR can be found in the relationship between arousal and the EEG. EEG is known to capture the arousal fluctuations of the sleep-wakefulness cycle and has displayed promise for identifying subtle differences of mental activation and individual differences (Stenberg, 1992). Furthermore, Eysenck's theory of extraversion (Eysenck, 1967) suggests that higher levels of arousal are found in introverts than in extroverts. Additional studies suggest that extraverts are expected to show rhythmic, low-arousal EEG activity (within the alpha range), than introverts which suggests a degree of stability connecting the EEG and personality characteristics (Sternberg, 1992). Therefore, validity for the TBR is established in the relationship between stable personality characteristics and the correlating arousal of EEG patterns.

The reliability of the TBR was difficult to determine as no specific research had been previously conducted. However, further examination of studies that measure specific brain waves and their relationship to vigilance provided a pattern that was used for the purpose of reliability for the study. In tasks of attention and performance, researchers have used EEG measurements to determine states of vigilance. These researchers concluded that an increase in theta brain waves results in a decrease in the physiological state of vigilance (Ballard, 1996; Corsi-Cabrera et al., 1996). Further evidence suggests that in tests of sustained attention, an increase in theta results in a decrease in an individual's performance on a vigilance task where they had to withhold a response if a specific number appeared (Smit, 2004). The theta evidence provides a

connection between the level of theta activity in the brain and a decrease level of vigilance and task performance. Therefore, a connection within scientific literature exists suggesting that an increase in theta decreases vigilance and performance on attention tasks.

Studies investigating attention and vigilance show that as beta increases in the brain, vigilance also increases (Coull, 1998). Within sustained attention tests, a higher beta level did result in better performance (Smit, 2004). However, in sustained mental task performance increases in beta have also led to feelings of anxiety (Knott et al., 1996). These results suggest a beta threshold wherein an increase in beta activity may aid in vigilance and attention performance; however, too much beta may result in feelings of anxiety. Therefore, the connection between beta waves and an increase in vigilance suggests that an excessive amount of beta may lead to feelings of anxiety.

In sum, the cited studies suggest that by dividing theta waves by beta waves, the resulting number provides a general understanding of the arousal an individual may be experiencing at any point in time. In combination with the Monastra et al. (1999) TBR explanation above, the TBR should be considered valid due to the evidence suggesting EEG is a measurement of arousal (Sternberg, 1992). Additionally, several studies suggest that EEG is inter-rater reliable due to similar results connecting theta brain waves to a decrease in vigilance and beta waves to an increase in vigilance and if excessive, to anxiety (Ballard, 1996; Corsi-Cabrera, et al., 1996; Coull, 1998; Knott et al., 1996).

Data Collection Procedures

Upon choosing to volunteer in the study, the patrol officers were contacted (see police officer recruitment letter in Appendix C) and given days and times during which the researcher was at the police department. The patrol officer was given the option to

sign up for a scheduled time. The researcher had both the questionnaires and the brain mapping equipment set up prior to the participant entering the room. The patrol officer reported to a quiet room within the police department to complete data collection. Prior to the data collection period, the researcher had reviewed informed consent information with the officer and obtained their signature. Next, the researcher gave the officer an addressed, stamped envelope, so the participant could mail the signed informed consent form to the IRB office. Once the IRB office received the mailed form and confirmed consent, the document was destroyed. At no point was the signed consent document associated with the data. After the researcher answered any questions posed by the officer, the officer was asked to complete the demographic form, the HVQ (Kimble et al., 2009), the PSQ-Op (McCreary & Thompson, 2006), and the PSQ-Org (McCreary & Thompson, 2006). Next, the researcher hooked the officer up to the neurofeedback equipment with a sensor on each ear and one on top of their head. When the sensors were in place, data was collected by the researcher for two minutes with the officer's eyes open. Upon completion of the brain recording, the conducting gel was removed from the officer and the data collection period was complete. The entire data collection period was no longer than 20 to 25 minutes and if a police call came in during the collection of data, data collection was immediately stopped to ensure the officer could respond to the call.

Data Analysis

Multiple regression is the statistical test that was used for the analysis as two or more independent variables were being tested against the dependent variable. The independent variables within the study included the number of years as a patrol officer, hypervigilance, as measured by the HVQ (Kimble et al., 2009), and the level of organizational stress of police officers, as measured by PSQ-Op (McCreary &

Thompson, 2006) and PSQ-Org (McCreary & Thompson, 2006). A continuous scale was used for the independent variables and therefore cut-off scores were not necessary. The dependent variable consisted of the theta/beta brain wave ratio gathered from the brain mapping procedure, using the EEGer neurofeedback system (Version 4; EEG Store, 2014). The multiple regression was conducted at a statistical significance level of $p = .05$ and the researcher used Statistical Package for the Social Sciences (SPSS Version 24.0.0; IBM Corporation, 2016) statistical software for the analysis. Additional analyses included using years of experience as a moderating factor and then running regressions on the interaction effect between years of experience and the other independent variables.

The data analysis was designed to answer the following research question: Are years of experience as a patrol officer, level of hypervigilance, and levels of police stress predictors of brain arousal in patrol police officers? The hypothesis that was addressed within the research question states that as the years of experience as a patrol officer, HVQ (Kimble et al., 2009) scores, PSQ-Op (McCreary & Thompson, 2006) and PSQ-Org (McCreary & Thompson, 2006) scores increase, the TBR will decrease, indicating higher levels of over arousal.

