THE APPLICATION OF VIRTUAL REALITY IN FIREFIGHTING TRAINING

THESIS

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Abstract

Immersive simulations such as virtual reality are becoming more prevalent for use in training environments for many professions. United States Air Force firefighters may benefit from incorporating VR technology into their training program to increase organizational commitment, job satisfaction, self-efficacy, and job performance. With implementing a new training platform, it is also important to understand the relationship between these variables and the perceived benefits and efficacy of the VR training, which has not yet been studied in previous research. This study addresses this issue by gathering data from fire departments currently fielding a VR fire training platform. Relationships between several different measures of organization commitment, personality traits, and perceived VR training benefits were studied utilizing bivariate correlations and linear regression models. Results of this study indicated that perceived VR training benefits have a significant relationship with job satisfaction. Self-efficacy was found to have significant relationship with job satisfaction and job satisfaction had a significant relationship with turnover intentions. Post hoc analysis indicated that leadership-member exchange had a significant relationship with perceptions of VR training benefits, job satisfaction, and self-efficacy. Of the Big Five, conscientiousness and agreeableness had a positive relationship with turnover intentions and neuroticism had a significant relationship with turnover intentions. This research has shown that several factors contribute to the successful implementation of VR training programs, as well as theoretical explanations as to why these relationships exist.

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I. Introduction

The use of immersive technology such as virtual reality (VR) simulations is becoming more prevalent for many professions in both the civilian and military sectors. VR is defined as a "computer-generated three-dimensional graphical representation of the real or imaginary environment in which users are immersed through a dedicated headset or an array of display walls" (Renganayagalu et al., 2021). VR is a type of simulation and is categorized as an immersive technology since it immerses the user in a computer-generated space which resembles the real-world environment. Augmented Reality (AR) is another immersive technology which is often combined with or compared to VR. However, AR is different in that computer generated objects are projected onto a user's real-world view, rather than creating an entirely simulated environment like VR (Pereira et al., 2020). Many different professions utilize immersive technology for training and exercising, with many seeing improvements in skill retention and job performance.

Background

One profession in the military which utilizes this immersive technology is a United States Air Force pilot, who has utilized simulations for training for many years. The career of a military pilot includes hundreds of hours in various aircraft simulators, enabling them to hone their skills in a low risk, low threat environment. This technology enables pilots to accrue vital experiences, test knowledge and capabilities, and receive feedback on their performance in a safe and controlled environment. Through the use of

these technologies, risk is substantially limited to both the pilot and the aircraft, while also providing cost effective training for real world events that would normally be difficult to conduct during a live sortie. A secondary benefit is the costs associated with a simulated flight versus an actual flight, which has high costs derived from fuel requirements, aircraft wear and tear, and aircraft maintenance. Some tertiary effects also include the ease of scheduling simulator flights time versus live flights in a busy airspace, no flight delays, or cancellations due to weather, and the ability to customize the simulated mission with inputs to change the weather, airspace, or emergency procedures.

While flight simulations are a common place in the flying community, recent VR technology has enabled the wide-spread applicability to many other professions and their training objectives. Even with expanding VR technology's capabilities and the growing industry, its' potential for risk limiting training in the USAF firefighting community has not yet been officially evaluated or fully incorporated. The Air Force Civil Engineer Center (AFCEC) believes that the firefighting community with the help of modern-day simulation technology, may now have the ability to adapt VR training into their battle rhythm to take advantage of the same opportunities the flying community has leveraged for years. For example, live fire training organized to test the proficiency of firefighters is oftentimes expensive, environmentally damaging, and dangerous. Live burns like these have been proven to expose firefighters to carcinogens like polycyclic aromatic hydrocarbons (PAH), regardless of the use of respirators during training, which have proven to increase the risk of cancer in firefighters (Rossbach et al., 2020). The use of aqueous film-forming foam (AFFF) for training and real-world events has also been investigated as potential sources of perfluoroalkyl substances (PFASs) in the soil and

ground water, resulting in toxic pollution and potentially harmful health effects (Taniyasu et al., 2015). However, these training events are frequently used in the absence of alternative means to train critical aspects of their jobs. Modern-day advances in VR technology may now enable firefighters to still gain the necessary proficiency needed to conduct their job tasks, but from the safety of a classroom in a designed virtual environment. This technology has the potential to be a good alternative for job training where traditional methods, like live fires, are unsafe to implement, difficult to replicate, and challenging to frequently conduct. VR also enables the creation of large, complex scenarios which can be easily tailored to the desired training objectives like an aircraft, car, or structural fire, as well as mass causality incidents. While a majority of the studies examining VR training in the firefighting career field are focused on spatial navigation training, there has been a large number of studies in other professions showing that simulation-based training has a greater effect than traditional training methods on self-efficacy, task performance, skill retention, and job performance (Renganayagalu et al., 2021).

The only VR simulation technology currently being utilized in the United States Air Force firefighting community is the Darley FLAIM trainer. Since this technology has not yet been approved by AFCEC for accomplishing training items, it is currently being utilized as an additional, non-mandatory training platform for firefighters to use when time allows. The implementation of this trainer in fire departments is limited, with only three bases having the technology: Royal Air Force (RAF) Lakenheath in England, McConnell Air Force Base (AFB) in Kansas, and Kunsan Air Base (AB) in South Korea.

For this reason, the scope of this research was limited to the fire departments at these installations.

With a paradigm shift such as incorporating a new technology into a career field, it is important to consider the firefighters' willingness to accept and use this type of training medium. The perceptions firefighters have on the efficacy, applicability, and the training benefits of the VR platform could greatly affect the training effectiveness of the new technology being implemented (Glaveli & Karassavidou, 2011). Studies have also shown that employees' perceptions of training are positively related to work engagement, in that positive training perceptions result in increased job satisfaction, self-efficacy, and organizational commitment (Guan & Frenkel, 2018). Therefore, it is important to gain an understanding of the potential ties between organizational commitment, personality traits, and perceived benefits from VR training. This will enable career field leadership to better understand how these aspects of a firefighter tie to increased job performance from VR simulations. The relationship between perceptions of training benefits and work attitudes has only been studied a limited number of times, with very few incorporating VR but rather, focusing on traditional training methods (Dysvik & Kuvaas, 2008, Guan & Frenkel, 2018).

Problem Statement

The current problem facing AFCEC and the firefighting career field is that real-world training for firefighters can be dangerous, difficult to plan or coordinate, environmentally damaging, and expose them to risks that could be avoided with different training methods. The potential use of VR technology in the United States Air Force

firefighter career field opens the aperture of training capabilities they could utilize in their portfolio, while limiting the risks faced during traditional training events. VR platforms may provide a more realistic training environment than a classroom and other traditional training methods, however, AFCEC and the fire community need more information to understand how firefighters could use this technology and what affects it could have on their employees'. The implementation of this technology can help ensure their airmen are fully prepared to execute their job duties by offering customizable and safe training scenarios that were once difficult to conduct and had varying levels of risk associated with them. This study can serve as an initial source of information for the United States Air Force, AFCEC, and firefighting community when deciding to pursue further research or invest in VR platforms.

Research Objectives

To address this problem, this research will investigate the relationships between perceived VR training benefits, turnover intentions, job satisfaction, conscientiousness, extraversion, and self-efficacy. These relationships will help answer the following questions. 1) What factors will contribute to effective training in the VR environment? 2) How will this VR platform affect their organization in terms of organizational commitment (turnover intentions), job satisfaction, and self-efficacy? 3)What types of personalities does VR training appear to have the greatest effect on. The eight hypotheses studied as part of this research are presented below, with further discussion and detail proved in the following chapters:

H1A) Perceived VR Training Benefits have a negative relationship with Turnover Intentions

H1B) Perceived VR Training Benefits have a positive relationship with Job Satisfaction

H1C) Job Satisfaction mediates the relationship between Perceived VR Training Benefits and Turnover Intentions

H2A) Conscientiousness has a positive relationship with Perceived VR Training Benefits

H2B) Extraversion has a positive relationship with Perceived VR Training Benefits

H3A) Self-Efficacy has a positive relationship with Job Satisfaction

H3B) Self-Efficacy has a positive relationship with Perceived VR Training Benefits

H4A) Job Satisfaction has a negative relationship with Turnover Intentions

Methodology

The data necessary to test the hypotheses of interest was not readily available, therefore, the development of an original survey was required. The survey was designed and accessed via SurveyMonkey.com due to the ease of virtual access via email links and optimal Statistical Package for the Social Sciences (SPSS) data output features, and it was designed to take 15-20 minutes. The survey included 36 questions, with many having several sub-questions to answer using the same Likert scale. The sections of the survey were broken down into different measures of interest, which included demographics,

perception of VR training benefits and efficacy, job satisfaction, Big Five personality traits, self-efficacy, and turnover intentions. The survey questions were either derived from published literature or organically created for the purpose of this research based on similar published studies. Once the squadron commanders and Institutional Review Board (IRB) approval were granted, the survey was sent digitally via email distribution lists and was open for two weeks.

The analysis for this study was conducted utilizing SPSS statistical analysis software. After the survey was closed and data collected, it was exported from SurveyMonkey.com into an SPSS file. Next, the data was organized, numerical values were input where necessary, and reverse coded variables were created where those questions were asked. Since the variables had multiple different questions pertaining to their measure, the questions testing the same measure were aggregated and a new total variable was calculated. Once this was complete, reliabilities for the measures were calculated using Cronbach's alpha to ensure they were reliable and valid. The hypotheses presented were tested using bivariate correlation and linear regression analysis in order to determine where significant relationships were present.

Preview

The following chapters will provide further details on the processes taken to complete this research. An overview of the relevant literature reviewed will be discussed, followed by an outline of the methodology, and then a breakdown of the results and analyses. Finally, the research findings and conclusions will be discussed, along with limitations and areas for future research.

II. Literature Review

This chapter outlines the literature review process used to develop the hypotheses studied in this research, as well as gain a better understanding of the different variables that may affect performance and perceived benefits in a VR training scenario. First, a review of significant variables is conducted discussing journal papers on the following areas: performance and perceived benefits of training, job satisfaction, the Big Five, and self-efficacy. Next, social exchange theory is presented and discussed which may explain the relationships between these variables. Finally, the hypotheses to be tested in this research are presented, which are based on the previously outlined literature review and link to social exchange theory.

Review of Significant Variables

This section will provide an overview of the literature regarding several variables of interest. It includes prevalent meta-analyses, systematic literature reviews, and VR specific studies for each of the variables utilized in the hypotheses. Also outlined are the gaps in the research reviewed and how this study can help address these gaps.

