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Correlating Residual Stress with Personal and Professional Characteristics in Aircraft Pilots

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Abstract

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by

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MBA, Bristol University, 1994

BA, Concordia College, 1989

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Every day aircraft pilots must successfully resolve significant inflight situations and then manage the possibility of residual psychological and physiological stress. Previous research has shown primary attention is given to presignificant event training and stress management, however there remains an important gap in the current literature regarding postsignificant event stress within the aviation profession. The purpose of this cross-sectional quantitative study was to use the observational lens of stress theory and survey U.S. pilots who have experienced an inflight emergency, looking for correlation between factors such as age, gender, flight experience, and training against a pilot's self-reported level of residual stress. Using snowball sampling methodology, 101 pilots were anonymously surveyed, with 89% responding that they had some level of residual stress via the Impact of Event Scale-Revised instrument. Using multiple linear regression analysis, the correlation between 9 personal and professional characteristics and pilot's stress level was significant, at R^2 =.22, adjusted R^2=.14, $F(9, 91) = 2.8$, $p < .01$. The sample's correlation coefficient was .47, indicating that approximately 22% of the variance in the residual stress was accounted for by the 9 personal and professional characteristics. Findings from this research will help clarify how pilot training and demographics can affect postsignificant event stress. This knowledge will be an important contribution to the existing literature and enhance social initiatives though an increased awareness of residual stress within the pilot profession. The results can be used to increase aviation safety by enabling the industry and government entities to develop and implement effective stress training initiatives.

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Dedication

I want to dedicate this study to the men and women who professionally and safely fly aircraft around the world, and in many instances which go unnoticed use their skills to successfully resolve complicated inflight emergencies, saving the lives of people both in the air and on the ground.

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I want to thank my family for putting up with many years of effort and time away from them as I completed this endeavor. Without their support and understanding this would not have been possible. I also want to thank Dr. David Milen and Dr. Christina Spoons who served as my Chair and 2nd Committee Member, as well as my University Research Reviewer, Dr. Kathleen Schulin. I would not have completed this without your advice and support.

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Chapter 1: Introduction to the Study

Introduction

The American Psychiatric Association's (APA) Diagnostic and Statistical Manual, 5th Edition (DSM-V), describes the requirement for patients to be diagnosed with post traumatic stress disorder (PTSD) as: the patient must have experienced death, or their own life was at risk; severe sexual trauma; or they experienced extreme violence (APA, 2017; Heaton & Wood, 2015). In today's world, with 24 hour news and the internet, there is a constant bombardment of examples of events which could cause PTSD-like symptoms. PTSD, an extreme form of residual stress, is being addressed in nearly every profession which has the potential to experience traumatic stress. This study uses the lens of stress theory and focuses on residual stress in the aviation industry, specifically on pilots who have encountered a significant inflight emergency.

Chapter 1 reviewed the background of the study, including a short primer on stress theory development, as well as its application to the aviation profession. The problem statement, purpose of the study, research questions, theoretical framework, and significance of the study are reviewed as they apply to this study.

Background of the Study

Stress theory applies to the aviation community as it does to any other highly stressful occupation. Most literature on aviation stress is reactive in nature, in that it addresses postevent analysis from major accidents, primarily because traumatic stress is relatively easy to observe and diagnose. The gap in the literature and the focus of this study is on inflight events that are severe, but less than catastrophic, where the pilot successfully resolves an emergency. Stress theory predicts there will be some residual stress conferred upon the pilot. Through this study I will attempt to correlate the level of residual stress with a pilot's personal and professional characteristics.

Stress Theory Development: the Natural Sciences

Stress theory in human physiology can be traced back to the development of the accumulated human knowledge on mechanical stress. Understanding and applying mechanical stress as a critical design theory in the natural sciences (e.g., math and physics) is a basic knowledge requirement for students learning these professions (Columbia University Requirements, 2017). In the simplest of explanations, the underlying principle of stress theory involves disturbing an object from an at-rest position by some measurable force, and then observing that object's resistance to that force; residual stress is the physical postevent changes in the object due to its resistance, or succumbing to, the applied force (Hibbeler, 2013). Centuries of accumulated human knowledge has yielded detailed laws and formulae which can predict relationships between objects and the forces applied to these objects. These formulae provide vital information, such as the failure point when a building will crumble from an earthquake (Bamer, Amiri & Bucher, 2016), or when an airplane wing will fail from bending and twisting under excessive air loads (Habib, Yousef, Mairaj & Khalid, 2017).

A positive result of this accumulated knowledge is that once an object's stress and failure points are well-defined, future potential stress factors can be precompensated for within the future designs of projects. A building, as an example, can have internal hydraulic dampeners installed, or be made out of more pliable materials, in able to absorb earthquake wave forces (Bamer, Amiri & Bucher, 2016); or an airplane wing can be constructed out of flexible and durable composite materials which then allow the wing to move dozens of feet from a neutral position without breaking apart (Habib, Yousef, Mairaj & Khalid, 2017; Nicolas, Sullivan & Richards, 2016). Stress theory can be applied to every aspect of human life where natural or man-made materials are used to for manufacturing.

Stress Theory Development: the Medical Sciences

Advances in the social sciences (e.g., psychology and sociology) and biomedical sciences have shown where stress theory can apply to these fields as well. The concept of what became known as physiological stress drew the attention of the scientific community in the early 20th century based on the pioneering work of Hungarian endocrinologist Hans Selye (1946). He observed that the physiology of mice reacted to disturbances in their biological homeostasis, the biological equivalent of stasis, with varying levels of responses (Jackson, 2014).

Homeostasis was a relatively new concept in the early 20th Century, as described by physiologist Walter Cannon (Cannon, 1935; Davies, 2016; Jackson, 2012). His research was the beginning of the development of what became known as homeostasis theory. The theory provided that a biological system, such as the human body, would strive to maintain a natural, innate, and internal balance once it detected an external or internal change. In other words, the human body's system of systems (all anatomical designs) would try via various compensating physical methods to return to what it considered normal. (Davies, 2016; Modell et al., 2015).

Prior to Selye (1946) and Cannon (1935), the medical community had focused on other common, more easily identifiable, biological responses to stimuli such as brain wave increases and heart rate changes (Jackson, 2012, 2014). Selye (1946) theorized that the organism as a whole was responding to disturbances in its homeostasis, even down to the endocrine, or chemical secretion levels (McCarty, 2017). Selye (1946) also observed that the longer and stronger the stimuli, or strain, the more physically devastating the residual stress impact was to the subjects. He developed the theory of general adaptation syndrome (GAS) in order to explain and understand how an organism would react to stressors placed on it through the various stages of the GAS: alarm, reaction, resistance (added in later years), and finally to the eventual physical and mental exhaustion stage of the subject (Jackson, 2012, 2014).

Stress Theory Development: the Social Sciences

Through the seminal works of Selye (1946) and Cannon (1935), and the rapidly maturing field of psychology, stress theory expanded from more than just a physical response to a disturbance in a subject's homeostasis. The community began to see residual stress as a subconscious biological response to a stressor when expected counteractions do not, or will not, work (Jackson, 2014). When this occurs, the human body begins its automatic progress through the phases of the Seyle's (1946) GAS (alarm, reaction, resistance, and finally exhaustion) (McCarty, 2017).

If a person is exposed to intense heat, for example, the body will react to cool the core temperature by sweating and increased breathing, but if this does not work the body becomes overstressed and can enter phases of sun stroke or heat stroke. The body has passed through the GAS phases of reaction all the way to exhaustion. The body "learns" this response as residual stress and the next severe temperature episode the body is exposed to it will tend to react more quickly. This results in the body reaching the GAS exhaustion phase faster than during the previous episode (Otani, Kaya, Tamaki & Watson, 2016).

The 3rd Edition of the APA's Diagnostic and Statistical Manual (DSM-III) had major impacts on the acceptance of traumatic stress and mental stress disorders within the social sciences and medical community, mainly due to its publication of standards for diagnosing stress. This version of the DSM is regarded as a turning point for acceptance of traumatic stress and launched countless research studies which detailed and changed society's views on stress (APA, 2017; Decker, 2013; Friedman, Resick & Keane, 2014).

In the mid-1980s, the concept of psychological stress was further refined by Lazarus and Folkman theorizing that stress and coping was transactional in nature, meaning a person's stress and coping interacted within their environment, such as their work space or living space (Folkman, 2013; Lazarus, 2013). This led them to the concept that that psychological stress overwhelmed a person's ability to manage the trigger event which in turn was based on that person's current set of coping tools; this was the operationalization of stress theory in human anatomy (Williams & Poijula, 2016). Their theory led to the design of their classic Ways of Coping Questionnaire (Cheng, Lau & Chan, 2014; Lazarus, 2013). This questionnaire is still widely used as a research instrument in the social sciences to gather data on stress and coping tools (Cheng, Lau & Chan, 2014; Lazarus, 2013).

The current version of the DSM is DSM-V, released in 2013, and it was the first version to have a wide array of diagnostic information on traumatic stress (APA, 2017). Some important additions from the older manuals include definitions for levels of stress less than full PTSD, but still considered important for treatment. Examples include acute stress disorder (ASD) as well as trauma and stressor related disorders (APA, 2017; Heaton & Wood, 2015). DSM-V notes that traumatic stress, such as PTSD or the lesser diagnoses, requires exposure to an event where death occurred or was possible, sexual violence, or where there was extreme violence (APA, 2017; Heaton & Wood, 2015).

Stress Theory Application: Aviation

Commonly thought of professions where stresses of the kind mentioned in the DSM-V are likely to occur would be the military, law enforcement, fire, and any other professions where one procedural mistake can lead to death or exposure to death. Pilots in the aviation profession are subject to death and massive violence in a crash by not following established procedures or the inability to control an aircraft malfunction. A classic example occurred in 2001 when an American Airlines aircraft departing an airport in New York City experienced severe turbulence while it was climbing after takeoff. As the aircraft began severe yawing back and forth, the pilot flying the plane applied incorrect procedures for the turbulence and sheared off both engines and crashed the aircraft, killing 260 people onboard and 5 people on the ground (National Transportation Safety Board, 2004). While the pilots did not survive this accident, had they survived it there would likely have been some residual mental or physical stressors they would have had to manage or cope with due to the stress of the situation.

The government and the aviation industry reacted to the accident by requiring more training for pilots to be able to recognize and apply proper procedures when experiencing wake turbulence. In essence, the government mandate provided more tools for the pilots to cope with stressors like severe wake turbulence. The civilian and military aviation communities are no different from other the professions who recognize stress and coping must be essential parts of their training programs. In many ways, the aviation profession has led the research and implementation of coping mechanisms due to the risks and stresses within the community. The medical community has used aviation related prestress training to help medical teams deal with traumatic situations such as the emergency operating room where immediate and timely life and death decisions are made (Griffith, Roberts & Wakeham, 2015; Ornato, Peberdy, 2014).

While the American Airlines accident is at one end of the stress and failure spectrum (i.e., a fatality), there exists a whole range of lessor stress levels from inflight incidents, which are potentially deadly, but were successfully managed by the pilots. Based on the definition from the DSM-V, many pilots have experienced events which could qualify them for having the potential of traumatic stress. This study continues in the same vein as previous research, acknowledging stress and residual traumatic stress are factors in aviation and that providing pre-event coping tools is highly effective.

Problem Statement

There is a problem within the U.S. aviation enterprise with regard to how the industry recognizes, understands, and prepares for postsignificant event residual stress in pilots. The industry needs a more defined analysis of how residual stress affects pilots so it can address presignificant event awareness, response, and recovery training among the more than 625,000 civilian and military pilots in the United States (Federal Aviation Administration, 2017; U.S. Air Force, 2016). A gap in the literature exists in addressing the specific impacts of postevent residual stress among pilots based on their individual and professional characteristics and qualifications. This can result in poor future inflight reactions, potentially negative physical and mental health issues, as well as potentially endangering the public.

Purpose of Study

The purpose of this quantitative study is to conduct a survey of U.S. pilots who have experienced a significant inflight emergency and attempt to correlate their levels of stress against their personal and professional qualifications in an effort to predict expected future stress levels. This will allow governmental entities and aviation researchers to develop appropriate pre-event training and provide pilots with better coping mechanisms to manage stressors both in real time and in postevent situations.

Research Question

The research plan involves designing a survey to collect the personal and professional characteristics of pilots (independent variables) as well as use an existing APA-approved instrument for defining scalable levels of traumatic stress (dependent variable). The result will be an examination of the severity of the residual stress correlated to the personal and professional qualifications of the pilots using statistical tools such as multiple-linear regression (MLR) and analysis of variance (ANOVA) looking for significance in the correlations.

H_0 (Null): There are not any significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

H_1 (Research): There are significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

RQ1: What correlation exists between a pilot's personal and professional qualifications and the severity of their residual stress levels, postsignificant event?

Theoretical Framework

The theoretical framework for this study is based on stress theory developed from the work of Selye (1946) and knowledge of GAS as well as Lazarus and Folkman's theory on stress and coping (Folkman, 2013; Lazarus, 2013; McCarty, 2017). Residual stress is comprised of remnants of the body's reaction to physical and mental stress. When the pilot's body physically or mentally attempts to cope with the stress, some of the personal characteristics or professional qualifications of the pilot can directly affect the severity and longevity of the residual stress.

Nature of Study

Through this quantitative study, the researcher seeks to show that certain predictor (independent) variables such as total flight time (translated into experience), age, gender, and the existence of specialized safety and resource management training, can possibly precharacterize the severity of residual stress levels (the dependent variable) within pilots.

Data will be collected from the pilots via a 22-question Likert scale measure called the Impact of Event Scale-Revised (IES-R) scale, an APA and U.S. Department of Veterans Affairs accepted and reliable method for determining the level of traumatic stress. The scale has been used in the social sciences for decades (Ashbaugh, Houle-Johnson, Herbert, El-Hage & Brunet, 2016; Beck et. al, 2008; Vilija & Lina, 2016; Choi, Kim, Jang, Bae & Kim, 2017; VA, 2017). The IES-R will provide the scalable dependent variable data for coping with stress and stress levels, and another nine questions based on pilots' professional characteristics will provide the basis for the independent, or predictor, variables. Using MLR and ANOVA statistical analyses, the researcher will identify potential correlations between the effects of the predictor variables on the outcome variable, the overall residual stress level, and look for possible relationships between the predictor variables themselves.

Operational Definitions and Terms

American Psychiatric Association (APA): Association of approximately 36,000 psychiatrists; publishes the Diagnostic and Statistical Manual (DSM) (Sargent, 2017).

Coping Tools: Method of minimizing the impact of real-time stress or postevent stress management (Lazarus, 2013).

Crew Resource Management (CRM): Coping method of reducing real-time stress utilizing group communication standards and teaming practices (Griffith, Roberts & Wakeham, 2015; Haerkers, Kox, Noe, Van Der Hoeven, Pickkers, 2017; Ornato & Peberdy, 2014).

Diagnostic and Statistical Manual (DSM): Widely used psychiatric coding manual of the APA; currently on 5th Edition (APA, 2017, Sargent, 2017).

Experience Level (Hours and Years): Measurement of pilot skillset based on either hours of flight time or years of accumulated knowledge in the aviation field

Federal Aviation Administration (FAA): Federal agency charged with issuing regulatory guidance for civil aircraft operations in the U.S. (FAA, 2017).

Gender: Sex of the respondent, male or female.

General Adaptation Syndrome (GAS): Progressive physical responses to outside stressors on the human body as noted by Selye (1946): Alarm, Reaction, Resistance, and finally physical Exhaustion (McCarty, 2017).

Homeostasis: Biological and psychological "neutral" or at-rest position of the human body; concept first put forth in scientific community in the early 19th century. Ground work set up the pioneering efforts of Selye (1946) to apply homeostasis to his General Adaptation Syndrome (Davies, 2016; Jackson, 2012; McCarty, 2017).

Heterostasis: New stasis (or biological homeostasis) based on impacts of a previous stressor (McCarty, 2017).

International Civil Aviation Organization (ICAO): United Nations sponsored organization for standardizing and coordinating airspace, airfield, and aircraft issues worldwide (Graham, 2014).

Impact of Event Survey (IES): One of the first widely accepted instruments for surveying levels of traumatic stress in patients by Horowitz (Horowitz, Wilner & Alverez, 1979; Weiss, 2007).

Impact of Event Survey-Revised (IES-R): Currently and widely accepted, updated, version of the IES, modified by Weiss (Feuerherd, Knuth, Muehlan, & Schmidt, 2014; Weiss, 2007; Weiss & Marmar, 1997).