Ethical Considerations

The Springfield College Institutional Review Board approved the study before formal contact was made with participants. The study also adhered to the research procedures of The American Psychological Association *Ethical Principles of Psychologists and Code of Conduct* (2017). The purpose of the ethical code is to prevent harm from occurring to participants of the research study. The study implemented informed consent procedures that protect the confidentiality of the participants even in the event the data was subpoenaed.

The informed consent process provided to participants included an explanation of the purpose of the study. The process also informed the participants about the kinds of data that were collected, potential risks and benefits from participating in the study, information regarding voluntary withdrawal of consent and participation from the study, information related to how confidentiality was maintained, and procedures for how collected data was stored.

The researcher ensured that participants clearly understood that they were able to withdraw from the study at any point with no penalty or repercussion from the police department or Springfield College. Discussing the right to withdraw with the participants was an important part of informed consent as patrol officers could have believed that the study may influence their standing within the department or how their supervisors view them. They were informed about the different types of questionnaires they were asked to fill out and informed about the brain mapping.

During informed consent, the researcher also clearly stated how the collected data was stored. All the questionnaires and brain mapping data was stored on an encrypted flash drive, thus preventing any unauthorized users from accessing the data. Furthermore, upon completing data collection with a participant, the data was assigned a number, so no names were attached to the data set.

Limitations

The study has several limitations. First, the findings from the study cannot be generalized to all police officers, as the occupational demands vary greatly within a police department. For example, an undercover officer and an analyst would have different levels of hypervigilance and exposure to critical incidents than would a patrol officer. Second, data collection was limited to on-site collection, which would suggest

that police officers had already been conditioned to be vigilant within the police department context. Third, interpretations of the finding were made with the understanding that much is still unknown about the human brain, suggesting that "if the brain were so simple we could understand it, we would be too simple to do so" (Robbins, 2008, p. 28-29). Fourth, temporal resolution of the EEG was excellent; however, its spatial resolution was limited (Dale & Sereno, 1993) meaning, the EEG was better able to acquire data from one location rather than a complete picture of the entire brain. Finally, a methodological limitation existed in using the TBR as test-retest reliability is still unknown.

Delimitations

The delimitations utilized within the research in the study were determined by a desire to gain a better understanding of how well occupational demands of a patrol officer influence police officer brain arousal. To obtain the data, the research only recruited patrol officers. Limiting the sample to patrol officers in this study allowed the researcher to gain the views of other police officers with different occupational demands. A second delimitation included the researcher's schedule regarding data collection. Conducting brain maps from patrol officers during the night shift may have resulted in different data when compared to brain maps collected during the daytime. A third delimitation is that the researcher only collected data from one New England state, which may therefore impede the generalizability of the findings. Finally, an environmental delimitation of this study was that data was only be collected while the patrol officers were on duty, which would suggest they could already be conditioned to be hypervigilant and therefore could impact the brain mapping conducted by the researcher (see hypervigilant biological rollercoaster in chapter two).

Results

The purpose of this study was to identify whether years of experience, hypervigilance scores, operational police stress, and organizational police stress were predictors of brain arousal in patrol police officers. Prior to data analysis, data was first screened for accuracy, missing values, outliers, and normality. Subjects missing more than two values in the demographic or questionnaires were removed. The mean impedance for the data set (n= 55) was 6.13 (ranging from 2 to 22), suggesting an overall strong connection between the surface of the participants scalp and the neurofeedback software. Overall, one subject was deleted due to high impedance (40), with this participant being the only extreme outlier detected. This section is organized into two parts: first, descriptive statistics and second, the findings from the correlation and regression analysis.

Descriptive statistics

The mean age of participants fell within the 41-45-year-old category and 92.7% (n = 51) of the participants identified as White. Officers who identified as male represented 87% (n = 48) of the sample with only 13% (n = 7) identifying as female. Of the participants, 65% (n = 36) reported the majority of their occupational tasks were patrol duties while only 35% (n = 19) reported supervisor duties. The mean number of years of experience was 12.95 (see Table 1 for additional descriptive statistics). No participant reported using stimulant medication. Finally, all the independent variables displayed symmetrical skewness (-0.5 to 0.5) except hypervigilance (-0.644) which displayed a moderately skewed distribution. The dependent variable also displayed symmetrical skewness (-0.151).

Correlations

First, the data was analyzed using bivariate correlations examining each independent variable's relationship with the TBR. The correlation between years of experience and the TBR resulted in a moderate to strong negative relationship (r = -.442, p = .001). Hypervigilance scores displayed a weak to moderate negative relationship with the TBR (r = -.266, p = .050). Finally, no relationship was identified between organizational stress (r = -0.008, p = .956) or operational stress (r = -.104, p = .452) and the TBR. See Table 2 for correlational data.

Multiple regression

Next, the data was analyzed using a multiple linear regression to understand the relationship between all the independent variables and the TBR. The results indicated that collectively the variables had a moderate degree of relationship with the TBR and predicted 26.7 % of the variability in TBR (p = 0.03) (please see Table 3 for the model summary). The unstandardized regression coefficient for years of experience was significant; b = -.020, p = .001. This can be interpreted as the slope of the relationship between years of experience and TBR, such that a .2 unit decrease in TBR would be predicted per 10 years of experience as a police officer. In addition, the unstandardized regression coefficient for hypervigilance was significant; b= -.011, p= .050. These results suggest a decrease in TBR of .011 for every unit increase in hypervigilance scores. Finally, there was no significant unstandardized regression coefficient for organizational police stress or operational police stress; b= -.002, p= .956 and b= -.027, p= .452, respectively. Please see Table 4 for the coefficient data.