Performance and Perceived Benefits of Training

Job performance is the value of the set of the behaviors the employees exhibit that aid in goal accomplishment (Colquitt et al., 2016). In this literature review, job performance research was narrowed down into how individuals perform in a VR, simulated, or immersive technology training for their career/workplace. Literature was also reviewed on the relationship between organizational commitment, performance, and the perceived benefits of training which was a metric collected for this research.

Organizational commitment is the employee's desire to remain a member of an organization and is what influences an employee to either stay or leave to pursue another job/work-place (Colquitt et al., 2016). The relationship between these three variables will help build the basis of the hypotheses for this research, specifically how the level of perceived training benefits from the firefighter VR training studied affect organizational commitment, and therefore overall job performance.

First, a literature review was conducted to gain a better understanding of how performance is generally measured and studied in a simulated setting and how training in an immersive scenario may affect job performance. Jonson, Pettersson, Rybing, Nilsson, and Prytz (2017) examined how small-scale computer-based simulation exercises affect nurse performance in the application of incident management skills during a major incident (MI). They assessed performance by measuring the nurse's time to treatment for both in-hospital and trauma patients during the MI scenario. Their results found that utilizing the simulation training improved management skills as demonstrated by shorter time to treatment for patients and that simulation exercises like the one studied could help better equip nurses to make critical decisions during stressful events such as during a surge in patients (Jonson et al., 2017). Previous studies researching the use of VR/simulations for clinical or MI exercise training have found similar results, concluding that simulation-based training can enhance performance and learning (Brannan et al., 2008; Okuda et al., 2009; Pattillo, 2006; Smith et al., 2015; Stefanidis et al., 2012; Watters et al., 2015; Wilkerson et al., 2008).

Another insightful journal paper reviewed was authored by Longo, De Salvatore, Candela, Zollo, Calabrese, Fioravanti, Giannone, Marchetti, Grazia De Marinis, and

Denaro (2021) who conducted a systematic review of the use of VR and Augmented Reality (AR) in orthopedic surgery training. Through their review of articles pertaining to this topic, the authors concluded that both VR and AR technologies greatly reduce the learning curves of trainees compared to residents who trained via traditional methods, and those who trained with VR scenarios could perform surgical tasks faster, with fewer errors, and with better clinical performance (Longo et al., 2021). A similar systematic review was conducted studying the use of VR for endoscopy training, which also concluded that trainees had improved technical and non-technical skills, enabling better surgical performance as an outcome of the virtual training (Mahmood et al., 2018).

Renganayagalu, Mallam, and Nazir (2021) conducted a more specific systematic review on the effectiveness of VR head-mounted display (HMD) technology used in several different career fields over a 30-year period. The authors highlighted the utility of VR for training scenarios that are either impossible or unsafe to exercise real-world in various industries including firefighting. Data from the 60 reviewed studies showed that performance metrics collected from user evaluations in VR research were often task completion rate, error rate, number of sequential processes completed correctly, and behavioral measures. These user evaluations were mostly self-reported measures collected via questionnaires of the user's perceptions of the training such as satisfaction, self-efficacy, etc. The authors concluded that the benefits of VR training are well-established, including increases to the user's confidence, skill retention, and performance (Renganayagalu et al., 2021).

When it comes to training conducted in a virtual realm with the aid of technology, it has been shown that the quality of training simulation influences the individual's

performance as well as the acceptance of using the specific technology. This was demonstrated by Igbaria and Tan (1997) who studied the various levels of user information technology (IT) acceptance and its influence on individual user performance at work. The results of their study were consistent with prior research, concluding that an individual's computer system acceptance had a significant effect on their performance by helping individuals increase their productivity and effectiveness in task completion, thus leading to higher job performance (Igbaria & Tan, 1997).

Next, this literature review will focus on the relationship between employee perceived benefits from training and two outcomes: organizational commitment and job performance. This body of research serves as the link between the collected survey data on the user's perceptions of the VR training and job performance. Guan and Frenkel (2018) examined how perceptions of training impacted employee performance in two Chinese manufacturing firms by conducting a literature review on this relationship, as well as collecting survey data to test their hypotheses. They found in the literature that perceived training benefits have an important relationship to employee organizational commitment, as well as organizational and individual performance (Ahmad & Bakar, 2003; Tharenou et al., 2007). Furthermore, several studies were reviewed demonstrating a positive relationship between training and employee performance (Bartel, 1995; Khan, 2012). After their review of the literature, the authors analyzed survey data which focused on how training is perceived by the employees and how that relates to their job performance; similar to previous studies, they concluded that employee's perceptions of training are positively related to task performance and organizational commitment (Guan & Frenkel, 2018). Additional literature supported these findings that there is a positive

relationship between perceived benefits of training and organizational commitment, as well as organizational commitment and job performance (Bartlett, 2001; Dysvik & Kuvaas, 2008; Glaveli & Karassavidou, 2011; Newman et al., 2011; Suharto et al., 2019).

Glaveli and Karassavidou (2011) explain the relationship between training perceptions and job performance via their hypothesized linkage model, which was supported by their study. This model shows that when employees view the training as beneficial, motivation to participate and the transfer of skills learned to their work increases, thereby increasing positive organizational behaviors and attitudes as well as job performance and job satisfaction (Glaveli & Karassavidou, 2011). This relationship is also explained by Newman et al. (2011), who use social exchange theory as a basis for their study and explain that when employers show their willingness to care for and invest in employees via quality training efforts, employees reciprocate by demonstrating positive behaviors and attitudes such as motivation and hard work. This will be further discussed in the theory section.

The review of this literature presents several gaps in research and areas for future work, which this thesis hopes to address. Even though the value of VR-based training is well-established in the literature, few studies focus on the performance of firefighters in this VR setting and those that do are predominantly centered only around spatial navigation training (Renganayagalu et al., 2021). Additionally, a limited number of studies have investigated the relationship between perceived training benefits and work attitudes, including in a VR environment, and how those relate to performance (Dysvik & Kuvaas, 2008). This thesis plans to address both gaps in literature by studying the

specific relationship between perceived training benefits and various work attributes, such as performance, in a firefighter VR training environment.

Since the job of a firefighter is inherently dangerous, the training necessary to prepare them for these environments come with their own set of risks. Utilizing VR for increasing firefighter job performance can help limit the risk of dangerous training events, such as live fires, which are often used due to lack of other means to achieve training objectives. Modern-day advances in VR technology may now enable firefighters to still gain the necessary proficiency needed to conduct their job tasks, but from the safety of a classroom in a VR simulation. This technology has the potential to protect United States Air Force firefighter's health by limiting their exposure to the risks associated with dangerous training events like live burns.

Job Satisfaction

Job satisfaction is the pleasurable emotions experienced from the appraisal of one's job or experiences on the job (Colquitt et al., 2016). More simply, it is how one feels about and what one thinks about their job. The job satisfaction-job performance relationship has been the subject of hundreds of studies, including the two most prominent meta-analyses being from Iaffaldano and Muchinsky (1985) and Judge, Thoresen, Bono, and Patton (2001).

Glass (1976) first proposed the term meta-analysis as the "statistical analysis of a large collection of analysis results from individual studies, for the purpose of integrating the findings." Iaffaldano and Muchinsky (1985) used this method, new at the time, to study the assumption that job satisfaction and job performance are related. Their research studying 217 correlations from 74 studies found that job satisfaction and job performance

is only slightly related, with a best estimate of the true population correlation to be only 0.17, and that moderators were "of little consequence." These results challenged the thought held by many organizational theorists that happy workers are productive workers and was accepted by fellow researchers for many years following the study, as demonstrated by their study being one of the most cited regarding this relationship (Judge et al., 2001). Their meta-analysis appeared to be most impactful to this body of research and the acceptance that job satisfaction and job performance were not related was commonly held until another meta-analysis was conducted by Judge et al. (2001).

Judge et al. (2001) recognized that Iaffaldano and Muchinsky (1985) provided many advances to this area of study and was more comprehensive than previous meta-analyses like Petty et al. (1984) but identified that several limitations were still present which impacted the accuracy of the results. With this, Judge et al. (2001) concluded that the magnitude of the relationship between job satisfaction and job performance derived from these studies was accepted too abruptly and that a more updated and comprehensive meta-analysis was needed. A total of 312 samples from 254 studies were included in their meta-analysis, which resulted in a true mean correlation between job satisfaction and job performance of 0.30 and a 95% confidence interval of 0.27-0.33 (Judge et al., 2001). Since this confidence interval excludes zero, they concluded that the average true correlation is relatively invariable, nonzero, and moderate in magnitude at 0.30. While the correlation of 0.30 is only a moderate effect size, Judge et al. (2001) still concluded that the correlation between these two variables should not be dismissed, especially since the job satisfaction/job performance correlation favorably compares to other job performance correlates.

Judge et al. (2001) also concluded that there was evidence that moderators of the relationship between job satisfaction and job performance were present, for example with job complexity. Their research found that the job satisfaction/job performance correlation was stronger when higher complex jobs were evaluated (Judge et al., 2001). Other moderators identified were personality/self-concept, autonomy, norms, moral obligations, cognitive abilities, aggregation, and level of analysis. However, Judge et al., (2001) identified that few of these were ever studied more than one at a time in a single study and concluded that future investigation into these moderators was needed. Similarly, this study found that behavioral intentions, low performance (operationalized as withdrawal), and positive mood mediated the effects of the job satisfaction/job performance relationship but further research was needed into these areas (Judge et al., 2001).

The next step in the literature review was conducted to examine how job satisfaction relates to performance, more specifically in VR, AR, simulations, or other immersive technology applications. There appears to be a wide range of VR training implementation in the medical field, specifically surgery, with many research articles discussing the efficacy of training and implementation of VR technologies. Salvatore, Vadala, Oggiano, Russo, Ambrosio, and Costici (2021) researched VR in preoperative planning of adolescent idiopathic scoliosis surgery using the Google Cardboard 3D modeling platform. In their study, the surgeons would either use VR or the traditional 2D computer on-screen scans to visualize the patient's anatomy, plan the surgery preoperative, and prepare for any complications. They then collected data on the operative times, blood loss, length of hospital stay, and satisfaction of the surgeon for each of the surgeries performed using the two different preoperative planning methods.

Their study found that the use of VR for preoperative planning significantly reduced operative times and blood loss; it also resulted in a significantly higher satisfaction score from the surgeon who performed the surgery (Salvatore et al., 2021). The VR preoperative planning platform allowed the surgeons to interactively view the anatomy of the patient with a broader field of view, thus enabling better avoidance of major risks and resulting in significantly higher job satisfaction and performance (i.e., operative time and blood loss). Albayrak, Oner, Atakli, and Ekenel (2019) also conducted a study examining job satisfaction and other outcomes utilizing immersive technology in the fast-food industry training system. They utilized AR glasses to develop an interactive training program for kitchen employees with the goal of increasing the quality of training, increasing new employee job satisfaction, and therefore increasing performance. The developed training also speeds up the learning process and makes the on-boarding of new employees less stressful and more efficient, thereby aiding in the increase of job satisfaction as well as performance (Albayrak et al., 2019).