Instructor Pilot: Pilot who has been issued a Certified Flight Instructor license by the FAA or a military service certification; allowed to teach unqualified people to become pilots (FAA, 2017).

National Transportation Safety Board (NTSB): Federal agency charged with investigating aviation (and other forms of travel/commerce) accidents in the U.S. in order to increase public safety (Vascik, Oye, & McCray, 2014).

Pilot: Person who has been certificated by the FAA or military service to act as a pilot in an air vehicle (FAA, 2017).

Post traumatic Stress Disorder (PTSD): Re-living of past intense psychological stressors to the point where the event has become physically and psychologically incapacitating to varying levels (APA, 2017; Heaton & Wood, 2015; National Institute of Mental Health, 2016).

Resilience Training: Pre/post traumatic event training in order to provide coping tools for persons likely to experience or have experience a traumatic event (Crane & Boga, 2017; Robertson, Cooper, Sarkar, & Curran, 2015; Thomas & Taylor, 2016).

Residual Stress: In physical sciences, the stress which remains within an object that resisted a force upon it; in the social/medical sciences, the psychological or physiological change from a person's homeostasis, generally in a negatively manner (APA, 2017; Heaton & Wood, 2015).

Snowball Sampling: Method of data collection from difficult to contact sample groups based on work of Goodman (1961) but becoming more widely used in research; respondent passes survey to another person they know meets research requirements and so on until sample size goal is met (Baker et al., 2013; Waters, 2015).

Stasis: In physical sciences, the at rest position of an object; in social sciences, the psychological or physiological neutral/normal operational of a human body (Davies, 2016; Hibbeler, 2013).

Stress: Physical and psychological disruptions to the biological homeostasis of a human being; results in biological and psychological compensations within the person's body in an attempt to alleviate the stressors and return the body to a state of homeostasis (Jackson, 2012, 2014).

Assumptions

It was assumed for this study that the term pilot refers to a person of any gender who has attained a license through the Federal Aviation Administration (FAA) and currently has an active or inactive license or is, or has previously been, qualified as a pilot in the U.S. Armed Forces. In either case, the rating of pilot for this study applies to fixed wing (airplanes) as well as rotary wing aircraft (helicopters), and also lighter-than-air aircraft (balloons and airships) (FAA, 2017).

Due to the nature of the sampling, the only assured initial data point will be that the pilots are actually pilots. Beyond that, there is an underlying assumption that they will have some flight experience that is worthy of analysis. As a note, in the demographics section of the survey there will be a section to collect data on the experience levels of the pilot. However, a presurvey assumption will still be that the pilots have some variation of experience to relate to the questions and experiences in the study.

Limitations

A potential limitation to the study will be the inherent nature of pilots to not self-report on medical issues for fear losing their medical clearances which could impact their jobs (Heaton & Wood, 2015). Because of the nature of flight, the responsibilities, and the potential impacts to people and property, pilots are some of the most medically controlled and restricted job professions (FAA, 2017). A direct result of this scrutiny is a limited willingness to discuss, even anecdotally, their medical situations. There will not be any collection of personally identifiable data within the survey and this will be made clear in the survey introduction and purpose statements.

Another potential limitation might be the experience levels of the pilots. Pilot experience is measured in hours of flight time, as well as total calendar years as a pilot, however there are some unique data possibilities that could arise. For instance, a pilot might get his or her license and never fly again. After 10 years of having a license to fly, but not flying, this would not make them experienced. However, a pilot who has flown 25,000 flight hours (the equivalent of nearly 2.5 years in the air) will have a vast repository of experience to sample. Pilots also generally record their fight time in personal logs, except the professional pilots and military pilots, so there could be some limitations based on the true level of experience as pilot may report on the survey.

Delimitations

A delimitation to this study is the sampling method. Due to the closed and highly dispersed nature of the subject group as well as the security and privacy issues of attaining a list of pilots from the FAA or the U.S. Armed Forces, a unique sampling methodology will be required. A nonrandom, nonprobability, snowball method of data collection will be utilized. The immediate effect of this method, due to the nonrandom selection of the sample, means that extrapolation to the larger population is not statistically viable without some validity issues (Baker et al., 2013).

Snowball sampling is a form of nonprobability sampling based on the work of Goodman (1961). The method is very effective at reaching target sample sets which are notoriously hard to clearly identify and reach (Baker et al., 2013; Waters, 2015). The method involves the survey being distributed initially to subjects known to meet the sample requirements and then having those people pass the survey to others they know to be of the same sample group

Significance and Social Change Implications of Study

Recent studies by the International Civil Aviation Organization (ICAO) have shown that the world-wide accident rates within the aviation industry have steadily decreased from a high of 80 incidents per 100,000 flight hours in the 1940s to less than 10 incidents per 100,000 flight hours in the contemporary aviation world (ICAO, 2011; ICAO, 2017; Vascik, Oye, & McCray, 2014). A potential explanation for this decrease is that most aircraft accidents are now nearly devoid of technical failures and are more impacted by human factors incidents (ICAO, 2011; 2017). Therefore, stress and coping in aviation is a critical node in understanding the human factors related incident rates, as well as reducing them (Griffith, Roberts & Wakeham, 2015; Ornato, Peberdy, 2014).

This study will focus on pilots who have had severe inflight emergencies and are experiencing some scalable level of residual stress. Showing that there are significant inflight experiences, such as engine failures and loss of pressurization that can cause residual stress, even though the events are less than fatal, will be useful to the aviation community. This study can help identify additional levels of training or self-analysis in order to assist the affected pilots in understanding how coping with the stress, or not coping, can affect their performance. Public policy leaders and aviation industry experts can use the results of this study to help create a dialogue that may yield better training and understanding of the effects of residual stress on the aviation industry.

Summary

This quantitative research study examined the aviation profession to see if there is some level of residual stress within pilots after they have encountered a significant inflight emergency where there was a moderate risk to themselves or their passengers. Using statistical analysis tools on data collected via a nonprobability snowball methodology, the research analyzed the correlations between the pilot's personal and professional characteristics and the pilot's level of residual stress.

Chapter 1 provided an overview of the study and the basis of the theory used to conduct the study. Chapter 2 will provide an analysis of the literature on stress and how stress has been identified and managed within the aviation profession. Chapter 3 will cover the theoretical framework of the study and address the methodological application of the Impact of Event Scale-Revised Survey instrument and the collection of individual pilot demographical data. Chapter 4 will present the results of the analysis of the data as it applies to the research question and hypotheses. Finally, Chapter 5 will examine the study's findings and conclusions and provide a roadmap for future studies of this subject so that policy makers can make informed decisions on ways to improve public safety in the aviation industry.

Chapter 2: Literature Review

Introduction

Chapter 2 includes a review of the applicable literature on stress, coping, and workplace residual stress as it applies to the aviation profession. There is a problem in the U.S. aviation enterprise with regard to how the industry prepares its pilots for post traumatic event residual stress. The purpose of this study was to fill in the gap of knowledge that exists by collecting data on levels of residual stress in pilots based on their professional and personal characteristics; this will enable government and industry leaders to amend or build training methods to increase the coping capabilities of the pilots prior to encountering a traumatic event.

A review of the literature showed that there is an ample amount of material on workplace stress, residual and post traumatic stress, as well as material on training pilots in the aviation career field to be able to address inflight emergencies, but it was all pre-event. There is also some literature available discussing postevent trauma in aviation, but the research was limited to how to get pilots back to full flying flight status. There appears to be a gap in the literature when addressing actual residual stress levels within pilots postevent, after they have experienced an inflight emergency and successfully returned the aircraft to the ground. The literature review analyzed the advancement of residual stress in the workplace, how residual stress affects human physiology within aviation, and how pre-event training attempts to combat stress during the significant event. Additionally, the literature review laid the groundwork for understanding postevent residual stress and how it applies to aviation community and why it is worthy of continued investigation.

Literature Search Strategy

The literature review was conducted through an analysis of peer-reviewed journal databases, recent technical and biographical books or manuals, U.S. government online data storage sites, as well as international aviation related institutions. Examples of databases used for the literature search included: The Dissertations and Theses at Walden University database, the Directory of Open Access Journals, the Free Medical Journals database, the Published International Literature on Traumatic Stress (PILOTS) Database, ProQuest Central, the American Psychological Association's PsycNET, and the Wiley Online Library. Keywords and phrase strings used for the database search for this literature review included: *pilots, aviation stress, residual stress in workplace, Impact of Event Scale-Revised, coping with residual stress, crew resource management, inflight emergencies, pilot training, PTSD, and pilot emergency procedures.*

The technique used for outlining the gap in literature was based on tabulating the relevant literature in a database. Search parameters focused on literature newer than 2012 (5 years), with clear exceptions for some seminal works by stress theory original researchers, for example Cannon (1935), Seyle (1946), and Goodman (1961). There were some cases where literature was used just outside the 5 year limit due to the importance of the contribution of the particular literature. It was clear that the literature search was becoming circular when the many of the articles were using similar resources and references. There has been considerable growth in traumatic stress literature in all professions since the release of DSM-III (APA, 2017) in the 1980s, and a significant amount of PTSD related studies since 9/11 and the war on terrorism began due to the large numbers of military personnel involved.

Theoretical Foundation

As noted in Chapter 1, stress theory has a solid foundation beginning in the physical sciences. The theory was adopted into the social and biomedical sciences based on research in the early to mid-1900s. The underlying theoretical proposition for stress theory is that inanimate objects as well as living organisms live in a stasis, or neutral state, and when that stasis is disturbed the object or organism will either remain in stasis or return to a new stasis, called heterostasis (Hibbeler, 2013).

In the physical sciences, an inability to stay in or return to stasis results in permanent physical damage, such as an inflexible bridge in an earthquake. In the social and biomedical sciences the inability to stay in stasis results in damage to the person which manifests itself as post traumatic or residual stress. The damage to the person can be psychological or seriously physiological requiring immediate medical attention. Stress theory in the social and medical sciences, as PTSD and residual stress, has become an accepted medical diagnosis (APA, 2017). Typical professions where PTSD is well-publicized include: law enforcement, first responders, and the military, based on the DSM-V typical conditions for being diagnosed with traumatic stress: exposure to an event where death occurred, sexual violence, or where there was extreme violence (APA, 2017; Heaton & Wood, 2015).

The aviation community is also susceptible to PTSD. Pilots make dozens of decisions on every flight that could have drastic impacts on the lives of the people on the plane as well as those on the ground if the decisions are incorrect, even more intense during a time-sensitive emergency. Stress theory applies to this study because pilots in the aviation community must react/cope with the stress of an inflight emergency once they have successfully concluded the event (Griffith, Roberts & Wakeham, 2015; Ornato, Peberdy, 2014). The alternative was that the pilots did not successfully conclude the inflight emergency and they were a fatality. The research question and research hypothesis for the study are whether pilots retain residual stress after they have experienced an inflight emergency and how severe is their residual or post traumatic stress level when compared to their professional and demographic characteristics.

Literature Review

The Development of Stress Theory

The field of biology had some extraordinary knowledge advancements in the late 19^{th} century. In the early 20^{th} Century Cannon (1935) added to this knowledge with his work on homeostasis. He used the term to explain what he observed in mice when their biological functions where disturbed out of a resting position and he noted their physiological efforts to return their systems back to the original state (Cannon, 1935; Davies, 2016; Jackson, 2012, 2014).

The full acceptance of homeostasis and operationalization of it into an accepted theory was based on the work of Selye (1946). He gave the biological and social sciences the GAS theory, which mapped the physiological steps a person's physiology would progress though when disturbed out of their homeostasis. Stress, according to Selye (1946), was the disturbances upon a biological system and the body's reaction to initially compensate for the stress and then eventually bring the system back to its original state (Jackson, 2012; 2014).

Selye (1946) also broached the concept of heterostasis, where the physiological system cannot get back to its original state and therefore established as new baseline of what it considers normal (Jackson, 2012, 2014; McCarty, 2017). An example of heterostasis is when the brain needs more blood flow it will increase blood pressure, and if the brain decides the new pressure is required constantly, that will be the new basis or heterostasis, even though there may be negative side effects (McCarty, 2017).

For many years, biological and social scientists had seen negative reactions in people who had been exposed to some significant physical or mental trauma. Soldiers in battle, first responders, or physical and mental abuse victims are typical examples. These people had been exposed to something for which their biological system tried to compensate, but could not. The results of the inability to return to their original stasis were being presented as physical or mental trauma. Their heterostasis, or new normal static operating level, could range from memories that come and go to complete physical or mental debilitation (Davies, 2016; Modell et al., 2015).

Another example is the difficulties air traffic controllers have after experiencing a traumatic event such as an aircraft crash. After the controllers have received some variance of medical support and retraining, they may try reintegrate back into their previous work environment and schedules, however their heterostasis has now been altered due to stress impact. This new baseline must be included in any diagnoses or remedies as well as evaluations of work performance (Cekanova, Mizenkova, Babry & Rozenberg, 2016). Post traumatic or residual stress is another term for the heterostasis that Selye (1946) propositioned. Post traumatic stress has some negative connotations due to what the general public associates it with: war, grisly death scenes, murders, and crime waves are examples.

As physiological researchers began to understand how trauma and stress were intertwined, the medical and social sciences responded with new methods of diagnoses and treatments. In the latter half of the 20th Century there was a flood of new measures and instruments for diagnosing post traumatic stress. For example, the U.S. Department of Veterans Affairs website for their National Center on PTSD lists 66 validated measures of PTSD available to clinicians and researchers (U.S. Department of Veterans Affairs, 2017).

One of the most heavily used of these measures, the Impact of Event Scale (IES), by Horowitz was released in the late 1970s (Ashbaugh, Houle-Johnson, Herbert, El-Hage & Brunet, 2016; Beck et. al, 2008; Choi, Kim, Jang, Bae & Kim, 2017; Horowitz, Wilner & Alvarez, 1979; Vilija & Lina, 2016; VA, 2017). At about the same time, the American Psychiatric Association (APA) was releasing its 3rd edition of its Diagnostic and Statistical Manual (DSM-III) of Mental Disorders (APA, 2017). Because the DSM-III was one of the fist diagnostic manuals which addressed traumatic stress disorders, the IES needed to be updated with similar its diagnostic criteria. The IES was updated by Weiss (2007) to the IES-Revised (IES-R) by the time the DSM-IV was released in 1994

(APA, 2017; Weiss, 2007). The IES-R is the planned instrument for residual stress level data collection in this research. The current DSM manual is DSM-V released in 2013 (APA), and it describes the diagnosis of PTSD requires the exposure to an event or risk of death or serious injury (APA, 2017; Heaton & Wood, 2015).

With the release of DSM-III (APA, 2017), many professions began to look for ways to identify potential stressors in the work environment, pre and postevent, especially those professions who are likely to experience high postevent stress levels. There was an acknowledgment that any profession can experience residual stress based on Lazarus' and Folkman's concept that stress is transactional. Transactional meaning that a relationship between the person and the environment (e.g., their workplace) existed and reacted with one another (Folkman, 2013; Lazarus, 2013). Lazarus described his three appraisals a person might apply based on what they are experiencing as:

- Harm/loss – something has happened
- Threat – possibility of something happening
- Challenge – person engages the something

One of the key contributions of Lazarus and Folkman was their Ways of Coping Survey (Folkman, 2013; Lazarus, 2013), but also his concept that people could be given tools to help cope with potential stressors, in the way of training. The term *tools* refers to skills or training methods that a person might receive in preparation for a stressful event or to cope with the event after it had been experienced. A person who has more tools to draw upon is likely to be able to withstand or cope with a particular stressor better than a person who does not have these tools (Lazarus, 2013).

As an example, first responders might take a class on what they can expect to encounter at an accident scene (pre-event training) and how to cope with the event afterward (postevent training). Pre-event training might include concepts such as practicing job tasks under stressful physical as well as visual threats which might give the first responders more tools to mentally or physically cope with an event. Postevent training for the responders might include talking about the event with peers, completing specific reports, or using available professional counseling resources to alleviate the stress of the incident.

Pre-event training is supported by many professions and they have started using the term *resilience training*. Resilience training is used to give workers coping tools in the event they encounter a potentially significant event. Lazarus was credited with the idea that resilience training is like giving people a skillset to withstand stress, like bendable metal, but snap back to their "stasis" (Robertson, Cooper, Sarkar, & Curran, 2015). The medical community (Mealer, et al., 2014) and the military (Crane & Boga, 2017; Thomas & Taylor, 2016) use resilience training to pretrain their workers for events they may encounter, with the goal being less of an impact on the person from what they are going to experience if they have already "pre-experienced" it. Resilience training has been recently termed as "bullet-proofing the psyche" (Thomas & Taylor, 2016).