To examine years of experience as a possible moderator of the relationship between each of the other independent variables and TBR, all variables were rescaled by transforming the data into standardized z scores. These were used to conduct three

subsequent regression analyses on the main effects and interaction effect of the independent variables on TBR. Years of experience was used as a moderating variable within the interaction effects. In each of these analyses, there was no significant moderating effect (p = .126, .182, and .624 for the interactions of years of experience with hypervigilance, organizational police stress, and operational police stress, respectively). Years of experience displayed a significant main effect (p = .001) in the regression analyses including hypervigilance and organizational stress and a significant main effect (p = .002) in the regression analysis including operational stress. The main effect of hypervigilance was significant (p = .036). The main effect of organizational police stress was not significant (p = .267). Finally, the main effect of operational police stress was not significant (p = .906). More details of the multiple regression results are provided in Table 5. In addition to the data showing that years of experience as a patrol police officer indeed change biomarkers of arousal in their brain, it is important to discuss the implication for practice and the limitations of the study.

Conclusion

Hypothesis one stated there is no significant relationship between years of experience, hypervigilance scores, organizational police stress, and operational police stress and TBR. The results of the study reject the null hypothesis as a significant relationship and small effect size account for 26.7% of the variability for TBR. In addition, a significant moderate to strong negative correlation for years of experience and TBR was found. Finally, a significant weak to moderate negative correlation for hypervigilance scores and TBR was found.

Hypothesis two stated there was no significant inverse relationship between the independent variables and the dependent variable. The null hypothesis is rejected for both

years of experience and TBR and hypervigilance scores and TBR as a significant relationship was found. The null hypothesis was accepted for both organizational police stress and operational police stress and TBR as no significant relationship was found.

Finally, hypothesis three stated years of experience does not moderate the relationship between the independent variables and the dependent variable. The null hypothesis is retained as years of experience was shown to not moderate the relationship between the independent variables and the dependent variable. However, a significant main effect was found between years of experience and TBR and hypervigilance scores and TBR.

Summary of the Findings

In sum, the findings of this study displayed a negative moderate correlation between years of experience and a change in the brain of police officers. The model of analysis showed that for every year of experience as a police officer, the TBR decreases by 0.02, which can result in patterns of over arousal later in a police officer's career. In addition, the TBR was shown to decrease at a rate of .011 for every unit increase in hypervigilance scores. The finding suggest that years of experience does not moderate the relationship between hypervigilance, organizational police stress, and operational police stress and TBR.

Discussion of Findings

The correlation produced by the study resulted in a strong negative relationship between years of experience and TBR. As years of experience being a police officer increased, TBR decreased resulting in an EEG biomarker of over arousal. These results contradict previous models of hypervigilance within the police literature. Previous literature by Dr. Gilmartin (2002) suggests a hypervigilant biological rollercoaster where

hypervigilance on duty leads to hypovigilance off duty resulting in biological homeostasis within the nervous system of the police officer. The results from the study appear to build upon the hypervigilant biological rollercoaster (Gilmartin, 2002) by suggesting that over time, the biological homeostasis of the police officer becomes more over aroused and therefore years of experience creates a new biological homeostasis within the nervous system. Therefore, instead of the nervous system of police officers oscillating between hyper and hypovigilance, over time, it appears that officers trend towards being stuck in the hypervigilant state. These results are also found within developmental trauma literature where exposure to adverse childhood experiences (ACEs) results in more over arousal in the nervous system of the children as they grow older (Shonkoff et al., 2009).

Trauma literature also suggests that accumulated exposure to traumatic events can lead to a number of difficulties, such as, PTSD, depression, anxiety, dissociation, anger, and somatic complaints (Cloitre et al., 2001). These difficulties establish a relationship between the findings of this study and previous literature suggesting that chronic trauma exposure impacts an individual's nervous system. Research also suggests that previous exposure to trauma signals a greater risk of over arousal symptoms from subsequent trauma (Breslau et al., 1999), which also supports the findings of the study as continuous exposure throughout a police career appears to increase cluster E symptoms of PTSD "marked alterations in arousal and reactivity" (American Psychiatric Association, 2013, p. 272). These findings may support the assertion by Maté (2010) that "extreme circumstances breed extremist brains" (p. 205).

The study also revealed the rate at which the decline towards over arousal takes place within the police officers in this study (0.20 units over ten years). The rate is meaningful given that it takes a police officer a minimum of 20 year in the line of duty in order to be eligible for retirement. Therefore, given the statistical model provided by the study, police officers could experience a TBR decline of 0.40 units throughout their career assuming they retire after 20 years. This is significant because it represents the shift from a more balanced TBR (1.5) to a more over aroused TBR (less than 1.5). It should be noted that the rate of change in the TBR could be dependent on other external factors that could either accelerate or decelerate the change over time. Although no literature exits related to external factors that may impact the TBR, one could hypothesize that social support, substance use, coping skills, traumatic brain injury, and traumatic exposure may all play a role in the TBR being more or less stable over time.

Next, the study found a weak negative correlation between the TBR and hypervigilance scores. Three possible explanations exist for these findings. First, vigilance within the police force is often normalized and positively reinforced through police training. Therefore, high baseline levels of vigilance may naturally exist within the sample. In addition, the study used a self-report measure of hypervigilance that may have resulted in self-report bias (Danaldson & Grant-Vallone, 2002) within the participants as what they may categorize as “normal” behaviors (i.e., sitting in a restaurant with their back to the wall) could have been greatly influenced by their training and experience as a police officer. In sum, the participants may have under reported their hypervigilance. Second, the weak negative correlation may also exist because the self-report measure averaged out the hypervigilant police officers with the police officers who have more

flexibility within their nervous system and are more skilled at being able to regulate themselves after a period of vigilance. This possibility may have reduced the effect within the correlation analysis.