The review of these and other job satisfaction and performance papers presented several areas for future work, which this thesis hopes to address. First, there were no articles examining the implementation of immersive technology like VR into firefighting training programs and how job satisfaction affects perceived performance in the simulation scenarios. Second, there were only a limited number of studies conducted researching how the implementation of VR training affected job satisfaction and if this also affected job performance. This thesis aims to address these deficiencies by studying the relationship between job satisfaction and perceived VR performance, collecting data

on these two metrics, and then analyzing the data to determine how these variables might be related in the United States Air Force firefighting community.

The Big Five

The Big Five personality traits, or five factor model, include extraversion, emotional stability (sometimes referred to as neuroticism), agreeableness, conscientiousness, and openness to experience (Barrick & Mount, 1991). These traits are further defined as follows: extraverted individuals are sociable, assertive, and bold and are not quiet, shy, or reserved; neurotic individuals are nervous, moody, and insecure and are not calm, relaxed, or secure; agreeable individuals are kind, cooperative, and courteous and are not callous, rude, or cold; conscientious individuals are dependable, organized, reliable, and hardworking and are not inefficient, negligent, or lazy; and individuals who are open to experiences are curious, creative, and sophisticated and are not simple, conforming, or traditional (Colquitt et al., 2016).

Prior to the 1990s, the utility of personality traits like the Big Five when determining future employees was looked down on due to the pessimistic conclusions made by previous research in this field of study (Hurtz & Donovan, 2000). Early meta-analysis of these traits conducted by researchers like Barrick and Mount (1991) began to turn the tides of these previously held views and started to provide evidence that the Big Five may yet prove useful for employee selection (Hurtz & Donovan, 2000). Barrick and Mount (1991) concluded that personality traits such as the Big Five are a useful predictor of job performance, especially with conscientiousness. Their study served as a turning point in this field of study, with subsequent studies finding similar results as the original work of Barrick and Mount (1991).

These studies included Behling (1998), which claimed that conscientiousness was just as strongly related to performance as was intelligence. Hurtz and Donovan (2000) later conducted a meta-analysis to revisit the relationship of the Big Five with job performance and aimed to address and correct some of the proposed threats to construct validity found in previous studies. Similar to Barrick and Mount (1991), their research used the 'type of worker occupation' and 'type of performance criterion' as potential moderators for the relationship between the Big Five and job performance (Hurtz & Donovan, 2000).

Their research produced results that were consistent with the work of Barrick and Mount (1991) with conscientiousness having the highest validity out of all the Big Five traits for predicting overall job performance. However, Hurtz and Donovan (2000) contend that the validity estimates for conscientiousness were overestimated in previous studies. While they conclude that 1) Conscientiousness has a moderate impact on job performance, 2) It appeared to generalize well across all occupations and job performance criteria, and 3) It will consistently explain a small portion of variance in performance, they also state that this is less of an impressive relationship than what appear in previous studies (Hurtz & Donovan, 2000). For this reason, they conclude that conscientiousness should not be viewed as having the same predictive ability for job performance as intelligence, contrary to Behling (1998) who viewed them as having the same ability to predict performance. Intelligence, also known as cognitive ability in organizational behavior, is defined as an individual's ability to acquire and apply knowledge in problem solving and has the strongest correlation with performance (Colquitt et al., 2016). However, this research focused on personality traits like

conscientiousness, which people can change overtime and control, unlike cognitive ability which usually cannot be changed. For this reason, cognitive ability was considered to be out of scope and was not included in this research.

Regarding the other Big Five personality traits, Hurtz and Donovaan (2000) found emotional stability had a stable influence on performance, agreeableness appeared to be more valuable in jobs which require interpersonal interactions, extraversion influenced sales and managerial jobs primarily, and openness to experience appeared to affect job performance in customer service-like jobs. While these other four traits appeared to be less generalizable than conscientiousness, they are nearly as important for predicting job performance for certain jobs and criteria (Hurtz & Donovan, 2000).

Similar to the above job satisfaction section, there are some studies in the literature examining how personality traits like the Big Five affect performance in a simulated, VR, or immersive technology training setting. More generalized personality studies, not specifically Big Five parameters, researching how personality might relate to performance in a simulated setting were common, like a study conducted by Wirth, Gradl, Mehringer, Kulpa, Rupprecht, Poirmann, Laudanski, and Eskofier (2020).

This research utilized a VR tool for personality trait assessment in soccer athletes, specifically whether action-oriented or state-oriented personalities affect athlete performance in the simulation. Here, action-oriented individuals focus on achieving specific goals and take risks, whereas state-oriented individuals are more risk-adverse and consider non-task specific information in order to minimize risks and consequences (Wirth et al., 2020). This study concluded that an individual's personality did have significantly different performance outcomes in the VR environments. Specifically, the

state-oriented players had greater accuracy, perceived more opponents, and scored more goals than the action-oriented group who had lower action times and higher fail rates (Wirth et al., 2020).

Another more generalized study on the relationship between personality and VR performance was conducted by Aranha, Nakamura, Tori, and Nunes (2018), who performed a systematic literature review on this topic. From their review of 387 articles, they concluded that personality traits impact VR user experiences in different ways and that an individual's personality traits can predict their behavior in the VR training environment (Aranha et al., 2018). One of these reviewed articles was the research of Rosenthal, Schafer, Hoffmann, Vitz, Oertli, and Hahnloser (2013) who studied surgical resident's personality and their performance in a VR operating room. While their preliminary study did not find a relationship between personality traits and technical performance, they did conclude that personality traits are expected to be a significant predictor of VR performance for non-technical skills, team cohesion, safe surgery, and therefore overall surgery performance (Rosenthal et al., 2013).

Several papers were reviewed regarding the relationship between the specific Big Five personality traits and VR/simulation performance. The literature appears to have varying conclusions on the specific relationship (or lack thereof) to performance in a simulated or immersive setting. Sakamoto, Okamoto, Shimizu, Araki, Hirakawa, and Wakabayashi (2017) conducted a study comparing the use of either a hands-on simulator or instructional video to train medical students and how the different Big Five traits may relate to performance. Their research concluded that not only was the simulation more effective in training the microsurgery skills than the instructional video, but also that

students with high scores of extraversion performed better in the scenario and took less time to complete the test (Sakamoto et al., 2017). This research did not find significant relationships between the other traits and scenario performance; however, the authors did state that the limitation of only testing medical students and not practicing surgeons may explain this lack of statistically significant relationships with the other four traits, which are found in other studies reviewed.

Falcao, Saraiva, Santos, and Cunha (2018) explored the effects that the Big Five personality traits have on a trained negotiator's performance in a simulated negotiation scenario. Their study concluded that personality does have an impact on the performance of a negotiator in the simulated scenario; specifically, they found extraversion and conscientiousness had a positive influence and agreeableness had a negative influence on negotiator performance (Falcão et al., 2018). Another paper investigating this relationship was published by Goldenberg, Fok, Ordon, Pace, and Lee (2017) who studied the effect of the Big Five personality traits on the performance of residents during laparoscopic surgery in a simulated setting. Their research concluded that only the conscientiousness of surgeons correlated with technical skills performance in the simulated scenario and that the other traits had no significant relationship (Goldenberg et al., 2018). Lackey, Maraj, and Salcedo (2015) also studied how the Big Five personality traits correlate with performance in a virtual environment by collecting the accuracy and response times of individuals completing various tasks in a VR scenario. They utilized their data as well as the collected personality surveys to analyze which traits may correlate with higher performance. They concluded that of all the Big Five traits, conscientiousness was the

fundamental variable for an individual's response time and that it correlated with VR performance (Lackey et al., 2015).

Through the literature review process of examining the relationship between the Big Five personality traits and performance, in and out of a VR setting, there are several gaps in research this thesis hopes to address. From the reviewed literature, it is clear that an individual's personality traits do predict their behavior and performance in VR settings (Aranha et al., 2018). While most of this research is in the medical field, even there, most studies have been descriptive and have not adequately tested personality traits with technical skills in a VR environment (Rosenthal et al., 2013). Additionally, there is little research into which specific personality traits firefighters may have and how their traits may or may not predict performance in a fire-specific VR training scenario. A firefighter specific study is necessary since personalities and work tasks are different in different career fields and exploring how traits are linked to performance has been found to be contingent upon the types of tasks and occupation (Lackey et al., 2015). This research aims to address these gaps by specifically studying the personalities of firefighters and analyzing their survey results in order to determine if there is a relationship between their personality (Big Five traits) and their perceived VR training performance.

Self-Efficacy

Self-efficacy is defined as someone's fundamental ability to cope, perform, and be successful in a variety of situations (Judge & Bono, 2001). Other terms synonymous with self-efficacy are self-confidence, competence, and task-specific self-esteem (Colquitt et al., 2016). Self-efficacy has been thoroughly researched, along with the other core self-evaluations, in its relationship with job satisfaction and has been found to have

consistent effects on job satisfaction, regardless of the job attributes (Judge, Locke, et al., 1998).

Judge and colleagues have also stated that these core self-evaluations should be related to work motivation, i.e., job performance (Judge, Erez, et al., 1998), which was the target of the Judge and Bono (2001) research along hypothesizing that self-efficacy is positively related to job performance. This study also looked at the relationship of the core self-evaluations with job satisfaction, also hypothesizing that self-efficacy is positively related to job satisfaction. The results of their meta-analysis found that self-efficacy did have a positive, nonzero relationship of similar magnitude with job satisfaction and job performance, even though the relationship with the latter was somewhat weaker than the former (Judge & Bono, 2001). Their results also suggest that self-efficacy has just as strong of a relationship in predicting job performance as does conscientiousness, with its correlations very close in magnitude with that of conscientiousness and job performance suggested by Barrick and Mount (1991). Stajkovic and Luthans (1998) also conducted a meta-analysis on this topic and further explored the moderators associated with self-efficacy, finding that task complexity is the strongest moderator of the relationship between self-efficacy and performance.

The relationship between self-efficacy and performance in these studies can be further explained and exists for several reasons. Colquitt et al. (2016) explains that employees who are more self-confident regarding a specific task will often perceive higher levels of expectancy (believing hard work will result in successful performance) and therefore are more likely to choose to exert higher levels of effort, thus enabling greater performance. This greater sense of competence/self-efficacy leads employees to

have higher levels of belief in their abilities to succeed at work, which also leads to higher intrinsic motivation, as well as work performance. This motivating force from self-efficacy has the strongest effect on performance since employees who have greater levels of internal self-confidence have the tendency to outperform others who doubt their own abilities (Stajkovic & Luthans, 1998). Stated in a different way, those who believe they can perform a task well will do better than those who worry they will fail (Gist & Mitchell, 1992).