Figure 1, from an Australian Army study on ways to improve resilience training, provides a good illustration of the way resilience training (pre and postevent) interacts with stressor events and coping methods (Crane & Boga, 2017). In Figure 1, adversity is tempered by the numerous self-reflection practices in an effort to reduce the impacts of the adversity as it occurring, these tools also to reduce the coping needs of the person during postevent recovery. These tools are used by the person in an attempt to maintain the physiological stasis that Selye (1946) described, or to minimize the difference between stasis and the "new normal" heterostasis (McCarty, 2017).

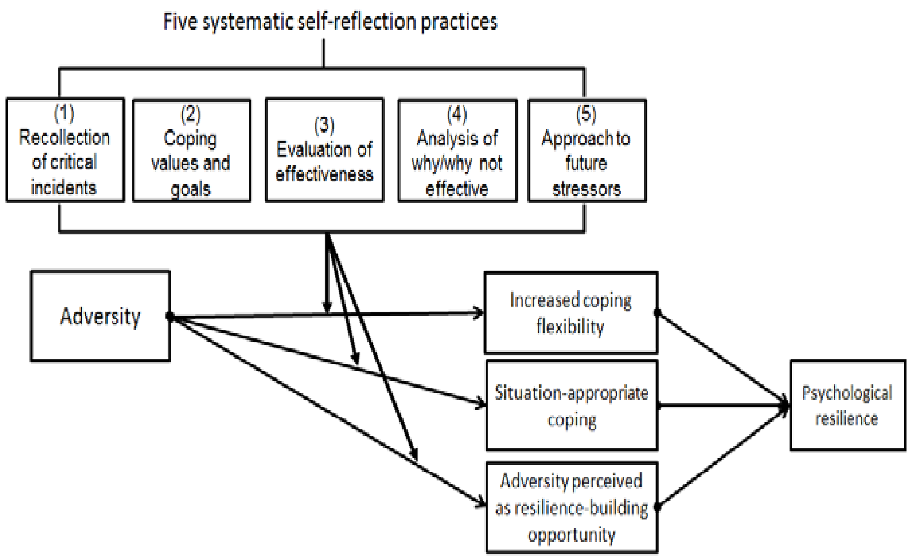

Figure 1. Resilience support process. Adapted from "A Commentary: Rethinking approaches to Resilience and Mental Health Training," by M. Crane and D. Boga, 2017, *Journal of Military & Veterans' Health, 25*(1).

Major U.S. hurricanes, named Sandy and Katrina, provide some clear examples of the differences in coping mechanisms and abilities between resilience trained professional responders and the non-resilience trained local volunteers who supported the civilian populace. PTSD tended to be higher in those responders who had little or no pre-event training (Rosen, Miller, Hughes & Remington, 2015). When pre-event training is insufficient, or not completed, then some form of postevent training will be required to support workers who were not prepared for the traumatic events they encountered.

As with the pre-event training, there is no perfect postevent PTSD solution for a particular profession, subgroup profession of people, or even an individual (Robertson, Cooper, Sarkar, & Curran, 2015; Taylor et al., 2003). The APA describes a few possibilities for postevent support: staying abreast of latest PTSD support breakthroughs/methods; peer support; and seeking professional psychiatric help (Parekh, 2017). Another study found that postevent trauma symptoms can disappear and then reappear years or even decades later, increasing the understanding that post traumatic residual stress is an important diagnosis to study (Boe, Holgersen, & Holen, 2010).

Application of Stress Theory to Aviation

The aviation industry is no different than other professions with regard to coping with stressors and significant events. Additionally, as with other professions, there are certain sub-groups within each profession that are more likely to experience significant stressors or an extremely stressful situation. In aviation (civil or military), typical sub-groups might include air traffic controllers, airport first responders, cabin flight crew, and pilots (Britt & Long, 2016; Čekanová, Miženková, Fábry & Rozenberg, 2016; Leonhardt

& Vogt, 2016; Spinehoven & Verschuur, 2006). Due to the hundreds of variables they must face, the criticality of their decisions, and the required timeliness of those decisions, pilots, in particular, are very likely to experience some variation of a significant inflight event within their careers.

The data displayed in Table 1 was synthesized from a European study trying to increase airline safety with respect to pilot errors. The researchers culled European aircraft accidents and presented the top causes of fatal aircraft accidents, describing nearly 90% of the fatal aircraft incidents that have happened in Europe between 1995 and 2011, over millions of flight hours (Stroeve, Van Doorn, & Cahill, 2016). The events in the table represent a significant portion of the trauma-inducing events which can plague a pilot, assuming they survive the emergency. While many of the events can be successfully managed by the pilot and crew with no impact to life or equipment, every single event has the potential to be catastrophic. Notably, the events can also combine during the flight event, making things even more stressful for the pilots. For example, an engine fire might occur which is significant enough by itself, but then perhaps the pilots have to deal with icing and terrain as they attempt to return safely. In this case, the Table 1 percentages would then go from 18% of all accidents, to a combined value of 30% of recorded accidents.

Pilots are charged with all aspects of safety of their aircraft from engine start to engine shutdown. They must make sure the plane is correctly loaded weight-wise, they must safely taxi, takeoff, and land in all kinds of weather, and they must monitor complex aircraft system and correctly respond to an emergency. All of this must be done with several hundred lives at stake on the plane and as many more on the ground. To provide tools for the pilots cope with threats they may encounter such as those described in Table 1, there are some pre-event training methods which can be used as well as postevent coping methods.

Table 1

Top Fatal Producing Aircraft Accidents – What Pilots Can Experience.

Incident Type	Frequency %	Methods to Reduce Severity Pre-event
Engine Failures in Flight	18.0	Simulator, Safety Training, CRM
Landing Emergencies	12.6	" "
Unstable Landings	10.2	" "
Terrain Impact	8.2	" "
Runway Incursion Errors	7.0	" "
Inflight Collisions	6.0	" "
Avionics Failures	5.8	" "
Takeoff Emergencies	5.0	" "
Pilot Medical Crisis	4.4	" "
Flight Control Failures	4.4	" "
Wing Icing	3.8	" "

Pre-event Stress Training for Pilots

Mentioned earlier was Lazarus's concept of providing tools to a person in order to reduce the impact of the stressor on the person during the event and after the event (Lazarus, 2013). For pilots there are various methods of preparing for the stressful or emergency events they are likely to encounter because the events are not infinite in scope. Table 1 lists likely emergencies a pilot could experience. The third column shows that in nearly every case there are three main ways to provide pre-event tools (coping methods) to the pilot to reduce the stress of the incident real time: flight simulators, safety training, and CRM training.

Studies have focused on focusing attention (mindfulness-based training) as a successful method to reduce anxiety and stress through attention management (Meland, Fonne, Wagstaff & Pensgaard, 2015). Attention management is really just practicing, through repetition, to ignore data inputs that are distractions and focus on critical events. Pilots operate just as other professions do in critical situations, as shown in the Challenge and Threat concept (Vine et al., 2015). Under this concept, if a pilot has enough tools to cope with the critical situation, then the situation will be seen as a challenge, if not then the situation is seen as a threat. Postevent effects on the pilot can be different for each possibility.

Hohmann and Orlick (2014) conducted a study of Canadian military pilots on what skills they relied upon to safely execute their missions. They noted that when the pilots were engaged (mentally) in preparing to fly they were focused on "being in the moment," not distracted by outside factors, had studied flight materials, mentally practiced procedures, and visualized potential significant events they might encounter. When they were not engaged their performance lacked. Simulators, safety training, and CRM training reinforce methods to safety execute emergency procedures by reviewing previous incidents (safety) and using all available team resources (CRM) to safely and successfully handle a significant inflight event before it occurs (Table 1).

Postevent Stress Training for Pilots

As with most professions, the primary processes for support, postevent, are the diagnosis of the stress and treatment methods proscribed. In the military, the U.S. Army's Aeromedical Research Laboratory (USAARL) conducted an analysis of the different military services' requirements to re-clear a pilot back to operational flying once diagnosed with PTSD-type symptoms. The USAARL found that the military services were similar and that most had a waiting period of six months to one year of no PTSD-like symptoms prior to re-clearance to fly (Britt & Long, 2016). Similarly, the U.S. Air Force Research Laboratory (AFRL) did an analysis of the Air Force's PTSD procedures for aircrews. The AFRL report discusses a need for better PTSD protocols, but more importantly, the report describes symptoms less than PTSD outlined out of the DSM-V (APA, 2017), which it calls Acute Stress Disorder (ASD) and Trauma and Stressor Related Disorders for pilots (Heaton & Wood, 2015). The distinction that there are diagnoses that are less than full-blown PTSD for pilots is central to this study. Disorders like ASD are difficult to encapsulate clearly and there is virtually no research on the manner in which lower levels of traumatic stress affects pilots.

Analysis of Residual Stress Levels in Pilots

While the available literature and existing training for residual stress among pilots seems to focus on preparing for or treating high levels of stress pre-event as during the event, there no research on measuring the actual residual stress levels of the pilots after they experience an inflight emergency (see Table 1 for typical life-threatening inflight emergencies). The postevent literature and treatment seems to focus only on the higher levels of postevent stress, and seem to lump treatment under generalized PTSD treatment methods. Not all levels of stress postevent may trigger PTSD diagnosis and treatment, there may be levels of residual stress that are enough to impact a pilot's life and career but not reach PTSD protocols.

An example of postevent residual stress is depicted in the 2016 motion picture *Sully*, which recounts the real-life events of the successful 2009 ditching of U.S. Air Flight 1549 in the Hudson River after striking a flock of Canada geese. The pilot is portrayed in his hotel room reliving the events over and over in his mind. He imagines himself crashing into buildings, people dying, and second guessing his performance from the ditching. The pilot recounts his post traumatic stress many times in his memoir (Sullenberger & Zaslow, 2009; Vine et al., 2015). Despite the fact that 155 passengers and crew on the plane lived (NTSB, 2016), but he is clearly reacting to levels of residual stress. Many variables can contribute to predicting the level of residual stress a pilot may encounter following a significant inflight event.

Key Variable Literature Review.

Residual Stress Level. The lone dependent variable in this study is the level of residual stress a pilot identifies with after they have experienced a severe inflight emergency (examples in Table 1). Discussed earlier in this chapter was the progression of stress as a physical concept to a physiological one over the 20th century and how with DSM-III in early 1980s the social sciences fully embraced postevent traumatic stress. Most professions have adopted some manner of pre and postevent training to assist their workers in managing this residual stress, and expectedly the professions with the highest likelihood of experiencing stress tend to lead the way: first responders, medical, and military.

The aviation industry has acknowledged residual stress in their training and developed numerous pre-event training tools for pilots and ground personnel (e.g., safety training and CRM). However, little attention has been focused on postevent analysis and support mechanisms other than established medical diagnoses. This is potentially due to the view that if the significant event was successfully resolved, it could not have been traumatic or cause residual impacts; the alternative is that the event does not get successfully resolved and the pilots or crew are killed.

One of the leading support agencies for post traumatic stress is the Veterans Administration (VA), simply due to the fact of the sheer number of PTSD cases it handles. Mentioned earlier in the chapter, the PTSD division of the VA has 66 validated instruments available for measuring PTSD levels, including the IES-R, which will be used in this study. Discussed more in depth in Chapter 3, the IES-R has been examined for reliability and validity many times and translated into numerous languages due to its ability to detect residual stress levels in patients (Ashbaugh, Houle-Johnson, Herbert, El-Hage & Brunet, 2016; Beck et al., 2008; Choi, Kim, Jang, Bae & Kim, 2017; VA, 2017; Vilija & Lina, 2016).

The independent variable scoring will come from the IES-R (see Appendix A) via 22 questions rating residual stress levels from a significant inflight event the respondents recollect on. The rating scale for the IES-R ranges from 0 to 88: 24 or more indicates PTSD concerns; 33 or more PTSD probable; and 37 and higher severe PTSD enough to cause immune system issues (Choi, Daeho, Eun, Hwalip & Seck, 2017; Christianson & Marren, 2013; VA, 2017).

Age. A person's reaction initial and continued capability to correctly and speedily act or react to critical action situations can be affected by age. Zimmerman and Iwanski (2014) studied a group (*N* = 1305) of males and females and measured emotional responses for sadness, fear, anger, and joy based on age grouping from young adolescent (age 11) to middle age (age 50) using the Negative Emotion Regulation Inventory (NERI). Their study showed that while there is some variations with regard to emotional control within the age groups, in general as a person ages there tends to be more emotional control (or using their term regulation), but also a higher tendency to internalize emotional responses, not seek peer or social assistance, and more reliance on avoidance strategies. Germaine to this study and the independent variable of age would be that older pilots would tend to internalize traumatic events, not seek social support opportunities, and my want to avoid recalling the event or discussing it.

In another study, a group of police officers (*N* = 967) were sampled and their levels of PTSD were compared to their age and gender (Van der Meer et al., 2017). The researchers used two well-accepted instruments for their analysis, the Structured Interview for PTSD (SI-PTSD) and the Clinician-Administered PTSD Scale (CAPS) to measure the levels of traumatic stress. The study showed that age had a positive effect on traumatic effects, meaning older participants seemed to cope better than younger participants when exposed to some traumatic event. These studies clearly identified that age is a variable worth controlling for when examining postevent stress in sample subjects.

Gender. This study will collect data on the independent variable of gender in the sample to examine if there is a different level of reaction, given the interaction of all the other independent variables, between male and females respondents. Two of the studies identified in the analysis of the age dependent variable showed that gender affects traumatic stress levels. Zimmerman and Iwanski (2014) showed that females had wider variations than males with regard to the four emotional responses surveyed. Van der Meer et al. (2014) found clear distinctions in the traumatic stress levels of women versus men in their survey, with women retaining higher stress than men. There is a vast amount of gender related studies having to do with interactions with levels of traumatic stress. The most recent studies target high-risk professions such as first responders and military, especially because the military started allowing women to serve in combat roles. Every study showed significance variations in stress levels based on gender, making gender an essential independent variable in this study (Hourani, Williams, Bray, & Kandel, 2015; Levine & Land, 2014; Villamor, 2014).

Crew Resource Management (CRM) Trained. One of the hallmark training programs within the aviation profession is CRM. CRM is risk management for pilots. Rudimentary forms of CRM had been around for years in the airline industry, but was formalized into a trainable and accepted concept in the aviation world by programs started by United Airlines in the 1981 due to an increase in pilot related incidents and accidents (Griffith, Roberts & Wakeham, 2015; Ornato & Peberdy, 2014). While CRM has evolved significantly over nearly forty years, the guiding principles remain the same: to reduce the errors committed by aircrew members due to interactions with others.

While it is difficult to conduct studies pre and postevent to examine whether CRM can affect the traumatic stress levels in a pilot, the core concept of CRM is providing emotional tools to a pilot to reduce stress during an event (Wagner, 2017). CRM has become a staple of the aviation industry and many other professions, especially medicine, have taken note of the successes and now use CRM principles for managing high-stress, high-risk operations. Medical teams and trauma teams use the identically named CRM for training their teams to cope with stress and reduce human errors (Haerkers, Kox, Noe, Van Der Hoeven, Pickkers, 2017; Siems, Cartron, Watson, McCarter, & Levin, 2017). The independent variable of whether a pilot has completed CRM training is essential to examining the impact of a traumatic event on a pilot, because without CRM the pilot is limited to emotional tools they can use to reduce stress during a significant event.

Instructor Rated. There are different levels of FAA issued pilot licenses (FAA, 2017). A person can rated as a recreational pilot, private pilot, commercial pilot, or airline transport pilot. A separate license can be issued if the pilot has passed examinations to be a certified flight instructor (CFI) (FAA, 2017). In most professions, the title of instructor is given to a person who has excelled at his or her job, or has had more training than standard and is then recognized as an expert. The person likely has met standards for teaching others, for example the state licensing requirements to be a K-12 teacher.

While there are no studies that show an instructor can process traumatic stress better than a non-instructor, the concept that a pilot who is an instructor will have has more flight experience and more training and therefore could possibly approach the stressful inflight situations differently than a new pilot. The independent variable of whether an a pilot is rated as an instructor is included in this study to gauge the effect the extra training and status might have on residual stress.