Another important finding from the study includes how much of the TBR the independent variables predicted. The independent variables predicted 26.7% of the TBR and specifically, years of experience predicted 19.2% of the TBR. These results display the important role that mere exposure to traumatic events plays in the ever evolving nervous system. When considering how cumulative trauma exposure may impact police officers, psychological assessment can provide unique insight. Considering that years of experience alone predicts almost one fifth of the variability in the TBR it would be important for police departments and clinicians working with police officers to consider how chronic trauma impacts police officers experience over time as prolonged exposure leads to over arousal within the nervous system.

The reason for the lack of relationships between TBR and organizational police stress and operational police stress remains unclear. Literature on stress has identified three factors that universally lead to stress in humans. These factors are: uncertainty, lack of information, and loss of control (Levine & Ursin, 1991). Adding to the literature, Maté (2010) also adds two more factors: conflict that the organism is unable to handle and isolation from emotionally supportive relationships. With organizational stress and operational stress measuring stress levels related to “dealing with coworkers,” “lack of resources,” and “over-time demands,” “paperwork,” respectfully, it appears that the measures of police stress lack construct validity; literature suggesting that the correlation between the police stress measures was .72 (r^2 = 52%). It is also possible that police

officers may perceive organizational and operational demand within their careers as something that can be predicted, is in their control, and is manageable on a daily basis.

Implications

This study was the first of its kind to explore the relationship between years of experience as a patrol officer and brain arousal in police officers. The findings of this study suggest a correlation between years of experience as a police officer and the neuro-functioning of the police officers' brain. These results have wide reaching implications within the field of psychology.

First, the findings of the study suggest an effective treatment strategy for struggling police officers would be one that targets the salience network and the regulation of the limbic system; specifically, treatment that would build flexibility between the three levels of the autonomic nervous system (sympathetic nervous system, ventral vagal complex, and the dorsal vagal complex; Van der Kolk, 2014) could aid clinicians in the effective treatment of police officers. This strategy could help psychologists and clinicians assist officers in working towards a more balanced and regulated nervous system (Hölzel et al., 2011). Techniques that may help engage the parasympathetic nervous system (or relaxation response) might be beneficial to the well-being of the police officers. For example, neurofeedback and biofeedback are techniques that could be used to directly address the physiological response to over arousal. In addition, treatment techniques that focus on combatting the effects of trauma exposure as well as techniques that help restore a sense of control and safety could benefit officers. Assisting officers in working towards a more balanced nervous system would ensure appropriate vigilance when duty calls but most importantly target the officers' abilities to return to baseline levels of arousal or what Gilmartin (2002) calls "biological

homeostasis" (p. 44) when off duty. The results could also aid psychologists and other clinicians in deploying and implementing effective, long term support for officers beginning in the police academy and extending throughout their careers. The long-term support could include programs such as mindfulness training, social support networks, and other effective treatment options.

The study also suggests that police officers themselves may underestimate how years of experience may impact the functioning of their brain. Therefore, clinical assessment by competent clinicians and the formulation of effective interventions that assist police officers to cope with the demands of police work in a healthy manner are of critical importance.

Second, the results of the study could help psychologists and clinicians working with police officers to partner with department leadership in formulating more effective policies to reduce the chronic stress they experience. Understanding that over a police officer's career, their brain may show more patterns of over arousal is important when considering other logistical influences of their job, such as the impact of shiftwork and specifically the resulting impact of shiftwork disorder (Conn, 2018). Shiftwork has been shown to alter the natural 24-hour cycle of the body, which is chemically stressful to the individual (Bonifacio, 1991). Therefore, the results of this study could help guide conversation and policy formation related to shiftwork and point to the need for more fixed schedules as it has been shown that individuals who work straight days get more sleep than those who work evenings or overnight shifts (Conn, 2018). In addition to shiftwork, overtime hours may also incentivize police officers though financial gain to pick up more shifts instead of decompressing and taking days off to allow their nervous

system to rebound from the stress of police work (Gilmartin, 2002). Conn (2018) states that police agencies struggle to maintain adequate staffing levels and therefore officers end up being "voluntold" (p. 96) they are going to work overtime or even worse, come in to work on their days off.

The results of the study may help psychologists and clinicians advocate for meaningful police officer rest within the complex logistics concerns of inadequate staffing levels. More globally, the results could inform clinicians that a long term approach would be helpful in reducing the impact a police career has on the police officers. As such, working with police departments to set up meaningful and realistic policies that incentivize healthy habits may be beneficial. Incentives for healthy habits may include, gym memberships, peer support groups, massage benefits, access to nutritionists, and confidential counseling services, which may be of great benefit to the well-being of police officers.

Third, the results of the study may also assist psychologists and clinician in taking a more prevention based approach. Some departments provide resources (books) or training related to the demands of police work and how officers can best manage these demands. Including the results of this study within the training of police officers may be helpful and could warrant the justification of annual check ins of police officer well-being. With support of department leadership, implementing annual check ins may provide insightful information into the functioning of police officer. Professional who conduct the annual check ins can ask broad questions about positive or negative changes the police officer may have experienced within the past year. In addition, questions about relationships, physical and mental health, and signs of stress would be important areas of

inquiry. For a more detailed example of what an annual check may entail please refer to Conn, 2018 (pp. 129-130). Annual check ins may assist clinicians in minimizing the negative consequences of police officer burnout. Burnout is "prolonged exposure to chronic emotional and interpersonal stressors on the job and is defined by three dimensions of exhaustion, cynicism, and inefficacy" (Maslach et al., 2001, p. 397). Results of the study suggest that years of experience as a police officer result in more biomarkers of over arousal which can lead to health concerns in police officers and therefore warrant the assistant of psychologists and clinicians to implement further preventative measures with the assistance of department leadership to ensure the long term health and well-being of police officers.