Stajkovic and Luthans (1998) also describe in their meta-analysis several underlying mechanisms that explain the nature of the self-efficacy and performance relationship. They found that individuals who have higher self-efficacy tend to develop more effective task strategies, which enable their heightened performance and are necessary for their successful completion of a task (Stajkovic & Luthans, 1998). They also found that individuals with low self-efficacy tend to be more self-focused rather than task-focused, which interferes with their optimal use of cognitive resources needed to create task strategies for successful performance.

A literature review was also conducted looking at published papers exploring the relationship between self-efficacy and performance specifically in a VR, AR, or another immersive technology platform. Similar to the previous sections, a majority of the papers reviewed came from medical field research and their utilization (or potential utilization) of immersive technologies. Jonson, Pettersson, Rybing, Nilsson, and Prytz (2017) studied if computer-based simulations could increase the self-efficacy and incident management skills of lead nurses in emergency departments. Their study concluded that the simulations significantly increased the nurses' self-efficacy and performance, which was

measured by the time required to treat the patients (Jonson et al., 2017). These results may be partially explained by previous research finding that in an educational situation, individuals with greater levels of self-efficacy learn more and therefore perform better than those with lower levels of self-efficacy (Bandura, 1997; Wood & Bandura, 1989).

Watters, Reedy, Ross, Morgan, Handslip, and Jaye (2014) also studied how self-efficacy and performance might be related using simulation training of interprofessional and collaborative scenarios for doctors, nurses, and midwives. They hypothesized that self-efficacy would increase with the use of the simulation, as would post-training learning outcomes (i.e., implementation of training to increase performance at work). The results of this research confirmed their hypotheses in that the simulation training significantly enhanced the user's self-efficacy and yielded higher performances of learning outcomes (Watters et al., 2015).

A study conducted by Hall, Riojas, and Sharon (2014) researched the potential differences to the self-efficacy of individuals between artificial simulation and live animal use for military emergency procedure training. The users in this study were randomly assigned to train either on a simulation software or a live pig and their performance during the procedures were tracked, as well as self-efficacy self-evaluations being collected post training. The results of their study concluded that both the simulator and live animal training had the same effect on individual's self-efficacy and that there was no statistical difference between the outcomes of the different trainings (Hall et al., 2014). In other words, hands-on live training increased an individual's confidence and their ability to perform the procedures to the same extent as the simulation training, thus showing that simulations can have just as positive of an effect on self-efficacy and

performance. Another study conducted by Jai, Bhatti, and Nahavandi (2014) studied the impact self-efficacy may have on the perception of VR training effectiveness. Their study showed support for their hypothesis that self-efficacy shares a positive relationship with perceived VR efficacy and that individuals with higher beliefs of self-efficacy are expected to have higher perceptions of the VR training efficacy (Jia et al., 2014). This conclusion was consistent with prior research, which also concluded that the self-efficacy and perceptions of computer system efficacy was positively related (Hasan, 2008; Igbaria & Ivari, 1995; Jawahar & Elango, 2001).

The review of these and other self-efficacy and performance journal papers presented areas for future work, which this thesis hopes to address. First, similar to the previous sections, no studies were found regarding the use of simulators or VR in the firefighting community studying how self-efficacy relates to individual performance in simulated training. This research aims to fill this gap by hypothesizing the relationship between self-efficacy and perceived VR performance, collecting data on these two metrics, and then analyzing multiple linear regressions to determine how these variables might be related in the United States Air Force firefighting sample size presented.

Theory

This thesis draws upon social exchange theory to conceptualize the relationship between the variables collected in the survey and job performance. This theory provides an explanatory framework to explain how employee perceptions of VR training are linked to organizational commitment and job performance. Social exchange theory is based on the idea that there is a mutual investment between employees and employers,

such that employees are willing to exhibit beneficial behaviors since they trust the employer to reward them for these actions (Blau, 1986; Colquitt et al., 2016). This extends to the training opportunities offered by employers in that employees have the expectation that they will be provided quality training that is pertinent to their jobs in exchange for their organizational commitment (Bartlett, 2001; Newman et al., 2011). This has been studied in the literature, concluding that when organizations take care of their employees via training opportunities, the employees will work harder and have increased job satisfaction and performance for the benefit of the organization (Alfes et al., 2013; Glaveli & Karassavidou, 2011; Karatepe, 2013; Newman et al., 2011). In this context, social exchange theory can be simplified by stating that employees who are treated well via quality training investment and opportunities respond by working more efficiently and effectively. This is due to the perception held by the employee that the employer is demonstrating their commitment to them through these training opportunities, thereby causing the employee to reciprocate by working harder and increasing their performance (Frenkel & Bednall, 2016; Shore et al., 2006). Thus, training that is perceived as beneficial and provided by the organization is the social exchange between the employee and employer, which creates the reciprocated obligations of the employee.

Hypotheses

Based on the previous discussion of the literature review and proposed relationship among variables, the following hypotheses are presented with the expected links between the measured variables. These are also shown in Figure 1.

H1A) Perceived VR Training Benefits have a negative relationship with Turnover Intentions

H1B) Perceived VR Training Benefits have a positive relationship with Job Satisfaction

H1C) Job Satisfaction mediates the relationship between Perceived VR Training Benefits and Turnover Intentions

H2A) Conscientiousness has a positive relationship with Perceived VR Training Benefits

H2B) Extraversion has a positive relationship with Perceived VR Training Benefits

H3A) Self-Efficacy has a positive relationship with Job Satisfaction

H3B) Self-Efficacy has a positive relationship with Perceived VR Training Benefits

H4A) Job Satisfaction has a negative relationship with Turnover Intentions

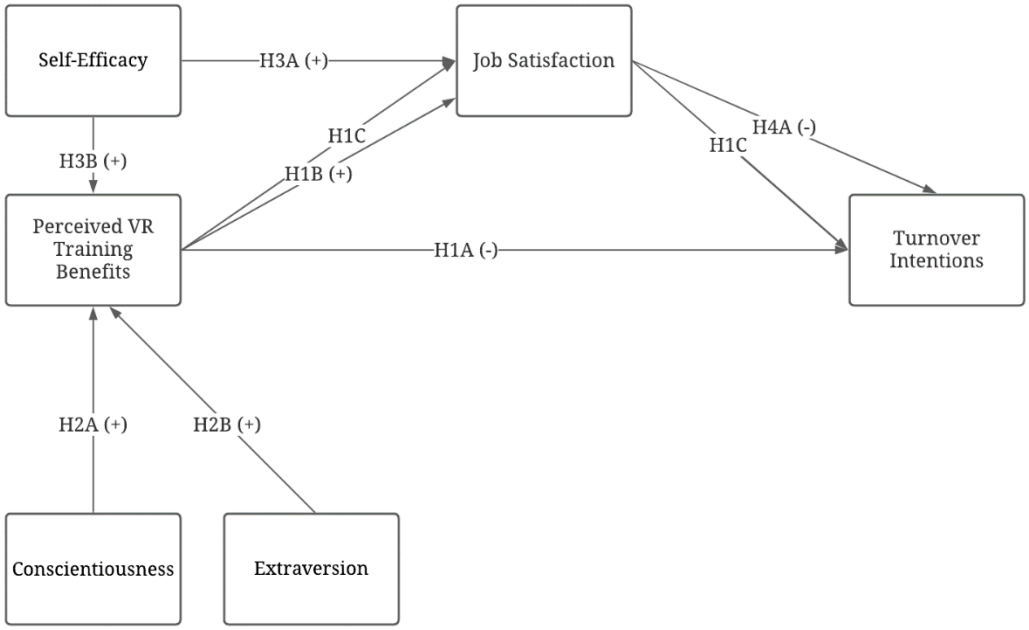

Figure 1. Model of Expected Relationships

Summary

This chapter provided an overview of the research conducted to gain an understanding of how these variables may relate to one another and organizational commitment. The chapter reviews the significant variables of interest, discussing overarching meta-analyses and studies, then VR specific studies, and finally limitations of the literature for each variable. This research yielded social exchange theory as an explanatory framework to explain how employee perceptions of VR training are linked to organizational commitment and job performance. Eight hypotheses were developed to test these expected relationships.

III. Methods

This chapter outlines the process used to collect the primary data for this research. First, the procedures of how the survey was created, what it was comprised of, and how it was distributed is reviewed. Next, the participants in this study are discussed and response demographics are shown. The specific measures of the hypotheses are presented and the creation of each of their survey items are then discussed. Lastly, the methods taken to complete the analysis of the data are outlined.

Procedure

The data necessary to test the hypotheses of interest was not readily available; therefore, the development of an original survey was required. In order to facilitate and inform the creation of this survey, a qualitative pilot study was conducted. This process involved several interviews with the fire departments who utilized the VR FLAIM trainer, as well as the VR training subject matter experts at these installations. This information was utilized to better inform what questions the users wanted answered from the study, as well as what measures may be beneficial to include in the survey. Interviews with representatives from FLAIM systems was also conducted to gain a better understanding of how the platform was developed specifically for firefighters and what information they have seen in previous studies. The survey was designed to incorporate several different measures some of which were used in the hypothesis and then post-hoc analysis, while others were additional measures not addressed in this study but collected for the potential investigation in addressing follow-up questions from AFCEC. The platform utilized for the survey creation and distribution was SurveyMonkey.com due to

the ease of virtual access via email links and optimal SPSS data output features. The survey was built to take the volunteer 15-20 minutes and included 36 questions, with many having several sub-questions to answer using the same Likert scale. The questions were broken up into different sections, for example demographics, perception of VR training benefits and efficacy, job satisfaction, Big Five personality traits, self-efficacy, and turnover intentions. Other measures (not listed here) were used for post-hoc analysis or for potential future use were included in the survey questions as previously discussed, with the entirety of the survey in Appendix A. The survey was sent digitally via email distribution lists to the fire departments who had the VR trainer once IRB approval and permission to collect survey data from the squadron commanders was received. The survey was open for a period of two weeks, after which it was closed, and the data collected. The analysis for this study was conducted utilizing SPSS statistical analysis software.

Participants

The participants for this study were United States Air Force firefighters who had access to the VR trainer at their fire department. This included approximately 125 civilians and enlisted members at RAF Lakenheath, McConnell AFB, and Kunsan AB, with a portion of this population not having previously used the trainer and the other having received the treatment of utilizing the FLAIM trainer. Table 1 and Figure 2 show the participation numbers per base, with a total of 48 responses being collected upon closing the survey.