Experience Level in Job. For aviators, experience in the job can be measured in two ways: total flight hours and total years of flying. In terms of total flight hours of experience, a person can be a FAA licensed pilot in as few as 40 flight hours (FAA, 2017). In contrast, a senior airline pilot over a career can accumulate over 25,000 flight hours, or the equivalent of nearly 3 years of time in the air without ever landing. With respect to total years of flying experience, a FAA private pilot license (PPL) can be attained in approximately 6 months or less, whereas a career airline pilot may have flown over 40 years, or more (FAA, 2017). The current FAA mandate allows scheduled airline (FAA Code of Federal Regulations (CFR) Part 121) pilots to fly to 65 years of age, and if the pilot is not flying passengers for an airline there are very little age restrictions as long as they can meet medical standards. FAA medical clearances are good for a minimum of 6 months and a maximum of 5 years depending on class of the medical examination and FAA pilot license issued (Brown, 2014; FAA, 2017).

There are no aviation studies showing a correlation between flight experience and stress coping. However, in a similar high-stress potential professions, such as the medical field, there have been some relationships shown between qualification levels and stress management levels, with higher levels of qualification tending to provide more capability to withstand stressors (Trousselard et al., 2016). This could correlate to more experience in pilots yields more likelihood they can handle stress. A pilot who has a lot of flight time or years of flying experience is likely to have more experience which can give them more capability to withstand residual stress because they have more time flying, more time practicing emergencies in flight simulators, and perhaps have already experienced the anomaly inflight. Collection of pilot experiences in hours and years of flying will provide valuable insight into the coping levels of pilots who have experienced a significant stress event.

Civilian and Military Experience. Data will be collected on the level of experience the pilot has with civilian flying, meaning under the purview and certification of the FAA for licensure. The majority of respondents are expected to have a significant amount of civilian experience as compared to military experience based on the sheer numbers of certificated pilots in the U.S., 584,000, compared to military pilots, such as the U.S. Air Force, 13,000. (FAA, 2017; U.S. Air Force, 2016). There are not any particular studies that show a difference in the capabilities of civil versus military pilots in term of flying abilities, but there is a significant difference in the types of flying the two categories do, and the requirements levied on the pilots for continuation-type training (safety, CRM, etc.).

As mentioned above, there is a difference between the way civilian and military pilots fly, both in terms of missions and in terms of mandatory ground and flight training. While the number of pilots is smaller, a significant number of professional civil pilots come from the U.S. military's many aviation branches. Generally, military pilots do not fly more than 20 years because this is the earliest point at which they can fully retire with pension from the military. Pilots who stay in the military longer than 20 years are usually of high rank and do not fly very much, if at all.

Safety Trained. Similar to the instructor trained and CRM trained independent variables is whether or not the pilot has had some form of formal safety training. The civil aviation world is moving to a new standard called the Safety Management System (SMS) which is being proposed by the International Civil Aviation Organization (ICAO). The U.S. civil flying organizations are going to eventually be mandated to adopt SMS through the FAA advisory circular (AC) AC-120-92A (FAA-2017); military departments in the DoD are estimated to be between 40-65% compliant, but are working toward adopting SMS as well (Ostrowski, Valha, & Ostrowski, 2014). SMS targets four areas for safety standardization training: 1) Safety policy; 2) Risk management; 3) Safety assurance; and 4) Safety programs; all in an effort to standardize training to enhance predictive indicators of an impending safety issue, in other words pre-event safety training (Ostrowski, Valha, & Ostrowski, 2014).

As with CRM training discussed earlier, if a pilot has undergone some formal standardized safety training, there are indications that CRM and safety training provide more tools for a pilot to successfully respond to a significant inflight event and potentially reduce postevent stress. Because of the continued focus on CRM and safety over the last 50+ years, world-wide aviation accidents have declined by 800% for every 100,000 flight hours (ICAO, 2011). Determining whether a pilot has safety training is an important data point for analysis for this study to examine how the variable interacts with the residual stress dependent variable.

Summary and Conclusions

Clear literature paths exist for the development of stress in the social and biomedical sciences, as well as the integration of residual stress within certain professions. The aviation profession has concerned itself primarily with presignificant event training as a way to increase the likelihood of a pilot or crew bringing a significant inflight event to successful conclusion. This training has included rote memorization of emergency procedures, intense simulator sessions, and various types of classroom instruction for events such as crew resource management and advanced instrument procedures. There is little, to no, direct research on pilots which have experienced an inflight event that was severe enough to trigger residual stress. This research provides a platform for more discussion of residual stress in the aviation community. Chapter 3 includes a review of the research design, sample size, instrument selection, and data collection methods.

Chapter 3: Research Method

Introduction

Chapter 2 included a review of the applicable literature existing with regard to the issues surrounding stress in the aviation community and that there is a knowledge gap in attention given to postsignificant event stress on pilots. Given that there is a need to examine this gap within the aviation profession, in Chapter 3 addresses the rationale for the sampling method based on the uniqueness of the population set, the procedures for collecting the data, the instrumentation used for the survey, and the analysis methods used to answer the research question and hypotheses.

Research Design and Rationale

Variables. There were 10 variables used in this study, one dependent and nine independent. The single dependent variable is of the ratio-type, measuring the residual stress level of the participant based on their recall of a significant inflight event in their flying career. This variable was collected via the IES-R instrument. This dependent variable will have a range of 0 to 88 depending on the severity of the residual stress selfidentified by the respondents, calculated by the IES-R itself (Feuerherd, Knuth, Muehlan, & Schmidt, 2014; Weiss, 2007; Weiss & Marmar, 1997).

There are nine independent variables. The first variable is of a ratio-type and the age of the respondent, and will have an expected range of 15 to 85 representing the minimum age for a FAA pilot and the maximum expected age, based on life expectancy. The binary-type categorical independent variables of gender, whether the pilot has had CRM training, whether they are instructor rated, and whether they have been safety trained will also be collected. Total flight time, in years, is another ratio-type independent variable to be collected which will have an expected range of 40 to 35,000. Total years of flying is a similar independent ratio-type variable with an expected range of 0.5 to 70. Finally, total military and civilian years of flying experience are also collected. These last two ratio-type independent variables have the ranges of 0 to 30 and 0 to 70, respectively.

Design v. Research Questions. The research question for this study is:

RQ1: What correlation exists between a pilot's personal and professional qualifications and the severity of their residual stress levels, post event?

In order to answer this question, the most effective research design would be a quantitative study of the population using a cross-sectional survey methodology research design for collecting the data. Using statistical analysis tools such as MLR and ANOVA, the relationships between the independent and dependent variables can be made with some level of confidence about the predictability of the influence of the nine independent variables upon the dependent variable. The only time constraints levied on the collection of data from the sample of the population is that the survey window for responses will only be open for 60 days.

A quantitative MLR study is well designed to answer both the research question and the research/null hypotheses. A quantitative study is designed to be used with strong statistical analysis of respondent data to look for correlations between variables and estimate strength of that correlation to create a repeatable survey but also so that the analysis can then be generalized to the larger population. The method of population sampling, called snowball or nonprobability sampling, is necessary due to the sensitivity of the aviation profession. The pilot population is hard to reach because there is not a unique method to reach all possible combinations of military and civilian aviators due to the unique privacy and security concerns. While the results of the study potentially cannot be directly generalized to the U.S. pilot population because of the nonprobability methodology, all processes and procedures will be followed to see what relationships exist in the study sample with the intent that, if there are significant relationships are discovered, further research can be directed, perhaps with FAA support and access to their pilot databases.

Population

The target population is certificated civilian or military pilots in the U.S. There are approximately 584,000 licensed civilian pilots in the U.S. (FAA, 2017). The primary aviation-related military branch, the U.S. Air Force, has approximately 13,000 pilots, or about 25% of its officer corps (U.S. Air Force, 2016). No public records exist for pilot estimates for the other military branches, but conservative researcher estimates put the total pilot population in the U.S. (civil and military) at 625,000. Inclusion criteria for this study will be FAA certificated civilian pilots or rated military pilots. The pilots do not have to be actively flying or medically qualified to be on flight status. There are no specific exclusion criteria for this study.

Sampling and Sampling Procedures

Sampling Method. Probability sampling research designs ensure each person in a population has an equal chance of being in the potential sample as another person in the population. This method is required for valid statistical generalizations of the sample to the larger population. The problem with the population set in this study, certificated U.S. pilots, is that there are only two ways to get access to names and contact information for the population: through the FAA database for civilian pilots and through the Department of Defense for the military pilots. While not impossible, there would be a significant amount of time expended in seeking permissions, and no guarantee they would even be approved. Extra institutional review boards (IRB) boards, editorial control, and possibly restricted release of results from these organizations would likely ensue. Additionally, post-9/11 there is more control and oversight of pilot data. Therefore another method of sampling is required.

Nonprobability sampling has uses when a population is known, but difficult to access for various reasons in order to create a sample set (Baker et al., 2013; Waters, 2015). The uniqueness of the pilot population, combined with possible oversight and restrictions placed on it by regulatory agencies or military departments makes make the use of nonprobability sampling methods such more efficient to this research study. The key concept of snowball nonprobability sampling is that it involves the researcher distributing the research instrument to known members of the population set with the direction that they are, in turn, to pass the instrument on to other potential sample members within the population (see Figure 2).

Snowball sampling, initially, was not an accepted method of collecting data on sample sets of populations by either quantitative or qualitative researchers (Baker et al., 2013; Waters, 2015). This was due to the basic premise that it was nonrandom and therefore of no use statistically because the results of the study could not be generalized to the larger population set. This theory ignored the usefulness of the method. There can still be useful statistical analysis done on the sample which can still contribute to the scientific knowledge base.

Goodman (1961) ran a statistical analysis of snowball sampling showing that it was an effective method, given its inherent assumption limits/biases. Atkinson and Flint (2001) describe some of these biases when using snowball sampling:

- Representativeness of sample: concerns that the sample will get corrupted with respondents that should not be in the sample, or do not meet the inclusion and exclusion criteria
- Beginning the chain referral: concerns that the researcher must begin the chain of the research and create bias
- Suspicion of respondents: concerns the contact by the researcher could create wariness on the part of the respondents and affect the quality of their responses

Despite the complaints of purist researchers on snowball sampling, it is a tool that is getting more use by qualitative and quantitative researchers (Atkinson and Flint, 2001; Baker et al., 2013; Waters, 2015). Their only other alternative is to not conduct the research. As Goodman (1961) mentioned in his statistical review of snowball sampling, the data is still there from the sample and worthy of analysis.

There is minimal concern for corrupting the sample data with erroneous values as this study is asking for respondents to forward to other potential respondent based on an unequivocal standard of being a certificated pilot. The study is not seeking opinions or personal values, but only other respondents with a nationally standardized professional qualification.

Sampling Procedures. In order to begin the exponential non-discriminative snowball sampling process, 20 email invites were sent to pilots to visit the commercial website and complete the survey. The 20 people will be recorded and kept in private research notes and verified by one other person that they meet the inclusion criteria. There will be no way to track them in the survey process, or even if they complete the survey. The email will ask them to forward this email to five of their associates who are pilots of either a civil or a military background. The email will ask to continue to forward with a termination date of forwarding the email of X + 60 days (X being IRB approval date). Survey Monkey® will also have a similar termination date for data extraction. The survey will continue collecting data past the sample size goal (*N* = 150), if the goal is reached early and also past the data extraction date for future research possibilities (see Chapter 5).

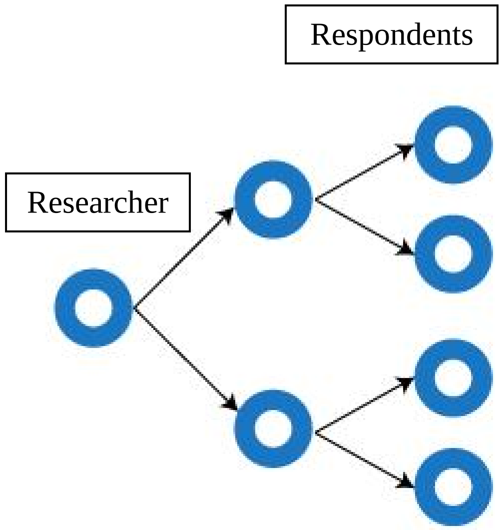

Figure 2. Exponential nondiscriminative snowball sampling process. Adapted from "Snowball Sampling," by B.R. Devkota, 2017, Mathstopia.

Power Analysis. Effect size, error probability, statistical power, and sample size are all interrelated in regression analysis. Knowing three of the variables allows a computation of the fourth variable. The assumptions for this study are: a recommended effect size (Cohen's f^2) of 0.15, an Alpha (α) error probability of 0.05, a power (β) of 0.20 (yielding a 1 – β = 0.80), and nine predictor (*k*) variables (Faul, Erdfelder, Lang & Buchner, 2007; Field, 2013). Using the University of Dusseldorf's G* Power 3.1.7 analysis software program (Faul, Erdfelder, Buchner, & Lang, 2007; 2009), and based on a target population of approximately 625,000 civilian and military pilots in the U.S., a sample size $N = 114$ was computed (see Figure 3 for F_{crit} plot with $df = 10$ for the sample size). However, the greater the *n* value, the better chance of finding effects in the sample applicable to the population and less chance of Type I and II errors, so the goal will be a

N = 150, which represents a 25% expansion of the sample size. Larger sample sizes will also assist in the correlation when non-random sample methods are used (Atkinson & Flint, 2001; Waters, 2015).

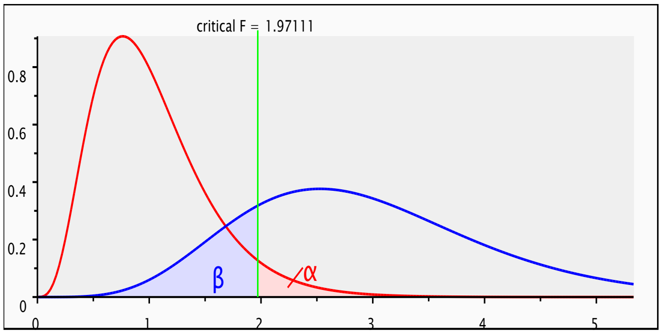

Figure 3. Power plot from G*3 Power. Adapted from,“ Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses,”by F. Faul, E. Erdfedler, A. Lang, and A. Buchner, 2007, *Behavior Research Methods, 41(4).*

Procedures for Recruitment, Participation, and Data Collection

Recruiting and Data Collection Methodology. I will start the survey by passing emails to 10 prospective pilots and then using snowball distribution methods the survey will be continually forwarded by respondents to other sample members. Each potential respondent will all be invited to visit the web survey and follows the instructions for completing the survey. There will be instruction on the website that there will not be any chances for follow up questions because the survey is completely anonymous.

Data will be collected via Survey Monkey®, which is a web-based engine built specifically for conducting survey research (see Appendix B for approval). The 31 questions for this survey will be built into the survey engine and include an informed consent banner. A research assistant will verify the settings in Survey Monkey® and ensure the 22 IES-R questions and possible answers are transcribed verbatim into the survey engine's software. The survey will ask respondents to not duplicate the survey if they have previously taken it, but to ensure anonymous status of the survey there will not be any tracking of the respondents.

This study complies with Walden University's policies and procedures for IRB oversight (Walden University Center for Research Quality, 2017), with appropriate U.S. Code on IRB's (Title 45), as well as recommended standards from the American Association for Public Opinion Research (AAPOR). AAPOR (2017) recommends for anonymous web surveys that a welcome screen at the beginning of the survey address respondent privacy concerns and provide informed consent, which is assumed on an anonymous online survey once the respondent has passed the consent screen verbiage.

Instrumentation and Operationalization Constructs

Instrument Developer. The instrument used for this study is the IES-R released in 1997 (Weiss & Marmar, 1997). The IES-R is an improved version of the Impact of Event Scale which is based on the pioneering work of Horowitz (Horowitz, Wilner & Alverez, 1979). In the late 1970s PTSD was becoming widely accepted as a diagnosis and Horowitz's theories that PTSD stemmed from a person's inability to reconcile a traumatic event was evident by displays of intrusion, or the replaying of images or events that occurred, and avoidance, which meant staying away from similar situations which may remind the person of the traumatic event.

Horowitz's IES had 16 questions for use in determining the level of traumatic stress in a patient, but did not match the wording and concepts in the APA's DSM-III as PTSD was a relatively new diagnosis at the time. DSM-III was released in 1980 (APA, 2017). By the time DSM-IV was released in 1994, Weiss has updated the IES to the IES-R which added 6 questions to address physiological arousal in PTSD patients, and the IES-R became a valuable instrument for diagnosing post traumatic stress (Beck et al., 2008). The IES-R has been thoroughly tested and validated, translated into numerous languages, and currently supports the 2013 version of the DSM-V (APA, 2017). Studies have shown that it has positive psychometric value, and can be a useful instrument in differentiating patients with and without levels of traumatic stress (Beck et al., 2008; Hyer & Brown, 2008).