Finally, the results of the study have implications for future research. Overall, the study reveals what little is known about the brain of police officers and how it may adapt to the unique demands of police work. Due to the limitations of the study (see below), a more comprehensive study that factors in more independent variables could help account for more the changes in the brain. For example, independent variables that measure self-care, adverse childhood experiences, military experience, time of shift typically worked, social relationships, and specific occupation demands may account for a larger percent of the changes in a police officer's brain. Accounting for a greater percent of changes in the brain of police officers would yield a more detailed and nuanced understanding of the impact of police work and would more specifically inform treatment, policies, and prevention.

The study conducted also indicates that a more advanced and complex form of brain mapping would be helpful in illuminating how police work impacts the brain of

officers. For example, conducting a study that uses a 19 channel QEEG (quantitative EEG; Demos, 2005) would provide more detailed information than what the current study yielded. Implications of this study suggest that longitudinal data investigating how a police officer's brain specifically changes at different time points over the course of their career would be a fruitful area of further research. Specifically, training the brain of police officers when they are first accepted into the police academy, all the way through to retirement may provide insightful information related to how the brain adapts to the demands of police work. The current study focused on medium sized departments in small urban locations. Additional studies that investigate the brain of police officers in small or large sized department and both in urban and rural locations would help build upon the results of this study.

Strengths and Limitations

The current study has several strengths and limitations. A strength of the study is the data collection method. First, the study was comprised of a community-based cross-sectional quantitative design, which provided the researcher the opportunity to gather data within police departments and gain first-hand knowledge of occupational demands related to police work. Police literature suggests that immersing oneself in police culture is important for meaningful work (Kirschman et al., 2014). Second, the study was designed with great intentionality related to the unique population being studied. Therefore, the researcher worked closely with a police captain and police chief to ensure the procedures (specifically, confidentality) would be accepted within the police culture. The cross-sectional design was an advantage for several reasons. First, the data are obtained at a single point in time and there is no loss due to follow up (Sedgwick, 2014) making it easier for busy police officers to participate. Second, cross-sectional studies are

helpful for the generation of hypotheses (Hua & David, 2008; Levin, 2006) and the expansion of a body of literature. Third, cross-sectional designs are generally easy, quick (Choy, 2014), and cheap to perform, which result in follow up studies being repeated at another time to assess trends over time (Sedgwick, 2014). The quantitative methodology also facilitates future comparisons between groups to determine the extent of differences or similarities (for example, a different population of police officers or perhaps a firefighter population) (Yauch & Steudel, 2003).

The cross-sectional quantitative design does provide compelling research data; however, there are limitations to this methodology. Cross-sectional designs are unable to assess individual differences across the participants (Hua & David, 2008); measuring important factors such as social support, adverse childhood experiences, and trauma exposure may impact the results within the study. In addition, while cross-sectional studies can explore the interrelationships between variables, they cannot prove the causal nature of the relationships (Hua & David, 2008). Therefore, due to the nature of cross-sectional designs only recording data at one point in time, one can only develop associations, and not causation (Levin, 2006; Sedgwick, 2014). Cross-sectional designs are also prone to non-response bias, which occurs if participants who consent to participate in the study differ from those who do not, resulting in a sample that is not representative of the population (Sedgwick, 2014). Generally, quantitative designs have difficulties capturing the characteristics of people and populations; for example, identities, beliefs, perceptions; therefore, quantitative desings cannot adequately understand and reduce characteristics to numbers resulting in potentially important contextual information being ommited (Dudwick et al., 2006). In addition, quantitative

designs, in general, have a shortcoming of not being able to obtain the experience of the police officers who participated in the study (Choy, 2014). An additional limitation to the study is the homogeneous nature of the sample size with the major of the participants identifying as White males; this lack of diversity within the sample may skew the data which may limit the generalizability of this study.

To what extent the TBR is a state measure is not known in the literature but should be considered a limitation to the study. Evidence also suggests that alcoholics tend to be hardwired differently from other people which makes it difficult for them to relax (Duffy, 2011) which suggests that substances may impact an individual's arousal. Specific literature regarding how TBR is impacted by other substances is currently unknown. As a result, the cross-sectional design of the study is appropriate to gather a snap shot of the police officer's brain arousal at one point in time but the arousal pattern of the officer's brain may have shifted depending on their work shift or other external factors. Therefore, more research is needed to further understand the relability of the TBR.

Conclusions and Future Research

The purpose of this study was to understand the relationships between occupational demands of being a police officers and brain arousal. The findings of this study offer evidence of new and fruitful information related to the brain of police officers. In conclusion, the results indicate that as years of experience as a police officer increases, the TBR decreases indicating over arousal. Specifically, years of experience accounted for 19.2% of the variability in the TBR and shows the neurobiological impact that years of experience has on the nervous system of police officers.

As studying the brains of police officers through accessible neurofeedback equipment has never been done before there are many areas of future research that would build upon the current study. First, the study accounted for 26.7% of the variability in the TBR; additional research that include more measures to account for more of the TBR would be helpful in revealing how the nervous system of police officers adjusts to the unique demands of the job. Specifically, future research should include the study of adverse childhood events (ACE) (Felitti et al., 1998), social support, coping mechanisms, types of critical incidents and their frequency, comparisons of male and female officers, impact of masculine gender roles, and military experience. In addition, a study utilizing a randomized control trial with potential civilian matching to the same demographics as the police officers would significantly add to existing research.