Table 1. Survey Response Percentages by Base

Which base are you stationed at?		
Answer Choices	Responses	
RAF Lakenheath	45.83%	22
McConnell AFB	35.42%	17
Kunsan AB	18.75%	9
	Answered	**48**

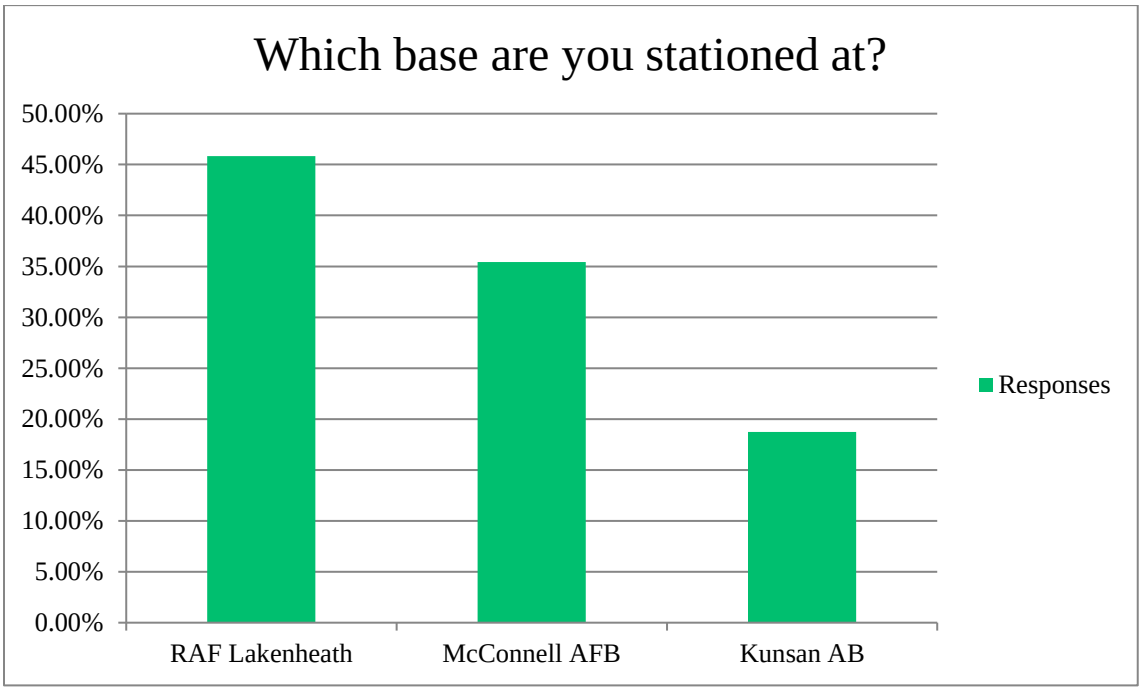

Figure 2. Survey Responses by Base

Measures

As previously stated, the administered survey was designed to collect data on several different variables of interest. Except for the demographic questions, each of these variables had their own set of questions and sub-questions in the survey which was answered using a Likert scale. The type of Likert scale varied depending on the variable being measured and was based on the suggested design from literature, all of which had previously been used and found to have established reliability and validity. This will be

further explained per variable in the following sections, which focus on the measures utilized in the hypotheses.

Cronbach's alpha is used to measure the internal consistency of a scale or test and is the most common used objective measure of reliability (Tavakol & Dennick, 2011). The internal consistency of a test is important since it is the measure of how well the items of a test consistently measure the same construct or concept. For example, if the job satisfaction questions on the survey have acceptable internal consistencies and Cronbach's alphas, then the questions will measure job satisfaction reliably and consistently for each volunteer answering the questions. Cronbach's alphas are expressed as a number between 0 and 1, with the acceptable range varying between 0.70 and 0.95 depending on the field of study and application (Tavakol & Dennick, 2011). For the purposes of this study based on previously reviewed literature, a Cronbach's alpha greater than 0.70 was used to determine whether the appropriate level of internal consistency was met. All the questions gathered from the literature and utilized in the survey met this threshold and were verified with the collected data in SPSS.

Performance and Perceived Benefits of Training

Along with the demographic questions asked in the survey, the performance and perceived benefits of training questions were organically created for the purpose of this study and were not found in previous literature, unlike the other variables measured. This enabled the collection of data for this variable to be more specific to the VR trainer used by the United States Air Force firefighters, as well as asking questions that were of interest to the firefighting stakeholders involved. Carlson and Zmud (1999) was utilized to help develop these questions since they studied a similar premise. Their research

focused on media richness perceptions, specifically how the use of email communication was perceived in an organization and which factors interacted with these perceptions (Carlson & Zmud, 1999). Their survey included questions regarding the experience of the user and the perceived efficacy of the technology, which served as a guide for some of the questions used for this section of the survey. The performance/perceived benefits of training measures included a set of nine questions gathering the user's perceptions of the VR trainer's efficacy, likeness to real-world work and scenarios (fidelity), and usability. These questions were answered using a common 7-point Likert scale ranging from 1-Strongly Disagree to 7-Strongly Agree and included questions like "I feel comfortable using the VR training" and "The VR training environment resembles the real-world environment". Since the questions were adapted from literature and not specifically created and used previously, there was no initial Cronbach's alpha to judge the preliminary reliability of the questions. However, once the data was collected and reliability was tested, these questions produced a Cronbach's alpha of 0.90 which was acceptable for further analysis.

Job Satisfaction

The job satisfaction questions in the survey were designed to measure the level of pleasurable experiences the firefighters had with regards to their job. These questions were adapted from Spector (1985, 1997), who extensively studied job satisfaction and organizational behavior. The questions utilized a 6-point Likert scale ranging from 1-Disagree Very Much to 6-Agree Very Much and collected data on eight different job satisfaction categories: pay, promotion, supervision, benefits, rewards, co-worker, work itself, and communication satisfaction (Spector, 1985, 1997). These different job

satisfaction categories were broken up into eight different questions utilizing the same Likert scale, with four sub-questions for each category. These measures had been previously used in research and had established reliability. This set of question's reliability was confirmed once the data was collected and produced a Cronbach's alpha of 0.87, which was acceptable for further analysis.

The Big Five

The Big Five questions on the survey were broken out into the different personality traits measured in this variable: neuroticism, extraversion, openness to experiences, agreeableness, and conscientiousness. These questions were adapted from the International Personality Item Pool (IPIP), which utilized either a 10 or 20 item set of questions for each trait and have been a proven, reliable way to measure personality (*International Personality Item Pool (IPIP)*, 2019; Johnson, 2014; Kajonius & Johnson, 2019). In order to keep the time to complete the survey under the goal of 15-20 minutes, the 10-item scales were utilized. These questions used a 5-point Likert scale ranging from 1-Very Inaccurate to 5-Very Accurate. The extraversion items included statements like "Make friends easily" and "Am the life of the party" which the user would then answer by selecting the response that best matched how they felt. This was the same process for the conscientiousness items which included statements like "Carry out my plans" and "Pay attention to details". The question's reliability, specifically extraversion and conscientiousness which was utilized for hypothesis testing, was confirmed once the data was collected. This resulted in the extraversion questions producing a Cronbach's alpha of 0.86 and the conscientiousness questions producing a Cronbach's alpha of 0.89, both of which were acceptable for further analysis.

Self-Efficacy

The self-efficacy questions were designed to measure how confident a respondent was at being a firefighter. These questions were similarly adapted from literature which had utilized and vetted these questions as being reliable measures of self-efficacy (Parker, 1998). A 5-point Likert scale was used to answer these questions, ranging from 1-Not at All Confident to 5-Very Confident. This measure had the user read a series of statements and then score how confident they would feel completing the tasks like "Analyzing a long-term problem to find a solution" and "Presenting information to a group of colleagues." This set of question's reliability was confirmed once the data was collected and produced a Cronbach's alpha of 0.86, which was acceptable for further analysis.

Turnover Intentions

Turnover intentions measure the level of desire the respondent has for leaving the organization, here being the United States Air Force, to find another job as a firefighter or new career. This is an aspect of organizational commitment, which is defined as the desire of the employee wanting to continue to be a part of the organization (Colquitt et al., 2016). Since the different types of organizational commitment was not measured, turnover intentions were utilized as a proxy based on the literature reviewed. This variable was incorporated into the survey by adapting previously studied survey questions from the literature (Cammann et al., 1979; Lawler et al., 2013). The measure was asked in a single question, broken into five sub-questions, that asked respondents to assess a series of statements and for each one answer how strongly they agreed with them utilizing a 7-point Likert scale ranging from 1-Strongly Disagree to 7-Strongly Agree. For example, these statements included "I want to leave the Air Force very much" and "I

think about quitting all the time." This set of question's reliability was confirmed once the data was collected and produced a Cronbach's alpha of 0.93, which was acceptable for further analysis.

Analysis

Data analysis was conducted utilizing SPSS statistical analysis software. Once the data was collected, it was exported from SurveyMonkey.com into an SPSS file. Next, the Likert data was converted to numerical values and variable names were updated for ease of use. The demographic data collected was also changed to numerical values on the same scale, since some of the questions were typed in responses resulting in varying ways to answer (ex. 12 months vs 1 year). Reverse coded questions were then addressed, which included some of the Big Five variables and job satisfaction measures. New reverse coded variables were created for the specific questions necessary, and the scale was inverted to account for these questions. Since the variables had multiple different questions pertaining to their measure, the questions testing the same measure were aggregated and a new total variable was calculated. For example, since the job satisfaction measure was broken up into eight different sets of questions, these were all aggregated to get a total job satisfaction measure. Once this was complete, reliabilities for the measures were calculated using Cronbach's alpha to ensure they were reliable and valid. These steps were saved in an SPSS syntax file for future review and use.

The hypotheses presented were tested in SPSS using bivariate correlation and linear regression analysis. For the correlations, there was a significant relationship between variables if the 2-tailed significance p-value was less than 0.05. For the linear

regression analysis, the assumptions of a linear regression model were first checked and then the significance level was reported, again showing a significant relationship if the p-value is less than 0.05.

Summary

This chapter provided an overview of the methods used to accomplish this study. The study was completed via the collection of survey data utilizing SurveyMonkey.com. The survey was distributed to United States Air Force fire departments who currently have VR training technology available, which included RAF Lakenheath, McConnell AFB, and Kunsan AB. The survey measures were collected via a series of questions which were designed using published literature with tested reliable items. Upon collection of the data, a preliminary analysis was conducted on each of the measures questions and found all items to have a reliability greater than 0.70.