Previous Instrument Use/Reliability and Validity. The IES-R is in current use in the mental health professions. A snapshot analysis of the National Institutes of Health (NIH) clinical trials website showed that there were nearly 50 ongoing mental health studies using or referencing the IES-R (NIH, 2017). The bulk of the available literature on the IES-R points out that, while the instrument is not a perfect method of diagnosing post traumatic stress, it is a useful tool for defining persons with or without some form of traumatic stress.

Beck et al. (2008) conducted one of the most recent and thorough analyses of the IES-R. They prescreened, then interviewed 182 people who had been in serious car accidents who self-identified that they were experiencing some sort of mental trauma from their accidents. The researchers administered not only the IES-R to them, but also the original IES and six other methods of traumatic stress surveys (e.g., Beck Depression Inventory and the Clinician Administered PTSD Scale (CAPS)). Their research showed that the IES-R was reliable with Cronbach's $\alpha = .95$ and all sub-sections were valid ($p < .05$). The IES-R was as strong, or stronger, than the other models, except for one (the Marlowe-Crown Social Desirability Scale), for diagnosing post traumatic stress (Beck et al., 2008).

The IES-R has been translated into many other languages for use in other countries, where researchers from those countries conducted research trials on the applicability of the IES-R. The Japanese version was reviewed for reliability and validity by Asukai et al. (2002). The researchers surveyed four groups who had experienced very traumatic events in Japan (e.g., sarin attack and major earthquake). The result was that the IES-R was a rated a significant tool for determining PTSD. Likewise, the Korean IES-R version was tested against 254 patients, some diagnosed with PTSD and some part of a control group (Lim et al., 2009). The researchers also used many of the same existing PTSD diagnostic surveys as the Beck group, including the Beck Depression Inventory and the CAPS. Once again, the IES-R was shown to be significant. Cronbach's $\alpha =.93$ and significant validity correlation between the IES-R and CAPS ($F = 139$, $p < .001$). Similar results can be found in the French version (Brunet, 2003), the Chinese version (Wu, 2003), and a newer Sri Lankan version (Miyazaki et al., 2006). The IES-R is recommended for use by the U.S. Department of Veterans Affairs on their National Center for PTSD website (VA, 2017).

Appropriateness for Study. As a clearly accepted and validated instrument for determining traumatic stress levels, the IES-R is a good fit for use in this study. The IES-R is short while still being effective, meaning that its 22 questions combined with the nine independent/demographic variables asked keeps the survey to 31 questions maximum. This makes the survey less time-demanding for the respondent. Additionally, as the IES-R is unmodified, this study can rely on previous studies for supporting documentation relating to the effectiveness and validity of the IES-R. Permission for use of the IES-R was obtained from the developer, Dr. Daniel Weiss, from the University of California at San Francisco. Approval documentation is presented in Appendix C.

Operationalization of Variables/Variable Scoring.

There are 10 variables collected in this study from each respondent, consisting of one dependent variable and nine independent variables:

Independent Variable. The lone dependent variable for this research is the level of residual stress the pilots retained once they experienced a significant inflight emergency. Tied directly to the research question and hypothesis, this scalar dependent variable will be collected via the previously designed and currently administered Impact of Event Scale-Revised (IES-R) instrument. IES-R asks 22 questions with a five level Likert scale for each question (ranging from zero to four points per question) with the patient answering the level of stress he or she is experiencing or has experienced following a significant event in their life. The expected range of this dependent ratio variable after tabulating the results of the 22 questions is 0 to 88. See Appendix A for the IES-R example, and Table 2 for example scoring.

Table 2

Example IES-R Question/Scoring.

Question: When thinking about a significant inflight event you experienced, please address the following comment:

Any reminder brought back feelings about it?

Answer	IES-RPoints	SPSS® Score	SPSS® Code
Not at all	0	0	iesr_1
A little bit	1	1	
Moderately	2	2	
Quite a bit	3	3	
Extremely	4	4	

Dependent Variables: There are nine independent variables used in this study, see Table 3 for a scoring methodology summary. Each one was selected to give maximum review of potential factors which can impact a pilot's performance. Age: The independent ratio variable of age with the expected range of 15 to 85 was collected. The lower boundary of the range was set based on the earliest a civil pilot can be certificated and the upper data boundary of 85 for years is figured on an expected lifespan of 85 years; Gender: The independent variable of gender of the pilots was collected for data analysis to see if there is a different level of reaction, given the interaction of all the other independent variables, between male and females respondents. Data collection for this study on this independent binary variable will have the range of male or female. CRM trained: The independent variable of CRM trained was collected for data analysis. Expected range of this independent binary variable is yes, or no.

Instructor Rated: The independent binary variable of instructor trained was collected with an expected range of yes or no; Experience Level in Job: For this study, the independent variables of total flight time and total years of flying experience was collected. Both are ratio independent variables. Expected range for total hours will be 40 to 36,000 and expected range for years of flying experience will be 0.5 to 70. The lower range of 40 is based on the minimum hours required by the FAA to be certificated. The upper range for hours is based on a civilian pilot flying from age 22 to age 65, at 70 hours a month (usual pilot contractual minimum). The upper data boundary of 70 for years is figured based on the earliest age a civil pilot can be licensed which is 15 years old and an expected lifespan of 85 years old;

Civilian Experience: The ratio independent variable with the expected range in years of flying of 0 to 70 was also collected for analysis. The upper data boundary of 70 is figured based on the earliest age a civil pilot can be licensed which is 15 years old and an expected lifespan of 85 years old. Additionally, there will be several respondents who will have a mixture of both civil and military flying experience; Military Experience: The nominal independent variable of military experience was collected and had the expected range in years of 0 to 30; Safety Trained: Similar to the instructor trained and CRM trained independent variables is whether or not the pilot has had some formal safety training. Data collection of this binary independent variable had the expected binary range of yes or no.

Table 3

Independent Variable Scoring Summary.

Variable	Measure	Range	SPSS® Code	SPSS® Score
Age	Years	15 - 85	age	Ratio #
Gender	Male; Female	n/a	gender	0 = M; 1 = F
CRM Trng	Yes; No	n/a	crm	0 = Y; 1 = N
Instructor Exp	Yes; No	n/a	instr	0 = Y; 1 = N
Exp Hours	Hours	40 - 35000	exphrs	Ratio #
Exp Years	Years	15 - 85	expyrs	Ratio #
Civ Exp	Years	15 - 75	civexp	Ratio #
Mil Exp	Years	0 - 30	milexp	Ratio #
Safety Exp	Yes; No	n/a	safexp	0 = Y; 1 = N

Data Analysis Software. Data will be analyzed using the IBM® Statistical Package for the Social Sciences (SPSS®), version 24. Survey Monkey® has direct SPSS® integration and the cases for each respondent can be delivered in numerous formats for SPSS® to analyze. There is minimal, if any, hand coding. However, before SPSS® analysis is run, the data will be cleaned and verified by using two-person integrity looking for errors in the database such as missing or corrupted case variable cells.

Research Question and Hypothesis. The research question posed by this study and associated research/null hypotheses are:

RQ1: What correlation exists between a pilot's personal and professional qualifications and the severity of their residual stress levels, post event?

H_1 (Research): There are significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

H_0 (Null): There are not any significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

In order to answer the research question and validate the null hypothesis, this study is looking for the relationships between the dependent variable and the nine independent variables. Ideally, the analyses of the relationships will yield information on the power of predicting the independent variable's value (e.g., pilots with high flight hours are less likely to experience residual stress). Table 4 shows the 10 variables in this study and their types. Since this study statistically analyzed a dependent variable that is continuous against all continuous or binary categorical independent variables, the best choice for regression analysis is MLR.

Table 4

Variable Types.

	Dep Variable	Independent Variables	Variable Type	Variable Sub Type
Residual Stress	X		Continuous	Ratio
Age		X	Continuous	Ratio
Gender		X	Categorical	Binary
CRM Trng		X	Categorical	Binary
Instructor Exp		X	Categorical	Binary
Exp Hours		X	Continuous	Ratio
Exp hours		X	Continuous	Ratio
Civ Exp		X	Continuous	Ratio
Mil Exp		X	Continuous	Ratio
Safety Exp		X	Categorical	Binary

Interpretation of Results. Once the data was transferred from Survey Monkey® either in Microsoft Excel® format, it was cleaned and screened to look for visual errors. Once confirmed error free, and coded properly, it was run though basic analysis routines in SPSS® (descriptive statistics) to verify percentages are correct, such as gender adding u[to 100% of total cases. This is another check for the homogeneity of the data (Field, 2013). Once the cases appear correctly coded and representative, SPSS® histograms were run looking for correlations and distributions of the dependent versus independent variables. Normal distribution checked with histogram plots are a required assumption for using MLR. A Pearson's correlation analysis that is set for two-tailed significance to look for linearity, is another assumption when using MLR. A coefficient greater than 0.05 indicated a significant correlation exists (Field, 2013).

If the data appears to be supportive of running the MLR (no outlier data points), SPSS® will run then full variable sets and present the data for interpretation. SPSS® also reviews the model summary looking for R^2 values which describe the percentage of variation on the dependent variable by the selected independent variables. An ANOVA was run showing the significance values for whether the independent variables can predict the dependent variable with a $p < 0.05$. The completed MLR yielded an equation describing the relationships between the variables.

Threats to Validity and Inherent Bias

External Validity Threats. Frankfort-Nachmias and Nachmias (2008) point out that one of the primary tenements to external validity in a survey method of study is ensuring a representative sample. As mentioned earlier the target population of pilots in the U.S. is approximately 625,000. The G*3 Power analysis software recommended a minimum sample size of 114 but the research goal will be 150. The uniqueness of the method of accessing the sample set, through non-random snowball sampling, creates a small threat to external validity in that there is a possibility that a non-pilot could inadvertently or intentionally access the survey and complete it. Discussed earlier is the fact that access to a named database was unlikely without government direction and oversight due to security issues, so this study was less concerned with generalization than with correlation and predictability of the variables as well as identification of the residual stress as an issue for the aviation community.

Internal Validity Threats. The research design that most closely approaches perfect internal validity is an experimental design where there are control groups and the researcher can manipulate settings and variables. As these scientific-type research designs are not always possible, the cross sectional or survey-type research design uses statistical analysis to compensate for, and explain relationships between, applicable variables (Frankfort-Nachmias & Nachmias, 2008). This statistical analysis combined with random sampling, or in the case of this study non-random snowball sampling, is the basis for the internal validity of this study. As with external validity, the weakest point of this study is the method of access to the sample. The variables and collection method are backed up by the literature and used consistently in the social sciences. One method that is recommended for snowball sampling to reduce bias, is to increase the sample size (Atkinson & Flint, 2001), which has been done for this study. The recommended sample size for effect was N = 114, but the goal was N = 150, a 25% increase in cases.

Statistical Validity Threats. Controlling the two types of statistical validity errors, Type I and II, is critical to the success of the study. Type I errors occur when the research reaches positive conclusions about the correlation of variables when none exists and Type II errors occur when the research concludes there are no correlations when actually there are correlations present. In order to minimize Type I errors this study used the accepted alpha ($\alpha = 0.05$) that provides increased power, meaning 95% of the time if there are effects in the sample, the null will be rejected (Field, 2013). For Type II errors, the accepted power (β) is 0.20, or 80% of the time an effect will be detected in the sample, calculated as $1 - \beta$ (Field, 2013).

Field (2013) also discussed some key assumptions in regression models which must be addressed to ensure the statistical model is valid and importantly that the resultant equation fully accounts for all cases and is therefore generalizable to the larger population set. The variables must be linearly related to one another, otherwise the data cannot be plotted and therefore an equation explaining their relation cannot be developed. The outliers of the independent variables need to be homoscedastic and normally distributed, if not then again the equation for the regression cannot be validated. Finally, the variables need to be continuous or categorical with only two categories (such as male or female), the independent variables must vary more than zero, and not vary perfectly with another independent variable (multicollinearity).

As described in the operationalizing of variables section above, the independent variables were selected both as discriminating but also meaningful variables, in other words, they are descriptive in the profession of aviation to what a pilot can expect to encounter on a daily basis. The independent variables were also selected to provide enough differences in the respondent's answers to begin to fill out the plot lines in the linear regression model and thereby contribute to the development of the explanatory slope equation.

Ethical and Privacy Procedures

Agreements for Access/Human Treatment Issues. There were no requirements for sample access for this study. All the pilots surveyed were surveyed as private citizens with the commonality that they were trained pilots, independent of their current or former employers. The pilots were contacted via other pilots for the survey in accordance with the snowball method of data collection, and no attempt was made to collect pilots from any particular source or background. There was no direct involvement with human sample subjects for this study.

Ethical/HIPAA Concerns. There were not any concerns for ethical violations for this research plan. The targeted sample was not identified by names, physical or audio recordings, or personal communications with the researcher. Data was collected via the research website Survey Monkey®, administering 22 questions defining the dependent variable level of stress of the individual and nine questions defining the demographic and professional independent variables. There was no way to identify subjects participating in the research, therefore the Health Insurance Portability and Accountability Act of 1996 (HIPAA) will not apply to this study.

Privacy Concerns. Privacy concerns for the subjects were assumed to be their major concerns. As discussed earlier, and a major reason for using snowball sampling for this research at this stage, was that pilots in the aviation career field are notoriously private and careful on what kinds of information they voluntarily divulge. This is primarily because of a fear that any detrimental or perceived detrimental information could have impacts on continued clearance to conduct flying operations based on company procedures as well as future FAA medical clearances. Prior to the subjects filling out the survey there was clear banners that this research had passed a Walden University Institutional Review Board (IRB), that the data collected was controlled, and that there was no personally identifiable data collected which could identify an individual. Walden University's IRB approval number was 08-02-17-0014621. The survey was completely anonymous; no personally identifiable data of any sort was collected. Additionally, Survey Monkey® allows for the ability to turn off internet protocol (IP address) tracking which was also made known to the respondents.

Data was collected and stored on Survey Monkey's® website. The website has provisions for direct downloads supported by the SPSS® software package. Data was also downloaded in PDF file format and used for cross-comparison and validation of the data tables SPSS® used for the linear regression analysis. Data was backed up on an independent and encrypted hard-disk drive per Walden University's IRB procedures.

Summary

This chapter described the research methodology that was used in this study which examined the effects of a traumatic inflight event experienced by a pilot when compared to their professional and demographic variables. Based on the research question and hypotheses, a cross-sectional survey and a quantitative method based multiple linear regress best fit the study. Due to the sensitivities of the aviation profession and pilots in particular, the research design was further refined to use non-random snowball sampling as the method for collecting data. Sample data was collected via a commercial website and used a well-known and peer-approved traumatic stress instrument, the IES-R, for dependent variable measurement.

How the data was collected as well as a detailed statistical analysis will be presented in Chapter 4, including an answer to the research question. Chapter 5 includes further analysis of the data, applicability to social change possibilities, as well as future study recommendations.

Chapter 4: Results

Introduction

Purpose. The purpose of this quantitative study was to conduct a survey of U.S. pilots who have experienced a significant inflight emergency and attempt to correlate their levels of stress against their personal and professional qualifications in an effort to predict expected future stress levels. This would aid governmental entities and aviation researchers in their efforts to develop appropriate pre-event training and provide pilots with better coping mechanisms to handle stress.

Research Question and Hypotheses.

RQ1: What correlation exists between a pilot's personal and professional qualifications and the severity of their residual stress levels, postsignificant event?

H_0 (Null): There were not any significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

H_1 (Research): There were significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

Data Collection

Time Frame for Collection. The timeframe established for the data collection was 60 days from Walden University's IRB approval date. At the 30 day point, 55 surveys had been completed online; at the 45 day point 95 surveys had been completed; and at the 60 day closeout point 105 surveys had been completed. Survey completion rate averaged 1.75 surveys per day.

Discrepancies Noted. The research goal for the study was to accumulate 150 survey responses for data analysis, with 114 responses being the targeted goal based on statistical power analysis. It was apparent at the 45 day mark that the survey response rate was decreasing at a rate that the research goal and power analysis goal might not be met. At the 60 day mark, 105 surveys had been attempted online, however four of those surveys were incomplete and had to be discarded, therefore the survey completion window closed with 101(*N*) surveys fully completed and validated.