Another area of future study would be the inclusion of a more detailed measure of the police officers' brain waves. For example, a quantitative electroencephalogram (QEEG; Demos, 2005) would provide more precise location of brain wave distribution, which may provide insightful information in relationship to other independent variables. Furthermore, physiological measures of hypervigilance (such as body temperature, pulse rate, breathing rate, or blood pressure) may provide insightful data into how the physiology of police officers may be impacted by their careers. Next, the current study was not able to build upon performance literature (i.e., the drive theory or the inverted- U hypothesis), as there was no measure for police officer performance. As such, future research that includes measures of police performance and the brain would be insightful in understanding how over arousal in police officers impacts their job performance. An alternative methodology to measure hypervigilance may be insightful in future research

due to the potential self-report bias within the current study. Alternative methods of measuring hypervigilance could include biofeedback skin response, variables of attention, an external report (such as a spouse), or the fear-potential startle paradigm (Brown et al., 1951). Finally, future research could expand the methodology by investigating the police officers' lived experience through qualitative methods relating to their years of experience and how they perceive themselves and the world around them. Currently, literature has investigated police officer job satisfaction (Johnson et al., 2005a), but no current literature looks to understand the police officers' perspective of how they view themselves and the world around them. These areas of further research may provide a meaningful map forward to understand the police officer brain.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Tables

Table 1

Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
TBR	0.71	2.01	1.46	0.29
Years	2	23	12.96	6.73
Hypervigilance	23	55	40.84	7.09
Organizational	1.25	5.25	3.39	0.95
Operational	1.30	5.30	3.48	1.13

Table 2

Correlation Results

		Years	Hypervigilance	Organizational	Operational
TBR	Pearson Correlation	-.442**	-.266*	-.008	-.104
	p- value	.001	.050	.956	.452
Years	Pearson Correlation		.064	.256	.202
	p- value		.644	.059	.139
Hypervigilance	Pearson Correlation			.074	.256
	p- value			.592	.060
Organizational	Pearson Correlation				.745
	p- value				.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Sig.
1	.516[a]	.267	.208	.26643	.003

a. Predictors: (Constant), Operational, Years, Hypervigilance, Organizational

Table 4

Coefficients

Model	B	Std. Error	Standardized Coefficients Beta	t	Sig.
Year	-.020	.006	-.438	-3.550	.001
Hypervigilance	-.011	.006	-.266	-2.006	.050
Organizational	-.002	.043	-.008	-.056	.956
Operational	-.027	.036	-.104	-.758	.452

a. Dependent Variable: TBR

Table 5

Multiple Regression Results

		Hypervigilance	
	Beta	*t*	*p*
Intercept		-.095	.925
Years	-.413	-3.473	.001*
Hypervigilance	-.257	-2.154	.036*
Years x Hypervigilance	.185	1.556	.126
		Organizational Stress	
Intercept		.348	.729
Years	-.466	-3.677	.001*
Organizational	.145	1.122	.267
Years x Organizational	-.169	-1.354	.182
		Operational Stress	
Intercept		-.099	.922
Years	-.430	-3.333	.002*
Operational	-.015	-.119	.906
Years x Operational	-.062	-.493	.624

*$p < .05$.

Note. Heading denotes the predictor (IV) included in each regression; TBR is the consistent DV for all.

Appendices

Appendix A: Informed Consent Form

Informed Consent Form

Consent to Voluntary Participate in a Research Investigation

Department of Psychology

Springfield College

Springfield, MA 01109

Dr. Sally Hage
Chair of Dissertation Committee

Scott Anderson, M.A., M.Ed.
Researcher's Name

You are being asked to provide consent in a research study exploring how occupational stress impacts the brain. **Participation is voluntary.**

Your participation includes the following:

- No more than 20-25 minutes of time which can be completed while on the clock
- Filling in four short questionnaires about your habits and occupational stress
- Having one sensory gently placed on the top of your head for 2 minutes of brain wave recording
- Having two sensors gently clipped to each ear for the 2 minutes of brain wave recording

I encourage you to ask questions now or at any time during the process. If you decide to participate, you will be asked to sign this form and mail it at your convenience to Springfield College Internal Review Board with a stamped addressed envelope provided by the researcher When the institutional review board (**IRB**), has verified the document is signed, it will be destroyed.

CONFIDENTIALITY:

- At no point will the signed consent form be associated with the data collected.
- The researcher at no point will have access to the consent form or your identifying information.
- Your data will be assigned a random number and will be stored in a secure location.

The individual data will not be released to the police department, community, or media. However, an aggregate of the findings may be presented in a professional presentation or in a journal article.

Risks

Your participation does not involve any risks other than what you would encounter in daily civilian life.

Benefits

Taking part in this study may help departments, researchers, and practitioner to better understand how the stressors of police work influences the human brain. These results may lead to more informed training and interventions designed to increase police officer well-being.

Participant Rights

Your participation in this research study is completely voluntary. You can withdraw at any time. Choosing not to be in this study or to stop being in this study will not result in any penalty to you or loss of benefit to which you are entitled. Your choice to not be in this study will not negatively affect any rights to which you are otherwise entitled.

Whom to contact with questions

All investigational projects are governed by both the Federal Government and Springfield College. These regulations require that the researcher obtain for you a signed consent to participate in this study. If you have any questions or problems during your time on this study, you should call Scott Anderson as the person in charge of this research study and can be reached at 303-818-2733. You can also contact Dr. Sally Hage (413-748-3663). Questions about your rights as a research participant may be directed to the Institutional Review Board (IRB) Office of Springfield College at (413) 748-3959.