IV. Analysis and Results

This chapter outlines the process used to analyze the results of the survey data. First, the descriptive statistics for the demographic and individual variable questions are discussed. Next, the correlations of the variables used in the hypotheses is presented, with initial significant relationships outlined. Finally, the relationships are examined further via linear regression models and the assumptions for each model are discussed, as well as a post hoc analysis conducted.

Descriptive Statistics

Table 2 lists the descriptive statistics for several of the key demographic information collected from the survey participants. This information gives an idea of the types of individuals who participated in the survey and their level of experiences. It also further clarifies how many participants have used the VR trainer and to what extent. This is important information which can help explain the hypotheses test results or help in future research recommendations. For the education question, a scale of 1-high school diploma, 2-associate degree, 3-bachelor's degree, 4-master's degree, and 5-doctoral degree was used. The first three questions show that the average time in service was 13.42 years, an average age of 34.38, and the highest level of education being between a high school diploma and associate degree.

The next set of questions was to determine the level of experience and exposure to the VR trainer. For whether they have used the VR trainer or not, a scale of 1-yes and 2-no was used resulting in a majority of the 48 respondents having had used the simulator (29-yes, 19-no). The survey had a built-in function where if the respondent answered no

to this question, the next three questions were skipped since they were not applicable to the respondent. These questions included how long ago their first VR training was, how many total training sessions have they had, and how many total hours have they spent in the VR trainer. These questions were answered by the 29 respondents (60.4%) who have used the simulation, resulting in an average of 183 days since their first training, 2 total training sessions, and 16 total hours in the VR trainer.

Table 2. Demographic Descriptive Statistics

	Minimum	Maximum	Mean	Std. Deviation
Time in service	1	39	13.42	10.034
Age	19	62	34.38	11.361
Select your highest level of education	1.00	4.00		.90787
Have you used the VR FLAIM trainer?	1.00	2.00		.49420
How many days ago was your first VR training experience?	1	1218	182.66	297.918
How many total training sessions have you had in the VR FLAIM trainer?	1.00	5.00	2.0690	1.57958
How many total hours have you spent training in the VR FLAIM trainer?	1	100	15.55	26.941

Table 3 lists the descriptive statistics for the variables used in the hypotheses. The skewness and kurtosis are also reported in the table to check if the variables are following a normal distribution, aiming for a standard between +1 or -1.

Table 3. Variable Descriptive Statistics

	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Perceived VR Benefits***	4.8148	1.41556	-1.176	.448	.951	.872
Job Satisfaction**	4.4583	.79272	-.532	.378	.638	.741
Extraversion*	3.5063	.65399	.421	.414	-.328	.809
Conscientiousness*	4.2152	.52209	-.383	.409	-.839	.798
Turnover Intentions***	2.4516	1.59329	1.450	.421	1.859	.821
Self-Efficacy*	3.6925	.56743	.617	.434	.524	.845

* Likert scale 1-5
**Likert scale 1-6
***Likert scale 1-7

Table 4 shows an ANOVA test comparing the sample used in this study of individuals who have and have not used the VR trainer. As previously discussed, the VR platform was not utilized by all the members of the fire departments. Therefore, some of the respondents had not used the VR trainer and skipped the perceived VR training benefits set of questions, moving on to the other questions measuring the additional variables of interest. Due to this aspect of the sample gathered for this study, an ANOVA test was conducted to see if the different groups of the sample (no VR use and the treatment of VR use) differed. Significant difference between the groups was observed if the p-value was less than 0.05. This table shows that the groups of no VR use and VR use

do not differ in terms of job satisfaction, self-efficacy, turnover intentions, extraversion, conscientiousness, time in service, rank/pay grade, age, and education.

Table 4. Previous VR Use ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Job Satisfaction	Between Groups	.225	1	.225	.352	.557
	Within Groups	23.655	37	.639		
	Total	23.879	38			
Self-Efficacy	Between Groups	.000	1	.000	.000	.995
	Within Groups	9.015	27	.334		
	Total	9.015	28			
Turnover Intentions	Between Groups	.056	1	.056	.021	.885
	Within Groups	76.101	29	2.624		
	Total	76.157	30			
Extraversion	Between Groups	.197	1	.197	.451	.507
	Within Groups	13.062	30	.435		
	Total	13.259	31			
Conscientiousness	Between Groups	.701	1	.701	2.707	.110
	Within Groups	8.022	31	.259		
	Total	8.722	32			
Time in service (years)	Between Groups	.102	1	.102	.001	.975
	Within Groups	4731.564	46	102.860		
	Total	4731.667	47			
Active-Duty rank or Civilian pay grade	Between Groups	.258	1	.258	.036	.850
	Within Groups	312.351	44	7.099		
	Total	312.609	45			
Age	Between Groups	36.323	1	36.323	.277	.601
	Within Groups	5900.784	45	131.129		
	Total	5937.106	46			
Highest level of education	Between Groups	.058	1	.058	.069	.795
	Within Groups	37.857	45	.841		
	Total	37.915	46			

Correlations

Table 5 reports the correlations for the variables used in the hypotheses, with significant relationships having a p-value below 0.05 (annotated with an asterisk in the

table). The Cronbach's alphas for each of the measures are also reported in parentheses in the table. Analysis of these results show significant positive correlations for the relationships between job satisfaction and perceived VR benefits, self-efficacy and job satisfaction, and self-efficacy and conscientiousness. The results also show a significant negative correlation for the relationships between turnover intentions and job satisfaction, turnover intentions and self-efficacy, and turnover intentions and conscientiousness. This provides initial support for hypotheses H1B, H3A, and H4A. Hypothesis H1A was not supported with this correlation analysis (p-value of 0.174 > 0.05) but did report a relationship in the negative direction as hypothesized. Further analysis via linear regressions is needed to confirm these results and determine if other relationships exist.

Table 5. Correlation Results

		Perceived VR Benefits	Job Satisfaction	Extraversion	Conscientiousness	Turnover Intentions	Self-Efficacy
Perceived VR Benefits	Pearson Correlation	(0.90)					
	Sig. (2-tailed)						
Job Satisfaction	Pearson Correlation	.700**	(0.87)				
	Sig. (2-tailed)	.000					
Extraversion	Pearson Correlation	.153	-.104	(0.86)			
	Sig. (2-tailed)	.509	.572				
Conscientiousness	Pearson Correlation	-.158	.328	.334	(0.89)		
	Sig. (2-tailed)	.495	.062	.062			
Turnover Intentions	Pearson Correlation	-.326	-.619**	-.171	-.480**	(0.93)	
	Sig. (2-tailed)	.174	.000	.375	.007		
Self-Efficacy	Pearson Correlation	.241	.464*	.011	.423*	-.605**	(0.86)
	Sig. (2-tailed)	.335	.011	.957	.025	.001	

Linear Regression Analysis

For each of the hypotheses proposed, a linear regression analysis was conducted in SPSS to test the relationship between the specified variables. The assumptions of a linear regression model were tested for each of the hypotheses to determine if the results were valid. The results were then compared to the correlations previous shown to conclude if and where significant relationships were present.

Assumptions

For the linear regression results of the hypotheses be valid, four assumptions must be met (McClave et al., 2018):

1. Residuals should follow a normal distribution.
2. Residuals should be equally distributed (homoscedastic).
3. Dependent and independent variables have a linear relationship.
4. Residuals are independent.

Each linear regression was tested in SPSS to ensure that these assumptions were met, with outputs shown below for each hypothesis. To test the first assumption, a normal p-p plot was created, and for the second assumption a scatterplot was created with the predicted and residual values. Since the first two assumptions were met for all the models, the third assumption of linearity was also met. The fourth assumption or presence of multicollinearity was not necessary to test for since this only applies to multiple linear regression models.

H1A: Perceived VR Training Benefits have a negative relationship with Turnover Intentions

As shown in Figures 3 and 4, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot.

This hypothesis did not have a significant relationship and was not supported via the previous correlation table, even though it did follow the negative direction as proposed. However, with the addition of control variables in the linear regression model, a significant relationship is supported in Table 6 with a p-value of 0.016, with a value less than 0.05 being significant. This relationship was found to be in the positive direction based on the beta coefficients however, contrary to the hypothesized relationship. Control variables added to the model included age, education, job satisfaction, and self-efficacy. These control variables help remove variance in the model which was attributed to error, allowing perceived VR benefits and turnover to have a significant relationship.