Basic Descriptive Statistics Compared to Population. Of the 101 surveys returned, with a completion rate of 96%, the data shows a sample that was 95% male and 5% female; 98% with civil experience and 60% military experience. The most useful comparison to the pilot population in the U.S. would be the ratio of military to civilian pilots. The presample estimate was 584,000 civilian pilots (93.5% of total U.S. pilots) in the U.S. and 41,000 military pilots (estimated at 41,000, or 6.5% of the total U.S. pilot population) (FAA, 2017; U.S. Air Force, 2016). The slight skew towards military could be due to the initial snowball sampling respondents selected as their pass-on subjects. The data shows that the sample population was primarily civil aviation pilots, with 6 out of 10 pilots also having some military flight experience.

Univariate Analysis. Assuming that the general population of pilots is flying without a significant stress level from a particular inflight emergency, an IES-R score of zero was tested against the sample set to see if the results of the survey were significant. With an Alpha of .05, a one sample *t*-test was conducted and the sample set showed itself to be significantly different from the baseline score of zero, at $t(100) = 7.29$, $p < .001$.

The 95% confidence interval for the IES-R score was 2.33 to 4.07, with an effect size of .72, which is considered large. The results indicate the mean IES-R stress score was significant within the sample, when compared to a general population score of zero. Assumptions required and validated for this test to be valid were: (a) the test variable (stress level) was normally distributed; and (b) The cases were collected via a randomized sample. See Figure 4 for distribution of the IES-R score across the sample set.

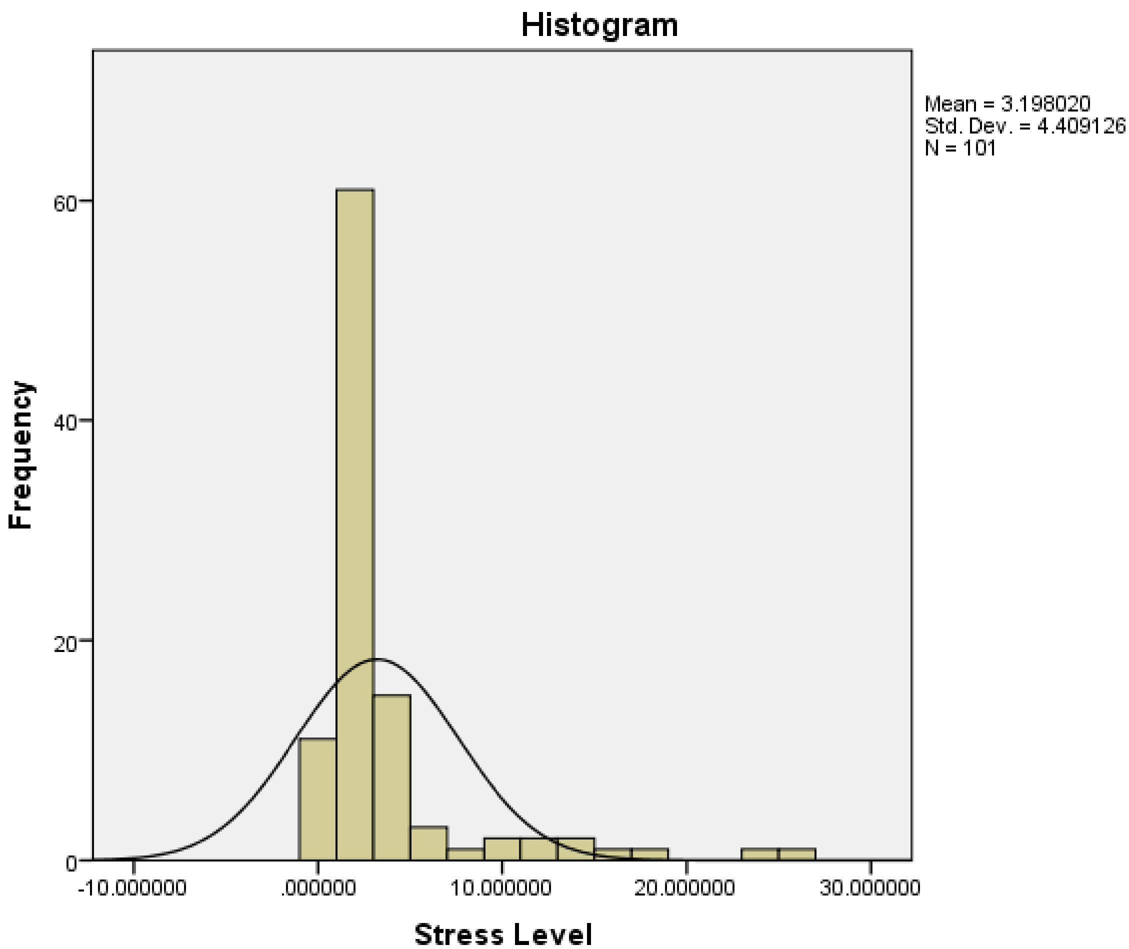

Figure 4. IES-R stress score across sample set. Adapted from data output from IBM's Statistical Package for the Social Sciences (SPSS®), 2017.

The next univariate analysis which was completed against the sample set was looking for relationships on the predicatbility of each variable against one another using bivariate correlation analysis, see Table 4 for results. The analysis showed some significant predictions between the variables at the $p < .05$ and $p < .001$ levels (all bold-faced cells). Specifically, the age variable was able to predict whether a pilot had completed CRM training, and to a lesser degree safety training and, as expected, the age of a pilot was able to predict the total flight hours, whether the pilot was instructor rated, total flight years, as well as total civilian and military flight years. The variable of stress does not show a strong correlation ,by itself, except to military flight years.

These correlations are important because they show that the data on the variables collected mirror what could be expected in real life, and help to validate the use of the variables in the study. In other words, as with any profession, as a person ages within that profession they are likely to increase their experience and training levels. Combined with the normal distribtion (Figure 4) and significant variance in the means of the independent variable stress (IES-R), the data appears to represent the population well. The sample set also behaves rationally amonst the variables when independently analyzed. Progessing to MLR was therefore warranted. MLR uses all of the variables in an attempt to answer the research question of whether the 9 independent variables (see Table 3) can correlate and then predict the level of the dependent variable of stress. There were no covariates identified during literature research for inclusion in this study.

Table 5

Bivariate Correlations

Variables	*Age*	Gender	CRM Trng	Instr Rated	Tot Flt Hrs	Tot Fly Yrs	Civ Fly Yrs	Mil Fly Yrs	Safety Trng	Stress Lvl
Age	-	.320	**.000**	**.007**	**.000**	**.000**	**.000**	**.000**	**.014**	.458
Gender	.320	-	.803	.452	.871	.273	.268	.445	.891	.177
CRM	**.000**	.803	-	**.026**	**.000**	**.000**	**.000**	**.000**	**.000**	.642
Inst Rated	**.007**	.452	**.026**	-	.158	**.003**	**.002**	**.013**	**.005**	.710
Tot Flt Hrs	**.000**	.871	**.000**	.158	-	**.000**	**.000**	.074	**.002**	.761
Tot Fly Yrs	**.000**	.273	**.000**	**.003**	**.000**	-	**.000**	**.000**	**.002**	.391
Civ Fly Yrs	**.000**	.268	**.000**	**.002**	**.000**	**.000**	-	**.038**	**.019**	.402
Mil Fly Yrs	**.000**	.445	**.000**	**.013**	.074	**.000**	**.038**	-	**.000**	**.000**
Safety Trng	**.014**	.290	**.000**	**.005**	**.002**	**.002**	**.019**	**.000**	-	.462
Stress Lvl	.458	.177	.642	.719	.761	.402	.402	**.000**	.462	-

BOLD = significant correlation at p<.05 or p<.001 levels

Statistical Results

Descriptive Statistics for Sample.

The sample set (*N* = 101) had an independent variable, from the IES-R stress scale, with a range of 25 (0 to 25), *M* = 2.00, *SD* = 4.41. The IES-R scale ranges from 0 to 88, with a score over 24 being clinically important, and a score over 33 indicating PTSD (with any number above 37 indicating a PTSD significant enough to affect the immune system). Table 6 shows that the majority of the sample respondents had an IES-R score of 2.0, and slightly over 81% of the sample reported a stress level of three or less. Only 14 respondents out of 101 had stress scores greater than four.

Table 6

Age IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (IV)	*n*	%	Cum %
0	11	10.9	10.9
1	22	21.8	32.7
2	39	38.6	71.3
3	10	9.9	81.2
4	5	5.0	86.1
5	2	2.0	88.1
6	1	1.0	89.1
8	1	1.0	90.1
9	1	1.0	91.1
10	1	1.0	92.1
11	1	1.0	93.1
12	1	1.0	94.1
13	1	1.0	95.0
14	1	1.0	96.0
15	1	1.0	97.0
17	1	1.0	98.0
23	1	1.0	99.0
25	1	1.0	100.0

The sample set (*N* = 101) had an age range of 42 (23 to 65 years of age), *M* = 44.60, *SD* = 11.03. The mode for the age range was 44. See Table 6 for a breakdown of the independent variable of IES-R stress level versus the dependent variable of reported pilot age. Notable data dispersion reflected in Table 7 for age would be that while the median age was 42, for the bulk of scores in lower IES-R stress ranges seemed to be fairly even distributed over the age ranges of the entire sample set, 23 to 65, which had positive impacts for meeting the assumptions for conducting statistical ANOVA and for the MLR correlations.

Table 7

Age IV Descriptives v. Pilot Age.

IES-R Stress Level (DV)	*n*	Mean	SD	Min	Max
0	11	40.82	10.21	28	60
1	22	42.09	10.54	23	62
2	39	46.28	10.80	29	63
3	10	45.00	14.77	24	65
4	5	47.80	14.15	24	62
5	2	41.00	15.56	30	52
6	1	55.00		55	55
8	1	46.00		46	46
9	1	47.00		47	47
10	1	46.00		46	46
11	1	28.00		28	28
12	1	50.00		50	50
13	1	53.00		53	53
14	1	47.00		47	47
15	1	35.00		35	35
17	1	50.00		50	50
23	1	59.00		59	59
25	1	38.00		38	38

The sample set (*N* =101) contained 96 (95%) males and 5 (5%) females. Dispersion analysis (Table 8) revealed that the while most of the sample is male, the majority of the respondent females' scores fell into the region where most if the male respondents existed.

Table 8

Gender IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Male	Female
0	11	11	0
1	22	21	1
2	39	37	2
3	10	10	0
4	5	5	0
5	2	2	0
6	1	1	0
8	1	1	0
9	1	1	0
10	1	0	1
11	1	1	0
12	1	1	0
13	1	1	0
14	1	0	1
15	1	1	0
17	1	1	0
23	1	1	0
25	1	1	0

The sample set (*N* =101) contained 76 (75.2%) pilots that had CRM training and 25 (24.8%) that did not. As Table 9 shows, the dispersion analysis demonstrates that the largest quantity of responses fell within the 2.0 to 4.0 range on the IES-R scale. This indicates that the pilot did have specialized crew resource management training to assist in managing real-time stressors. Tight dispersions such as this, while showing good sample homogeneity, limit the impact the variable may have on the correlation of the independent and dependent variables.

Table 9

CRM IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*N*	Yes	No
0	11	7	4
1	22	17	5
2	39	31	8
3	10	7	3
4	5	4	1
5	2	1	1
6	1	1	0
8	1	0	1
9	1	0	1
10	1	1	0
11	1	1	0
12	1	1	0
13	1	1	0
14	1	1	0
15	1	0	1
17	1	1	0
23	1	1	0
25	1	1	0

The sample set (*N* =101) contained 65 (64.4%) pilots that were instructor pilot rated, 35 (34.7%) that were not, and 1(1%) unsure. The dispersion analysis in Table 10 showed that the pilots who reported whether they were either military or civil instructors were grouped in the lower scores on the IES-R stress scale. The tight grouping of scores and tends to minimize the impact that a variable might have on predicting stress levels when correlating with MLR.

Table 10

Instructor IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Yes	No	Unsure
0	11	5	6	0
1	22	12	10	0
2	39	31	8	0
3	10	7	3	0
4	5	2	3	0
5	2	1	1	0
6	1	0	0	1
8	1	1	0	0
9	1	0	1	0
10	1	1	0	0
11	1	0	1	0
12	1	0	1	0
13	1	1	0	0
14	1	0	1	0
15	1	1	0	0
17	1	1	0	0
23	1	1	0	0
25	1	1	0	0

The sample set (*N* =101) contained a range of flying hours reported of 22060 (240 to 22300) total flying hours, M = 6906, SD = 5948, and the mode of 3400. Table 11's dispersion analysis of total flying hours compared to reported stress levels indicated that there was good grouping of lower stress levels with flight ranges that approximated the overall range well, so the data appeared normally distributed. The large range of flight hours is attributable to new civilian pilots at the low end, to professional airline pilots at the high end, which indicated a sample that had multiple levels of pilots within it.

Table 11

TOT Hours IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Mean	SD	Min	Max
0	11	4038.73	2135.24	1200	7900
1	22	7520.45	6321.88	256	21500
2	39	7587.44	6333.29	450	22300
3	10	6128.40	5971.49	350	21300
4	5	10268.00	7935.81	240	20000
5	2	4000.00	707.11	3500	4500
6	1	4000.00		4000	4000
8	1	10500.00		10500	10500
9	1	5678.00		5678	5678
10	1	2700.00		2700	2700
11	1	840.00		840	840
12	1	2600.00		2600	2600
13	1	3500.00		3500	3500
14	1	22000.00		22000	22000
15	1	3450.00		3450	3450
17	1	6500.00		6500	6500
23	1	5500.00		5500	5500
25	1	3800.00		3800	3800

The sample set (*N* =101) contained a range of flying years reported of 37 (3 to 40) total flying years, M = 19.28, SD = 8.5, and the mode of 12 (see Table 12); the sample set (*N* =101) also contained a range of civilian flying years reported of 40 (0 to 40) total flying years, M = 17.71, SD = 8.9, and the mode of 12 (see Table 13); and finally the sample set (*N* =101) contained a range of military flying years reported of 40 (0 to 40) total flying years, M = 6.43, SD = 6.5, and the mode of 0 (see Table 14). As with Table 10's dispersion analysis, the analysis of the total flying years, total civilian years and military flying years all showed good grouping of the stress level over the range of years of experience reported. All three variables indicated good distribution over their respected years of experience ranges.

Table 12

TOT Years IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Mean	SD	Min	Max
0	11	15.09	7.56	8	30
1	22	17.73	7.56	3	32
2	39	20.64	8.63	7	40
3	10	17.90	10.43	4	34
4	5	23.20	10.04	6	30
5	2	21.00	12.73	12	30
6	1	24.00		24	24
8	1	23.00		23	23
9	1	20.00		20	20
10	1	13.00		13	13
11	1	15.00		15	15
12	1	14.00		14	14
13	1	37.00		37	37
14	1	28.00		28	28
15	1	12.00		12	12
17	1	27.00		27	27
23	1	22.00		22	22
25	1	14.00		14	14

Table 13

CIV Years IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Mean	SD	Min	Max
0	11	15.09	7.56	8	30
1	22	17.73	7.56	3	32
2	39	19.56	8.56	7	40
3	10	15.90	11.62	0	34
4	5	17.20	10.43	6	30
5	2	21.00	12.73	12	30
6	1	7.00		7	7
8	1	23.00		23	23
9	1	10.00		10	10
10	1	10.00		10	10
11	1	15.00		15	15
12	1	5.00		5	5
13	1	37.00		37	37
14	1	22.00		22	22
15	1	12.00		12	12
17	1	27.00		27	27
23	1	.00		0	0
25	1	15.00		15	15

Table 14

MIL Years IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*n*	Mean	*SD*	Min	Max
0	11	3.09	4.30	0	9
1	22	4.41	4.04	0	12
2	39	5.90	5.33	0	20
3	10	7.30	7.45	0	22
4	5	12.20	9.34	0	23
5	2	5.00	7.07	0	10
6	1	23.00		23	23
8	1	.00		0	0
9	1	10.00		10	10
10	1	13.00		13	13
11	1	.00		0	0
12	1	11.00		11	11
13	1	20.00		20	20
14	1	6.00		6	6
15	1	.00		0	0
17	1	25.00		25	25
23	1	22.00		22	22
25	1	14.00		14	14

The final independent variable was whether the pilots in the sample set had safety training, see Table 15. The sample set (*N* =101) contained 83 (82.2%) pilots that were safety trained, and 18 (17.8%) that were not. While over 82% responded they did have safety training, the dispersion showed that the IES-R stress scores in the lower numbers regions (1 to 4) had the bulk of the responses with yes, which indicates good tightness of data, but may not be a strong MLR correlation indicator when stand-alone analysis is conducted.

Table 15

Safety IV Descriptives v. IES-R DV Scores.