I certify that I have read and fully understand the above research. All my questions have been answered to my satisfaction by the researcher. I willingly give consent to participate in this study.

_____ _____

Signature of Participant Date

Appendix B: Recruitment Flyer

Recruitment Flyer

PATROL OFFICER STUDY

Be part of an important police research study

- Do you have experience as a patrol officer?
- Do you want to help understand how job demands affects patrol officers?

If you answered YES to these questions, you may be eligible to participate in a confidential police research study.

The purpose of this research study is to predict how occupational demands of police work may influence patrol officers' brain waves.

This study has the approval of police chief _____ and participants will be able to participate when they are on duty.

FULL confidentiality will be provided to participants. No names will be attached to the data and the researcher has applied for a federal certificate to protect identifiable research information from forced disclosure.

This study is being conducted by Scott Anderson, M.A., M.Ed., a Springfield College doctoral student, and has been approved by the IRB at Springfield College.

Please call Scott Anderson at (303) 818-2733 or email sanderson15@springfieldcollege.edu

Appendix C: Police Officer Recruitment Letter

Patrol Officer Recruitment Letter

RE: Patrol Officer Study

The proposed study has been approved by Chief __name__.

_____	_____
Chief X signature	IRB signature
Department name	Springfield College

Dear Officer,

Do you have experience as a patrol officer?

Do you want to help understand how job demands affects patrol officers?

If you answered YES to these questions, you may be eligible to participate in a confidential police research study.

My name is Scott Anderson. I am a graduate student at Springfield College in Counseling Psychology. I am conducting research on patrol police officers in New England, and I am inviting you to participate because you have experience as a patrol officer.

Participation in this research includes the completion of four short questionnaires as well as a few minutes of recording brain activity. If you agree to participate, the total time commitment will be 30 minutes which you can complete while you are on duty.

If you have any questions or would like to participate in the research, I can be reached at (303) 818-2733 or sanderson15@springfieldcollege.edu.

Appendix D: Staff meeting and roll call script

Script for Police Staff Meetings and Roll Calls

Introduction- Why:

- Hello, thank you for your time today. My name is Scott Anderson and I am a doctoral student at Springfield College. I come from a family of first responders with my younger brother finishing his schooling to be a paramedic and my grandfather was a police detective. I come from a different educational background than most of my peers where I studied sport psychology in Colorado and did some research with Olympians. As a result, I have come to believe that everyone in different situations has a different optimum level of arousal to do their best. However, in my experience working with first responders, the consequences of the job are very different. In speaking to the Captain, he gave me Dr. Gilmartin's book which I have read several times now and I am sure you are all familiar with the hypervigilant biological rollercoaster. The rollercoaster helped me think about police work the same way I think about elite athletes, but it got me asking… "what about the officer's brain?" So, through collaborating with the Chief and Captain, we have worked together to develop a project that has never been done before; the purpose of the study that we came up with attempts to further understand how police work impacts the officer brain. Participation is voluntary and can be done while on duty.

Study explained- How:

- Understanding the relationship between occupational stress and the officer's brain has never been done before. It will consist of having the officer fill out four short questionnaires and then have brain data collected. There are a few ways in which we can collect brain data. An MRI or an fMRI can be expensive, time consuming, and inconvenient but the way I have designed the study, it consists of placing one clip on each ear and a sensory on the top of the officer's head for 2 minutes to record data. Participation time will take no more than 25 minutes.
- I will then take the questionnaire data and analyze whether there is a relationship with the brain data. The purpose of my study is to determine if years of experience as a patrol officer impact the brain.
- Confidentiality is extremely important to me and I have taken considerable efforts to ensure I protect the officers who choose to participate. Working with the Captain and the review board at Springfield College we have decided it would be best that the informed consent be separate from the data collected and I will only identify the officer by number and don't need their name. When the officer signs the informed consent, they will be provided an envelope to send it to the review board; when they confirm the signature, the consent form will be destroyed.
- What questions do you have for me?

Appendix E: Demographic Survey for Police Patrol Officers

Demographic Survey for Police Patrol Officers

Age (please check one):

- ☐ 20-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41-45
- ☐ 46-50
- ☐ 51-55
- ☐ +55

Race (please check one):

- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black/African American
- ☐ Hispanic, Latino, or Spanish origin
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ White
- ☐ Some other race or origin

What is the majority of your occupational tasks (please check one)?

- ☐ Patrol duties
- ☐ Supervisor duties

Years of experience as a patrol officer (please check one):

- ☐ 0-3
- ☐ 4-6
- ☐ 7-9
- ☐ 10-12
- ☐ 13-15
- ☐ 16-18
- ☐ 19-21
- ☐ +21

How long ago was your experience as a patrol officer (please check one)?

- ☐ Current
- ☐ 1-5 years ago
- ☐ 6-10 years ago
- ☐ 11-15 years ago
- ☐ 16-20 years ago
- ☐ 21-25 years ago
- ☐ +25 years ago

Gender (please check one):

- ☐ Male
- ☐ Female
- ☐ Other

How many **caffeinated beverages** have you consumed in the past 24 hours (please check one)?

Note: one cup is 8 ounces.

- ☐ None
- ☐ 1-2 cups
- ☐ 3-4 cups
- ☐ 5-6 cups
- ☐ 6 or more cups

How many **caffeinated beverages** do you consume on an average day (please check one)?

Note: one cup is 8 ounces.

- ☐ None
- ☐ 1-2 cups
- ☐ 3-4 cups
- ☐ 5-6 cups
- ☐ 6 or more cups

How much tobacco do you consume on an average day (please check one and indicate use)?