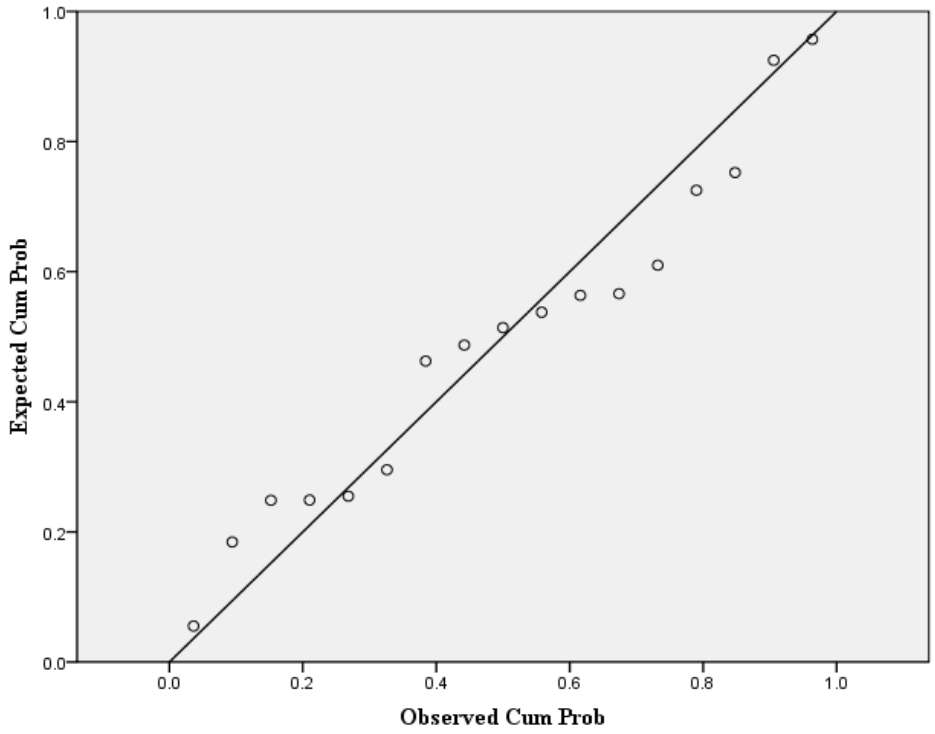

Figure 3. H1A Normal P-P Plot

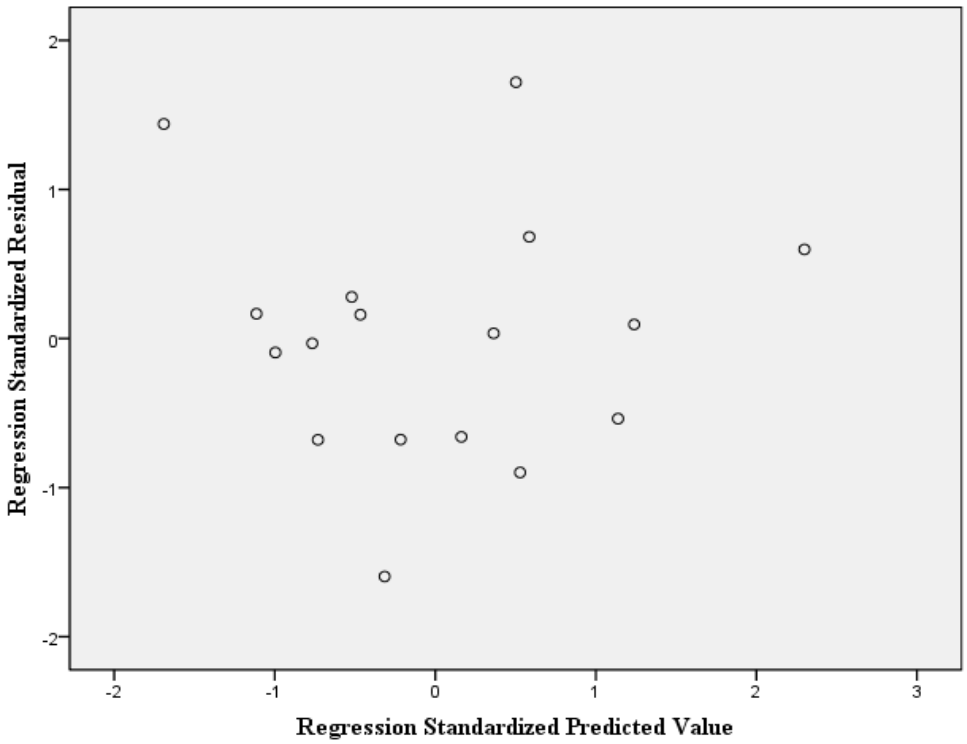

Figure 4. H1A Residuals Scatterplot

Table 6. H1A Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.543	1.848		6.248	.000
	Self-Efficacy	-1.377	.510	-.432	-2.700	.019
	Job Satisfaction	-.947	.279	-.489	-3.395	.005
	What is your age?	.037	.018	.295	2.026	.066
	Select your highest level of education.	-.425	.280	-.247	-1.517	.155
2	(Constant)	11.433	1.465		7.806	.000
	Self-Efficacy	-1.313	.405	-.412	-3.243	.008
	Job Satisfaction	-1.704	.346	-.880	-4.927	.000
	What is your age?	.040	.015	.321	2.767	.018
	Select your highest level of education.	-.320	.225	-.187	-1.424	.182
	Perceived VR Benefits	.614	.216	.487	2.847	.016

a. Dependent Variable: Turnover Intentions

H1B: Perceived VR Training Benefits have a positive relationship with Job Satisfaction

As shown in Figures 5 and 6, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did have a significant relationship in Table 7 with a p-value of 0.000, with a value less than 0.05 being significant and was also supported via the previous correlation table.

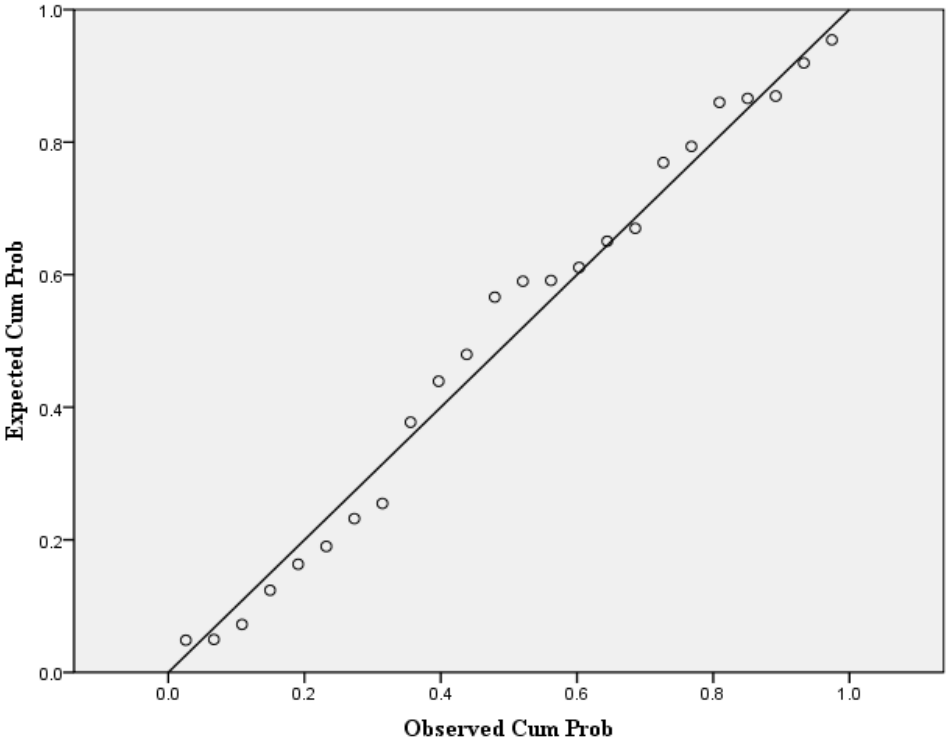

Figure 5. H1B Normal P-P Plot

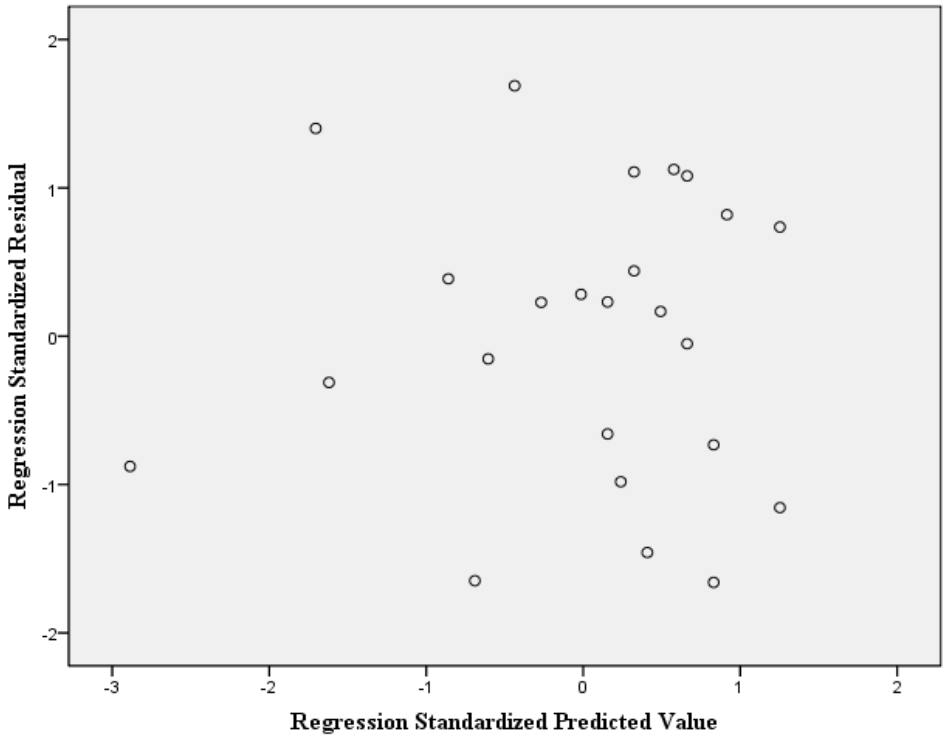

Figure 6. H1B Residuals Scatterplot

Table 7. H1B Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.538	.452		5.617	.000
	Perceived VR Benefits	.409	.089	.700	4.597	.000

a. Dependent Variable: Job Satisfaction

H1C: Job Satisfaction mediates the relationship between Perceived VR Training Benefits and Turnover Intentions

Based on further analysis, this relationship was unable to be tested with the data collected. Since H1A required control variables, testing this mediation relationship would require structural equation modeling and the current data's sample size is not big enough for this type of analysis. However, since the individual paths in H1A and H1B were supported, this relationship appears to have the potential to be supported. Future research would have to confirm this conclusion with a larger sample size.

H2A: Conscientiousness has a positive relationship with Perceived VR Training Benefits

As shown in Figures 7 and 8, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did not have a significant relationship in Table 8 with a p-value of 0.495, with a value greater than 0.05 not being significant, and was also not supported via the previous correlation table.