IES-R Stress Level (DV)	*N*	Yes	No
0	11	6	5
1	22	18	4
2	39	33	6
3	10	10	0
4	5	5	0
5	2	1	1
6	1	1	0
8	1	1	0
9	1	0	1
10	1	1	0
11	1	1	0
12	1	1	0
13	1	1	0
14	1	1	0
15	1	0	1
17	1	1	0
23	1	1	0
25	1	1	0

Statistical Assumptions. The descriptive analysis (frequencies, means, distributions, and dispersions) of the independent and dependent variables in the sample set indicate that they matched the literature for inclusion in the survey because they would provide useful data for analysis. In order for the correlation analysis to be conducted on the data sample, using multiple linear regression (MLR), there are four critical assumptions which must be met for the correlations to be valid. These assumptions are linearity, homoscedasticity, independence, and normality (Field, 2013).

Linearity of the independent and dependent variables is a requirement assumption for a MLR analysis. Linearity refers to the slopes generated by the variables independently and after the MLR is conducted to ensure the data can be used to generate a predicted slope (through a fit line and an equation) to be able to predict the overall MLR equation (Field, 2013). In most cases the linear slope of the variables resulted in a positive sloping fit line, except for CRM Training, Instructor Training, TOT Flight Hours, and Safety Trained (see Table 16). Linearity was shown across the variables and the statistical assumption requirement for MLR was met.

Table 16

IV Slope Plot for Linearity.

IV	Slope	Linearity Slope
Age	Y = 1.87+0.03*X	Positive
Gender	Y = 0.33+2.74*X	Positive
CRM Trained	Y = 3.79-0.48*X	Negative
Instructor	Y = 3.65-0.33*X	Negative
TOT Flight Hrs	Y = 3.35-2.27e-5*X	Negative
TOT Flight Yrs	Y = 2.34+0.04*X	Positive
CIV Flight Yrs	Y = 3.94-0.04*X	Negative
MIL Flight Yrs	Y = 1.51+0.26*X	Positive
Safety Trained	Y = 4.2-0.85*X	Negative

Homoscedasticity in a MLR refers to the variances in the ranges of the residuals, when plotted, to make sure the ranges (above and below a fit line) are equal or close to each other (Field, 2013). During the univariate/bivariate analysis, box plots were analyzed to ensure that the ranges for each variable showed a proportional range, and the box representing the range appeared symmetrical in shape, indicating variance symmetry and confirming the MLR statistical assumption requirement.

Independence in a MLR refers to the ability to take two observations of data and the residuals (distance the variable is positively or negatively from the line of best fit in a

MLR solution) should be uncorrelated (Field, 2013). The Durbin-Watson test is used to check for independence of residuals, and usually has a range of 0 to 4, with 1.5 to 2.5 being considered normal. A Durbin-Watson test was run on the sample data set with a result of 1.533, indicating the data was independent and meeting the MLR statistical assumption requirement.

Normality in a MLR reflects the distribution of the residuals between the observed data variables and the MLR model equation (Field, 2013). The residual plots need to be as close to zero as possible. For all nine independent variables, regression standardized residual plots were examined and in all cases the residual plot showed tight grouping at the (0,0) coordinates, indicating normality in residual distribution and that this MLR statistical assumption requirement was met.

Statistical Analysis v. Research Questions. The univariate analysis, statistical descriptives, and MLR assumptions all indicated the collected independent and depend variable data met the requirements to proceed to regression analysis. The research question and hypotheses were:

RQ1: What correlation exists between a pilot's personal and professional qualifications and the severity of their residual stress levels, postsignificant event?

H_0 (Null): There are not any significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

H_1 (Research): There are significant predictor variables between a pilot's personal and professional qualifications and the level of the pilot's residual stress.

A multiple linear regression was conducted to evaluate the predictive level of a pilot's personal and professional characteristics on a pilot's residual stress level after they encountered a severe inflight emergency. The linear combination of personal and professional characteristics was significantly related to residual stress levels, R^2= .22, adjusted R^2=.14, $F(9, 91) = 2.8$, $p < .01$. The sample's correlation coefficient was .47, indicating that approximately 22% of the variance in the residual stress was accounted for by the nine independent variables. See Table 17 for relevant strengths of the variables. The null hypothesis is therefore rejected and the research hypothesis is accepted, indicating there is significant correlation between the dependent variable of residual stress and the independent variable which reflect a pilot's personal and professional characteristics.

The resultant multiple linear regression equation (using standardized coefficients) was: y = .16(Age) + .1 (Gender) + .17 (CRM Trained) +.02 (Instructor) - .01 (TOT Flight Hrs) +.41 (TOT Flight Yrs) - .32 (CIV Flight Yrs) + .42 (MIL Flight Yrs) - .01 (Safety Trained).

Table 17

Bivariate and Partial Correlations of Independent Variables (IV).

IV	Correlation	% of DV Variation	Correlation v. Other IVs	Sig
Age	.075	.51	-.077	.463
Gender	.135	1.8	.110	.292
CRM Trained	-.047	.22	.131	.210
Instructor	-.037	.12	.019	.859
TOT Flight Hrs	-.031	.01	-.011	.916
TOT Flight Yrs	.086	.74	.145	.166
CIV Flight Yrs	-.084	.71	-.158	.130
MIL Flight Yrs	.388	15.5	.311	**.002***
Safety Trained	-.074	.55	-.008	.942

*** = *p* < .05**

Additional Statistical Analysis. To further illustrate the combining effects of the independent variables (personal and professional characteristics) on the dependent variable (residual stress level) a second analysis using multiple linear regression was run in a case-wise profile. The results indicated that as each variable is added to the linear equation, the predictability of the outcome dependent variable residuals increases and the correlation power of the equation becomes stronger, see Table 18.

Table 18

Case-Wise Analyses of IVs v. Linear Regression Predictability.

IV	Cumulative Correlation (R^2) to DV	Cumulative % of DV Variation
Age	.006	.6
+ Gender	.026	2.6
+ CRM Trained	.026	2.6
+ Instructor	.026	2.6
+ TOT Flight Hrs	.038	3.8
+ TOT Flight Yrs	.044	4.4
+ CIV Flight Yrs	.134	13.4
+ MIL Flight Yrs	.219	21.9
+ Safety Trained	.220	22.0

Summary

The purpose of this study was to identify predictive (independent) variables which could affect the level of stress a pilot might experience after a severe inflight emergency. 101 surveys were returned over a 60 day period collecting 31 data points per sample case, 3131 individual pieces of data. The analysis on the data cases showed that the variables were, as the literature showed, useful predictors or at least affected the level of stress a pilot might experience after an emergency. Using multiple linear regression statistical analysis, the data showed that 22% of the time the variation in stress levels among the 101 cases was attributable to the 9 independent variables examined. This rejected the null hypothesis and answered the research question, that in fact there is correlation between qualities and qualifications a pilot might have and the resultant stress level they may have postsignificant event. This chapter discussed the statistical data analysis in-depth, Chapter 5 will review the study with recommendations for further study and application of the results to the aviation community.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

This chapter reviews the study on a more general level and expands the data analysis to the application level to the aviation profession and the benefits to society. The purpose of this study was to answer the research question of whether there are predictor variables for pilots in the aviation profession which could affect the level of stress the pilots might have once they encountered some form of stressful event in flight, such as an engine fire. After conducting an exhaustive literature review and comparing other professions, the predictor variables of age, gender, crew resource management training, total flight hours, total flight years, civilian flight years, military flight years, and safety training were selected as the nine independent variables to represent the personal and professional characteristics of the pilots within the study. I analyzed these variables against the lone dependent variable of residual stress, scored on the IES-R scale, which has a range of 0 to 88. 101 surveys where returned over a 60 day period yielding 3300 pieces of data.

Interpretation of Findings

The study showed that the nine predictor variables selected did indeed have an impact on the level of stress as reported by the pilots. Correlated together, the nine variables showed that they could explain variances in the level of stress of a pilot 22% of the time. While not a high correlation percentage, the study did two things: (a) the results validated the research hypothesis and answered the research question in that there are personal and professional characteristics of pilots which can affect the level of stress they encounter; and (b) the study showed that pilots who experience significant events are just like workers in other professions with high risk or life and death decisions; they will retain stress and therefore more attention needs to be paid to pre and postevent training to help them.

Stress Theory Framework Application. This study contributes to the knowledge base of stress theory as the theory applies to work professions. The literature review traced the lineage of stress theory back to the biological beginnings in the work of Selye (1946) and Cannon (1935), and the adaptions of the theory by Lazarus (2013) and Folkman (2013). The literature review showed how stress theory has been used in professions such as first responders, military, and the medical field to increase awareness of how stress can affect job performance pre-event. To prepare for the job stressors, these professions create training programs to mimic the eventual stress and give the workers more tools on how they can defend against harmful stressors. The aviation profession is no different, and as the literature showed, the profession had led the way in pre-event stress training for decades, influencing profession such as the medical career field to develop crew resource training for emergency rooms much like the same training used in airlines and military air professions.

This study increases awareness of postevent stress levels on pilots. Many professions seem to have studies on postevent stress levels, as compared to little analysis on postevent stress levels of pilots in aviation. This study showed that there are pilots in the profession’s population set that have experienced an inflight emergency or event of some significance to generate, at the minimum, some low levels of stress on the pilot.

This stress level could be as small as non-routine memories, to something the pilot thought about quite often. While the stress levels on the IES-R PTSD scale were low on a scale of 0 to 88 (with a mean of 2.0), the fact that 101 pilots returned surveys and 89.1% (90 out of 101) of the pilots indicted some level of stress, should warrant further study within the profession.

Limitations of Study

Generalizability of Results. The study noted in earlier chapters that using non-probability snowball sampling method of the selected sample set from the pilot population was needed to access the population set for various reasons: reluctance of pilots to discuss medical issues for fear of losing flight status; the security issues with getting access to civilian and certainly military address and rating, and the sheer size of the group in general. Snowball sampling, while becoming more accepted as a technique, also does not meet the strict requirements for pure random selection of a population. While this sample method compromises the way the data can be truly generalized to the overall pilot population, the study's goal was not only generalization, but to identify that residual stress is an issue in the aviation community.

Validity and Reliability. Frankfort-Nachmias and Nachmias (2008) described statistical methods which can be implemented to control Type I and II errors. Type I errors to statistical validity are when an effect or correlation is detected when one does not exist. This study used an Alpha of .05 to control for Type I errors, meaning that 95% of the time the null hypothesis would be rejected if there was a correlation detected. The significance for the correlation during the regression analysis of this study was significant at .005, well under the target setting. Type II errors occur when the research does not find a correlation when one actually exists. The study used a Beta, or power, or .8 to calculate the size of the sample set and was set at 114 for statistical purposes. For this study, 89% of the targeted sample size from the population was achieved, with 101 surveys completed

External validity, the representation of the sample to the population set, for this study was excellent. The goal was to reach pilots, and due to the snowball sampling method, the surveys were only given to pilots who met that basic criterion. To control for internal validity, or repeatability of tests/results, a detailed literature review was conducted to ensure that the independent variables used in this study could be supported by peer-reviewed research for inclusion in the study and the dependent variable was determined using a standardized stress measurement instrument routinely used in the psychology field.

Recommendations

Lessons Learned. Some clear lessons for improvements on this study and applicable to future studies were learned. First, the application of stress theory was clearly evident in the sample, but the design of the IES-R instrument is a rather specifically tuned scale for measuring residual stress. The IES-R scale ranges from 0 to 88, with anything over 24 being clinically important and anything over 33 as indicating PTSD (above 37 is PTSD significant enough to affect the immune system). The scale seems appears to be too large based on the responses to this study, as they ranged from 0 to 25, with the majority of the values falling between 0 and 4 (86%). A scale with more fidelity would be more effective for the types of questions asked. The scale is also designed to be given to a person within 7 days of a stressful event, although the literature did show that it still had some strengths and usefulness beyond that point (Beck et al., 2008; Hyer & Brown, 2008). A scale more tailored to aviation and less susceptible to postevent time constraints would be a better tool for analyzing stress levels, perhaps given better fidelity to stress scores. A larger range of scores would increase the effectiveness of the regression analysis because it gives the equation more distribution of scores to base the analysis and prediction of residual upon.

The second lesson learned was that there was limited ability to assure mixed gender responses with the survey method used (nonprobability snowball sampling). In this study, there were five female responses out of 101 surveys returned. For a study to be truly representative, a better cross-section of the population set for gender would be important. Industry or governmental support of a future project would enhance the accessibility to gender and increase the representative cross-section of the sample to the populace.

A third lesson learned was that the data collection method, snowball sampling, is not a very efficient method of ensuring a significant return rate. This method of sampling requires and initial seeding of surveys by the researcher to known sample participant or participants within the population. While this method is very effective for reaching and surveying hard to reach populations, as the research literature showed (Baker et al., 2013; Waters, 2015), the practical application within this study showed a lower than expected return rate. The statistical goal was 114 respondents and the research goal was 150 respondents. Over a 60 day period, the study averaged 1.75 survey returned per day, but when examined from a macro level, the bulk of the survey where retuned in the first two weeks and then over a one week period four weeks later when reminders were re-sent. The researcher, by using this collection and sampling method, is at the mercy of the sample participants for continued return and forwarding of the survey in order to reach participants.

With aviation profession support, either through governmental entities, non-profits, or even aviation industry corporations, a more traditional survey methodology might increase the return rates which will strengthen the data analysis and resultant findings. This would require access to personal databases within organizations like the FAA where pilot licenses are maintained, or perhaps organizations where pilots are members such as the Aircraft Owners and Pilots Association (AOPA).

A final lesson learned for this study would be a recommendation to include some aspects of qualitative investigation to go along with the quantitative methodology. As with most stressful events, there is a personal level of a PTSD-like event that needs to be captured. While professional qualifications, demographic data, and stress levels are easy to quantify and correlate, there is a significant amount of back story that could assist industry leaders and researchers in future efforts to develop training and tools to help pilots manage variations in stress levels. Using a mixed method approach for methodology would provide a quantitative source for data analysis, while preserving and rounding out the personal story side of the respondent to more clearly understand the nature of the stress the pilots are dealing with, and thereby increasing the likelihood of developing training or treatments to support the pilots both personally and professionally.

Recommendations for Further Study. Beyond the lessons-learned recommendations above which should increase the strength of future studies closely aligned with this study, there are two other recommendations for further study. The first recommendation is to expand the analysis of the types of CRM and Safety training currently being taught in both the civil and military pilot training programs. Much of the current training, as the literature review showed, is aimed at presignificant event training and the medical career field is left to handle the postsignificant event therapy or treatment. The training should be reviewed and study to see if there are ways to adapt postevent stress training into the curriculum and see if that training can help aircrews deal with lower levels of stress. This study showed that 89% of respondents had some level of residual stress, so it would follow that some method of acknowledgement and training could assist these pilots.

Another recommendation would be to expand the scope of future studies to more than just pilots, but to all aircrew. The literature review did address some residual stressors on flight attendants after major crash incidents, but more examination of aircrew residual stress of a lower nature. If the pilots in this study indicated they had some residual stress, even at the lower levels shown, there still is an indication of stress and perhaps that stress would be evident in other aircrew positions. If so, the same attention should be paid to these aircrew members as is paid to the pilots. In the civil world, there are numerous flight attendants on each aircraft who have specific duties during emergencies and are training similar to pilots, and the military has many more crew positions on its various mission aircraft.

Implications

Positive Social Change Implications. This study has provided a window into the stress levels of a profession that is guarded of their medical clearances, which are necessary for continued employment. Pilots must undergo medical evaluations as early as every six months for an airline pilot, to every five years for a private pilot, depending on age and type of FAA license (FAA, 2017). Industry leaders and researchers as well as governmental agencies charged with flying safety could use the data gleaned in this study as an impetus to design and implement more in-depth studies. These studies could provide more information on stress levels in aviation which would allow for the design and implementation of more targets and effacement pre and postevent stressor training for aircrew. Most in-place training for pilots is approaching 30 to 40 years in age, such as CRM training, and could be fine-tuned with the latest PTSD training which is being developed for first-responders and the military.

Methodological Implications for Aviation Community. A significant positive outcome of this study was that pilots will respond to questions about their stress levels when proper safeguards for anonymity are in place. Like other professions, there is a risk that "self-identifying" can have negative impacts on future employment. This study's anonymous approach was able to glean some detailed information on pilots' personal and professional characteristics and their stress levels which no other literature reviewed was able to show. A properly authorized, financed, and supported future study could build on the data collected here and father increase the knowledge base in the aviation community which would only increase the safety of both aircrews and the traveling public.