- ☐ None
- ☐ Cigarettes
  - o Daily use
  - o Weekly use
  - o Monthly use
- ☐ Smokeless
  - o Daily use
  - o Weekly use
  - o Monthly use
- ☐ Cigar
  - o Daily use
  - o Weekly use
  - o Monthly use
- ☐ Pipe
  - o Daily use
  - o Weekly use
  - o Monthly use

Are you currently taking any medication for ADHD or the like (please check one)? (i.e., Adderall, Ritalin, Concerta, etc.)

- ☐ Yes
- ☐ No

Appendix F: Operational Police Stress Questionnaire

Operational Police Stress Questionnaire

Below is a list of items that describe different aspects of being a police officer. After each item, please circle how much stress it has caused you over the past 6 months, using a 7-point scale (see below) that ranges from “No Stress At All” to “A Lot Of Stress”:

No Stress At All			**Moderate Stress**			**A Lot Of Stress**
1	**2**	**3**	**4**	**5**	**6**	**7**

1. Shift work	1	2	3	4	5	6	7
2. Working alone at night	1	2	3	4	5	6	7
3. Over-time demands	1	2	3	4	5	6	7
4. Risk of being injured on the job	1	2	3	4	5	6	7
5. Work related activities on days off (e.g. court, community events)	1	2	3	4	5	6	7
6. Traumatic events (e.g. MVA, domestics, death, injury)	1	2	3	4	5	6	7
7. Managing your social life outside of work	1	2	3	4	5	6	7
8. Not enough time available to spend with friends and family	1	2	3	4	5	6	7
9. Paperwork	1	2	3	4	5	6	7
10. Eating healthy at work	1	2	3	4	5	6	7
11. Finding time to stay in good physical condition	1	2	3	4	5	6	7
12. Fatigue (e.g. shift work, over-time)	1	2	3	4	5	6	7
13. Occupation-related health issues (e.g. back pain)	1	2	3	4	5	6	7
14. Lack of understanding from family and friends about your work	1	2	3	4	5	6	7
15. Making friends outside the job	1	2	3	4	5	6	7
16. Upholding a "higher image" in public	1	2	3	4	5	6	7
17. Negative comments from the public	1	2	3	4	5	6	7
18. Limitations to your social life (e.g. who your friends are, where you socialize)	1	2	3	4	5	6	7
19. Feeling like you are always on the job	1	2	3	4	5	6	7
20. Friends / family feel the effects of the stigma associated with your job	1	2	3	4	5	6	7

Appendix G: Organizational Police Stress Questionnaire

Organizational Police Stress Questionnaire

Below is a list of items that describe different aspects of being a police officer. After each item, please circle how much stress it has caused you over the past 6 months, using a 7-point scale (see below) that ranges from "No Stress At All" to "A Lot Of Stress":

No Stress At All			**Moderate Stress**			**A Lot Of Stress**
1	**2**	**3**	**4**	**5**	**6**	**7**

1. Dealing with co-workers	1	2	3	4	5	6	7
2. The feeling that different rules apply to different people (e.g. favoritism)	1	2	3	4	5	6	7
3. Feeling like you always have to prove yourself to the organization	1	2	3	4	5	6	7
4. Excessive administrative duties	1	2	3	4	5	6	7
5. Constant changes in policy / legislation	1	2	3	4	5	6	7
6. Staff shortages	1	2	3	4	5	6	7
7. Bureaucratic red tape	1	2	3	4	5	6	7
8. Too much computer work	1	2	3	4	5	6	7
9. Lack of training on new equipment	1	2	3	4	5	6	7
10. Perceived pressure to volunteer free time	1	2	3	4	5	6	7
11. Dealing with supervisors	1	2	3	4	5	6	7
12. Inconsistent leadership style	1	2	3	4	5	6	7
13. Lack of resources	1	2	3	4	5	6	7
14. Unequal sharing of work responsibilities	1	2	3	4	5	6	7
15. If you are sick or injured your co-workers seem to look down on you	1	2	3	4	5	6	7
16. Leaders over-emphasize the negatives (e.g. supervisor evaluations, public complaints)	1	2	3	4	5	6	7
17. Internal investigations	1	2	3	4	5	6	7
18. Dealing with the court system	1	2	3	4	5	6	7
19. The need to be accountable for doing your job	1	2	3	4	5	6	7
20. Inadequate equipment	1	2	3	4	5	6	7

Appendix H: Hypervigilance Scale (HVQ)

Hypervigilance Scale (HVQ).

Citation:

Kimble, M., Fleming, K., and Bennion, K. (2013). Contributors to Hypervigilance in a Military and Civilian Sample. Journal of Interpersonal Violence, 28(8), 1672-1692.

Please indicate by circling a number how true each of these statements is regarding your current behavior:

When I enter the room, I often scan it for entrances and exits.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

I often feel as if I'm "on guard".

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

When I come to a new place, I usually survey the scene to see if there are possible risks.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

If I were to sit in a crowded movie theater, I would always sit in a seat where escape would be easy.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

When I am out on the street, I am often "looking over my shoulder".

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

I am always aware of situations in which I could be trapped.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

I often check the locks on my house at night to make sure they are secure.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

When I sit in a restaurant, I will typically sit where I can see everything.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

I always try to be aware of objects or places where danger could be lurking.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

I frequently pay attention to even the slightest sound or noise.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true

In a crowd, I often wonder whether someone might be hiding a weapon.

1	2	3	4	5
Not at all true	Slightly true	Somewhat true	Very true	Extremely true