Conclusion

This study was concerned with improving the safety of the aviation enterprise by examining residual stress in pilots after they had experienced an inflight anomaly or emergency of some nature. Aircrews successfully react to aircraft issues and equipment malfunctions every single day all over the world, and little fanfare is noted. When they do not successfully react to, or cannot react to an issue, the result is usually catastrophic and is newsworthy all around the world. This study surveyed 101 pilots who had experienced some issue inflight and 89% of them responded that they had some level of residual stress over the event. By reviewing nine personal and professional characteristics of the pilots versus their residual stress levels, the study showed that 22% of the time those characteristics could affect the outcome of the pilots' stress. This is important because this study can be used as a genesis to create postsignificant event training to assist these pilots in dealing with their stress, but also in that this study can help develop training to prepare the pilots **pre**significant event.

In any professional the goal is continuous process and training improvements to minimize risks and increase safety and efficiencies. In the professions where great responsibilities are placed on workers who must make decisions which can affect life and property, the training they receive is absolutely critical and must be continuously improved. The goal of this study was to increase awareness on issues with the pilot profession and add to the knowledge base so that leaders in the field and within government could make informed decisions for the betterment of the community and public.

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Appendix A: IES-R Example

IMPACT OF EVENT SCALE- REVISED

(Original, as provided by Dr. Daniel Weiss, 2 May 2017)

INSTRUCTIONS: Below is a list of difficulties people sometimes have after stressful life events. Please read each item, and then indicate how distressing each difficulty has been for you **DURING THE PAST SEVEN DAYS** with respect to______, which occurred on _____. How much were you distressed or bothered by these difficulties?

Not at all = 0	A little bit = 1	Moderately = 2	Quite a bit = 3	Extremely = 4

1. Any reminder brought back feelings about it.
2. I had trouble staying asleep.
3. Other things kept making me think about it.
4. I felt irritable and angry.
5. I avoided letting myself get upset when I thought about it or was reminded of it.
6. I thought about it when I didn't mean to.
7. I felt as if it hadn’t happened or wasn’t real.
8. I stayed away from reminders of it.
9. Pictures about it popped into my mind.
10. I was jumpy and easily startled.
11. I tried not to think about it.
12. I was aware that I still had a lot of feelings about it, but I didn't deal with them.
13. My feelings about it were kind of numb.
14. I found myself acting or feeling like I was back at that time.
15. I had trouble falling asleep.
16. I had waves of strong feelings about it.
17. I tried to remove it from my memory.
18. I had trouble concentrating.
19. Reminders of it caused me to have physical reactions, such as sweating, trouble breathing, nausea, or a pounding heart.
20. I had dreams about it.
21. I felt watchful and on-guard.
22. I tried not to talk about it.

The Intrusion subscale is the **MEAN** item response of items 1, 2, 3, 6, 9, 14, 16, 20. Thus, scores can range from 0 through 4.

The Avoidance subscale is the **MEAN** item response of items 5, 7, 8, 11, 12, 13, 17, 22. Thus, scores can range from 0 through 4.

The Hyperarousal subscale is the **MEAN** item response of items 4, 10, 15, 18, 19, 21. Thus, scores can range from 0 through 4.

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Weiss, D.S. & Marmar, C.R. (1997). The Impact of Event Scale-Revised. In J.P. Wilson, & T. M. Keane (Eds.), *Assessing Psychological Trauma and PTSD: A Practitioner's Handbook*. (pp. 399-411). New York: Guilford.

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Appendix B: Survey Monkey® Approval for Study

SurveyMonkey Inc.
www.surveymonkey.com

Re: Permission to Conduct Research Using SurveyMonkey®

To whom it may concern:

This letter is being produced in response to a request by a student at your institution who wishes to conduct a survey using SurveyMonkey® in order to support their research. The student has indicated that they require a letter from SurveyMonkey® granting them permission to do this. Please accept this letter as evidence of such permission. Students are permitted to conduct research via the SurveyMonkey® platform provided that they abide by our Terms of Use, a copy of which is available on our website.
SurveyMonkey® is a self-serve survey platform on which our users can, by themselves, create, deploy and analyze surveys through an online interface. We have users in many different industries who use surveys for many different purposes. One of our most common use cases is students and other types of researchers using our online tools to conduct academic research.
If you have any questions about this letter, please contact us through our Help Center at help.surveymonkey.com.

Sincerely,
SurveyMonkey® Inc.

Appendix C: IES-R Use Approval

Using the Impact of Event Scale-Revised (IES-R)

(Original, as provided by Dr. Daniel Weiss, 2 May 2017)

Permissions and Costs

The IES-R is available for use without cost, and the author will grant permission to use the measure to anyone with the appropriate training and context to administer the measure. For graduate students and their advisors, this document is the permission to use the measure in dissertation or other program requirement research.

Event

The IES-R was designed and validated using a specific traumatic event as the reference in the directions to individuals completing the measure. Any use of the measure requires that this issue be made explicit by the person administering the measure, and that respondents are clear about what specific event they are reporting on. Events like "the automobile accident," "the earthquake," "the sexual assault," "the rescue effort at the WTC on 9/11," are all appropriate events. It is not appropriate to use the IES-R to measure things like "stress on the job," "my divorce," "my boss's criticism," and the like. For specific questions on this issue refer to the discussion in the DSM-IV on the event on page 424 and the specific language of the "A" criterion of Posttraumatic Stress Disorder on pp. 427-428 and p. 431 for Acute Stress Disorder.

There is some controversy about whether events like receiving a diagnosis of breast cancer or finding out one is HIV positive is an example of a traumatic event. Individual researchers need to make their own decision about this and be able to provide a rationale for how it fits the description in the DSM. As well, many researchers desire to broaden the referent from a specific event to a class of events: e.g., “my abuse as a child,” “my service in Vietnam,” and my being beaten by my husband.” This is a trickier issue, and one that must be decided by the point of the study, but a guiding principle could be this: if the referent for the IES-R would not qualify as an event for DSM-IV because it is too broad, then the referent is not appropriate for the IES-R. Researchers should also be aware of the conundrum created and the difficulties for respondents when some but not other symptoms are present for one instance of a class of events but the others are present for a different instance. The DSM is not specific about this issue, but the vast majority of the data using the IES-R are in reference to a specific incident, so if a class is used as the referent, the data collected will not be comparable to other data in a potentially important way.

Modifications in the time frame

The IES-R was designed and validated using a specific time frame of the past seven days. Any change in this interval likely makes the data collected not comparable to those collected with the standard time frame. Thus, such a change is not recommended. Should a researcher decide to do so anyway, she or he should be aware that any write-up of the research should clearly disclose that a non-standard, modified version of the measure was used and that no reliability or validity data exist for this new, non-standard measure in the standard IES-R literature. If there are other data in papers that used the identical modification, the researcher is, of course, free to cite those papers as evidence in support of the characteristics of this modified measure.

Modifications of the items

Any modification to the item wording, order, content, punctuation, etc. renders comparisons of the data collected using such a version problematic, and without further study, problematic in unknown ways. Should a researcher decide to do so anyway, she or he should be aware that any write-up of the research should clearly disclose that a non-standard modified version of the measure was used and that no reliability or validity data exist for this new, non-standard measure. If there are other data in papers that used the identical modification, the researcher is, of course, free to cite those papers as evidence in support of the characteristics of this modified measure.

Use with children

The IES-R was neither developed nor validated with children. Some of the items have content that is probably comprehensible to children below the 7th grade, but at least one item, Item #12, comprises a fairly sophisticated internal psychological process concept. The Flesch-Kincaid Grade Level score is 6.6, but the user should be aware that using the measure with children must be considered preliminary or experimental until such time as the literature contains published evidence that the IES-R functions with children in the same way it functions in adults.

Cutting scores, cut-offs, and categorical uses

There are no "cut-off" points for the IES-R, nor are they envisioned or appropriate, despite analyses that present them (e.g., Asukai et al., 2002). The IES-R is intended to give an assessment of symptomatic status over the last 7 days with respect to the 3 domains of PTSD symptoms stemming from exposure to a traumatic stressor. Neither the

IES-R, nor the original IES for that matter, was intended to be used as a proxy for a diagnosis of PTSD, and with the very well-developed stable of clinical interviews that were designed to provide diagnoses (Weiss, 2004b), the only reasons to use the IES-R in this fashion is either a misunderstanding of its goals or a choice not to expend the resources (time, funds, good will) to obtain a valid diagnosis.

This issue is neither new nor confined to symptom measures. Over 30 years ago Rotter (1975) attempted to persuade and cajole researchers interested in the construct of internal-external locus of control not to conceptualize it as a categorical variable, nor to use it that way. The number of “diabetics” in the United States increased dramatically on 1 July 1997, despite any important clinical changes in those who became diabetic. What did change was the official cut-off score promulgated by the American Diabetes Association. For a fasting plasma glucose test, the criterion went from 140 mg per dL (7.8 mmol per L) to 126 mg per dL (7.0 mmol per L). Thus, an estimated 2 million people went to bed on Monday night not being diabetic and on Tuesday morning had become diabetic without any change in their clinical status (Diabetes Monitor, 2005). The use of a classification in and of itself is not necessarily problematic unless it is reified, which it typically is. A short-hand technique for communicating information becomes understood as conveying substantive qualitatively different clinical status. In reality, there are few such situations: pregnant, infected with the HIV virus, dead, boy or girl/male or female. However, even with the last categorization, careful observation has revealed a range of anomalies in which even gender is unclear. The point is that classifying gives the appearance of greater knowledge and understanding than is actually present. My bias is to avoid it if possible.

With respect to the IES-R, there are even more substantive issues that weight against even attempting to set a cut-off score. One of these is the time elapsed since the traumatic event. Early in the course of reaction to traumatic stress, the level of symptoms on the IES-R may suggest the presence of PTSD but distinguishing the normal course of response to trauma from PTSD is a difficult issue at five weeks or two months, regardless of the one month criterion in the DSM. A review of conjugal bereavement (Windholz, Marmar, & Horowitz, 1985) suggested that six months was not out of the ordinary for a period of time during which recovery from the loss. Thus, acute PTSD and chronic PTSD might well require different cuts, if one were to attempt to select them. A second of these is the severity of the traumatic event, all other things being equal, the more severe the higher the symptoms. A third issue is reactions accompanying exposure—both peritraumatic emotionality (Brunet et al., 2001) and peritraumatic dissociation (see Ozer, Best, Lipsey, & Weiss, 2003) may well moderate symptoms and symptom report, in a way that would ultimately affect diagnosis.

Most important, however, is the impact of the base rate of stress reactions in the sample being studied (firefighters versus women who have been beaten during a sexual assault) and used to determine a fixed cut-off. Indeed, in presenting an update on the CAPS, Weathers and colleagues (2001) carefully and systematically describe the need for a variety of decision rules (which are functionally equivalent to a cut-off score), to make a diagnosis of PTSD. They explicitly consider the choice of cut-off in light of the types of errors different values will produce, minimizing or maximizing false positives or false negatives. It has been well known for over five decades (Meehl & Rosen, 1955) that the base rate of the phenomenon can have a sizeable impact on the validity of any cut score. Thus, it is simply inappropriate to require or to attempt to set any cut-off that will universally apply, in which having cut-offs really serves no useful function.

The choice of the anchor points and the utilization of a mean score, rather than a sum (not universally followed in the literature), was an explicit decision to aid users in interpreting scores. For example, if an individual's score or a group's mean on the Intrusion subscale was 1.89, that would indicate that for intrusion, for this person (group), in the last week their distress from intrusive symptoms was close to, but not quite moderate. For individuals similar statements regarding the other two subscales can be made. For groups, using the SD will help immensely in making the pattern of scores meaningful. This ability is consistent with the goal that the IES-R set for itself.

Normative data

Most, but not all, of the issues that pertain to the futility of setting cutting scores apply equally well to the production of normative data. The central issue in establishing normative data for any measure (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999) is a clear specification of the group (population) to which the normative data apply (see also Wilkinson & Task Force on Statistical Inference, 1999). In the case of measures of PTSD, this task is daunting, since defining the normative population is complicated and complex, most saliently because the time elapsed since the traumatic event creates intractable problems. Average scores on the three subscales measured two months after exposure will likely be higher than when measured two years later (e.g., Zilberg et al., 1982). Unlike measures like the SCL-90, where an "average" score on any of the subscales is straightforward since there is no referent event, by definition the IES-R is answered about symptomatic status in the last week in reference to an event varying greatly in time elapsed. Moreover, specification of normative groups, non-patients, outpatients, inpatients is understandable in a manner that does not easily translate to measures of PTSD because of the necessity of specifying a traumatic event from which the symptoms arise.

One solution would be to create norms that apply to all individual who have ever been exposed to a traumatic event. Doing so, however, would not deal with the issue of time elapsed, nor would it deal with individuals who have had multiple exposures (Brunet, Boyer, Weiss, & Marmar, 2001).

A second choice would be to limit the norms to those who carry a current diagnosis of full PTSD. Doing so, however, would not deal with a large number of individuals with significant symptomatology but who do not meet current criteria—those with current partial PTSD, those with PTSD in partial remission, and those with lifetime and current partial PTSD (see Weiss et al., 1992). As well it would not deal with the issue of elapsed time.

A third choice would be to select a single event (e.g., 9/11), fix a point in time, recruit only those with exposure, and carry out the measurements and building of norms. Doing so would take the time elapsed into account. It would not, however, take account of the likely differences between subgroups (e.g., civilians versus emergency personnel workers) in symptomatic response. Additionally it would create a new dilemma—the norms would then apply only to a single type of traumatic event, thus largely defeating the purpose of creating norms in the first place.

These issues do not merely effect self-report measures of symptoms. The most commonly used interview measure, the CAPS (Weathers et al., 2001), does not provide a set of norms, nor does the SCID PTSD module (First, Spitzer, Gibbon, & Williams, 1996) or the MCS (Keane et al., 1988). Indeed, almost all measures of PTSD symptoms of any form present data regarding internal consistency, stability, and some construct validity (Cronbach & Meehl, 1955), typically only convergent but not divergent relationships. The argument, therefore, that norms are neither particularly useful nor especially meaningful, appears to be supported by the virtual absence of norms for any measure of PTSD, either symptoms or diagnosis. Finally, it should be not be overlooked that in the 30 plus years that the original IES has been used in the field, normative data have never been presented.

<u>Translations</u>

The IES-R has been of sufficient interest to scholars worldwide that it has been translated into many languages. The following published translations are have been located as of November 2009.

Chinese [1]	Wu et al. (2004)
Chinese [1]	Wu et al. (2004)

Chinese [2]	Guo et al. (2007)
Congolese French	Mels et al. (2009)
Dutch	Olde et al. (2006)
Farsi	Renner et al. (2006)
French	Brunet et al. (2003)
German	Maercker & Schuetzwohl. (1998)
Greek	Mystakidou et al. (2007)
Hebrew*	Shalev, & Freedman (2005)
Japanese	Asukai et al. (2002)
Korean	Lim, et al. (2009)
Lithuanian	Kazlauskas, et al. (2006)
Norwegian	Eid et al. (2009)
Peruvian Spanish	Gargurevich, et al. (2009)
Russian	Renner et al. (2006)
Spanish	Baguena et al. (2001)
Swahili	Mels et al. (2009)
Swedish*	Paunović & Őst (2005)
Turkish	Çorapçioğlu et al. (2006)
*inferred	

Translation is a non-trivial enterprise for the IES-R, since the items contain American English idioms. Word for word literal translations do not produce an acceptable scale. Any researcher who wishes to use a translated version of the IES-R is urged to use one of those cited above, if that is a language in which your research will be conducted. If a new translation is required, translation and independent back-translation is a must. The core steps in back-translation are these:

1. One or more individuals **[not the researcher]** translates the original English version into the new language.
2. **One or more different individuals [again, not the researcher]** translate the results of step 1 back into English.
3. The researcher compares the original to the results of step 2 and identifies phrases or whole items that require more work.
4. Ideally, steps 1 and 2 would occur again, but often that is too labor and time

> intensive. In that case, a consensus among all who have so far been involved is arrived at and this is used.

If you do a translation, I urge you to consult pages 224-228 of my chapter in the Wilson and Tang book (2007), as the description above is only a rough guide. I would be eager to receive a copy of it and any associated citations.

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	Air Command and Staff College, Air University, 2002
	Squadron Officer's School, Air University, 1995
	MBA, Executive Management (*summa cum laude*), Bristol University, 1994
	BA, Political Science (*cum laude*), Concordia College, 1989
Experience	Deputy Director of Operations, Pilot, GS-14, 2009–Present, USAF
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Awards and Honors	Senior Civilian of the Year
	Numerous USAF and NATO Medals