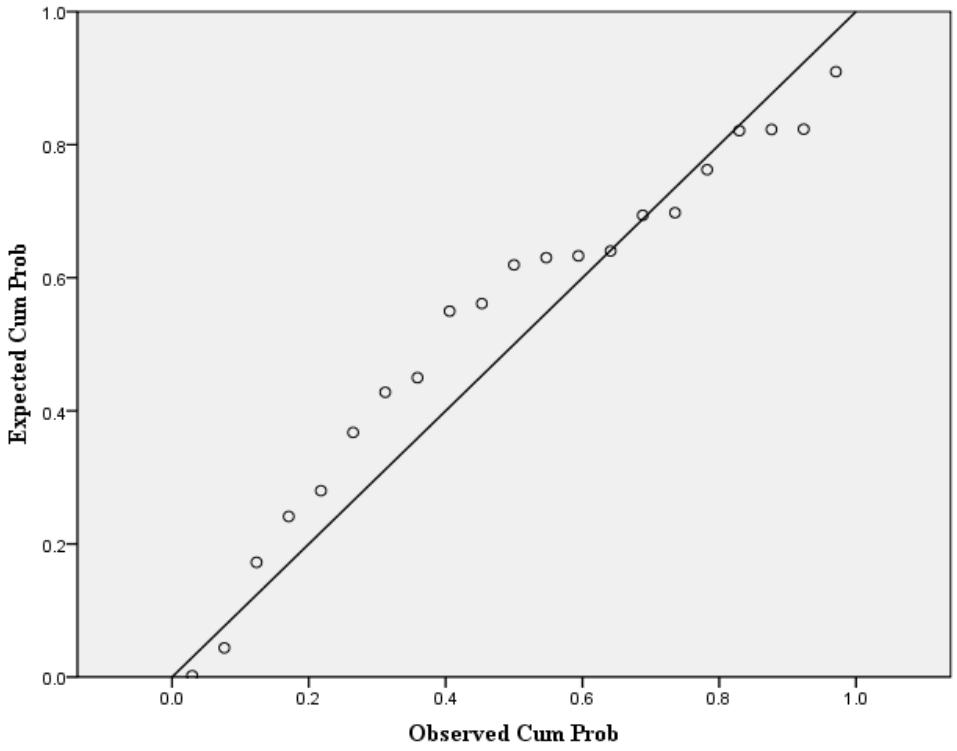

Figure 7. H2A Normal P-P Plot

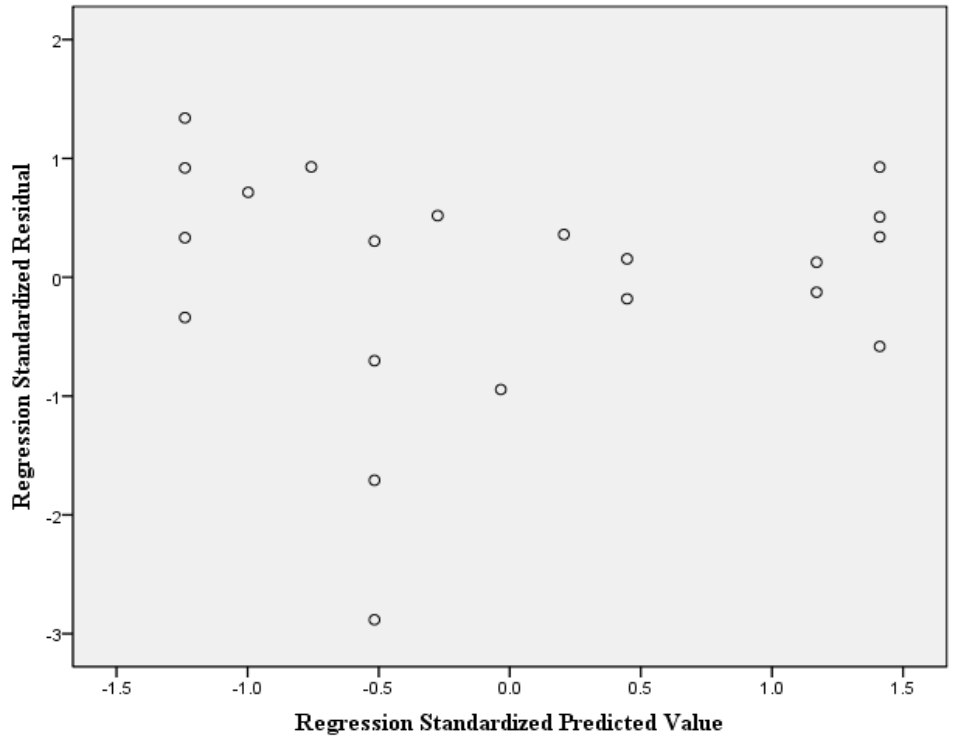

Figure 8. H2A Residuals Scatterplot

Table 8. H2A Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.165	3.073		2.332	.031
	Conscientiousness	-.497	.714	-.158	-.696	.495

a. Dependent Variable: Perceived VR Benefits

H2B: Extraversion has a positive relationship with Perceived VR Training Benefits

As shown in Figures 9 and 10, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did not have a significant relationship in Table 9 with a p-value of 0.509, with a value greater than 0.05 not being significant, and was also not supported via the previous correlation table.

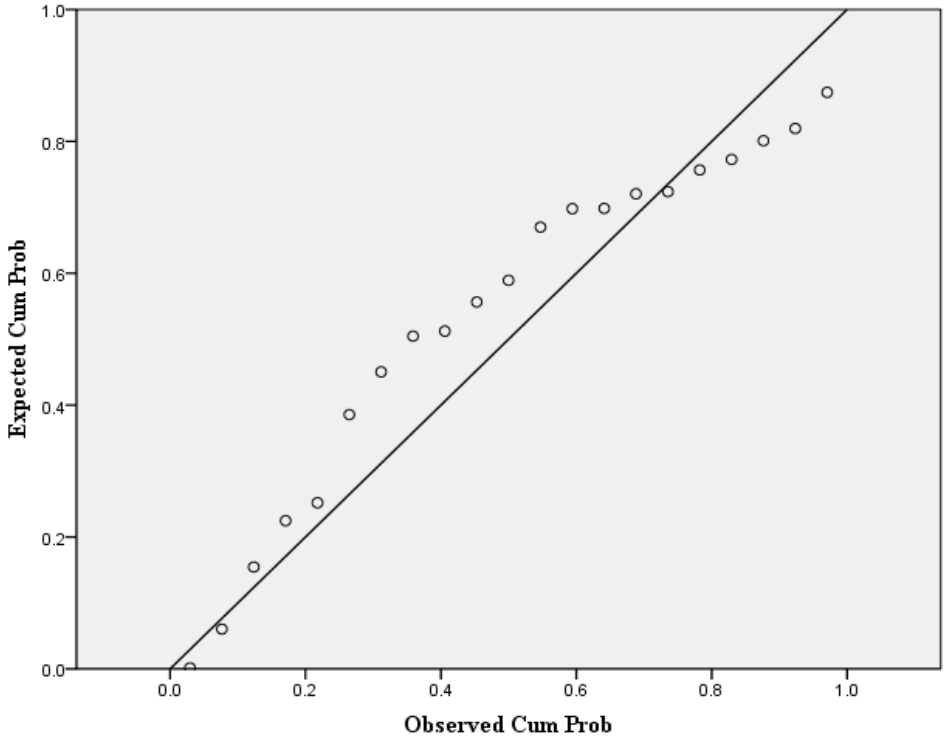

Figure 9. H2B Normal P-P Plot

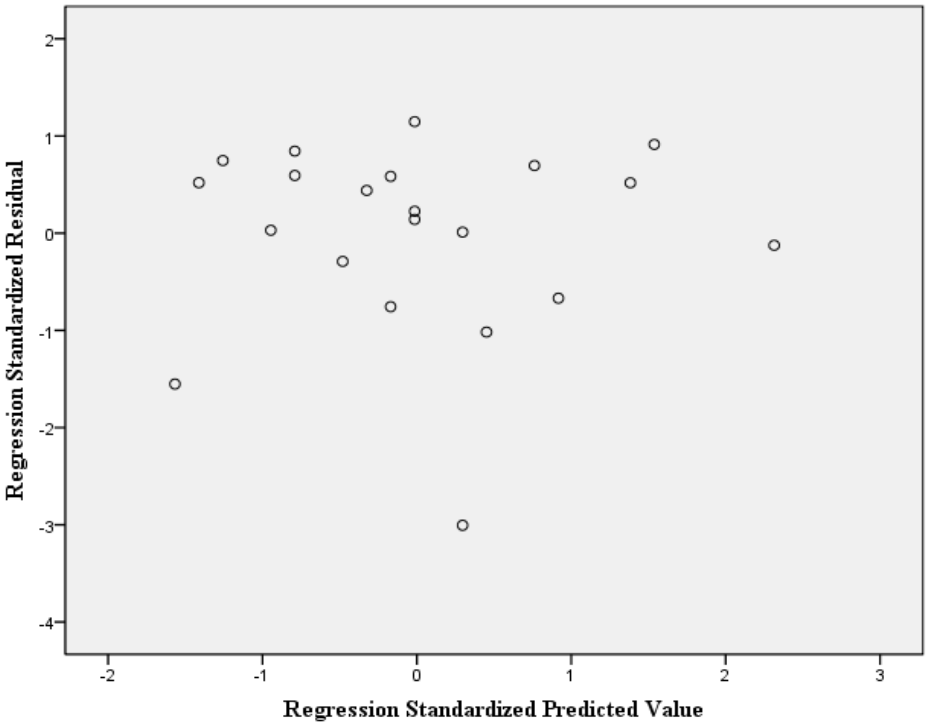

Figure 10. H2B Residuals Scatterplot

Table 9. H2B Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.950	1.641		2.407	.026
	Extraversion	.310	.460	.153	.673	.509

a. Dependent Variable: Perceived VR Benefits

H3A: Self-Efficacy has a positive relationship with Job Satisfaction

As shown in Figures 11 and 12, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did have a significant relationship in Table 10 with a p-value of 0.011, with a value less than 0.05 being significant, and was also supported via the previous correlation table.

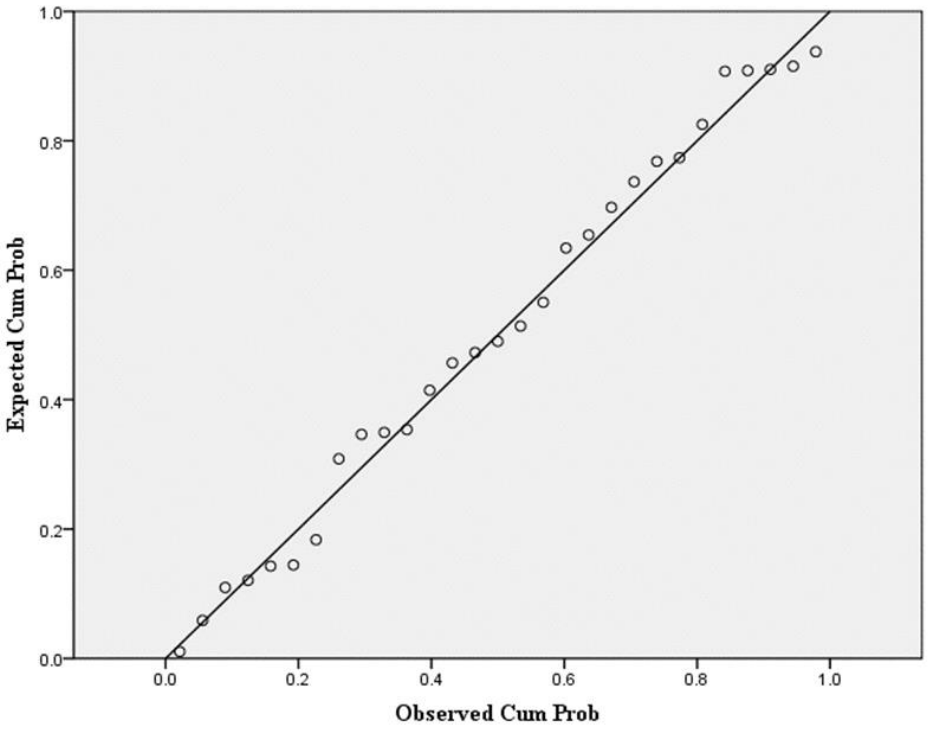

Figure 11. H3A Normal P-P Plot

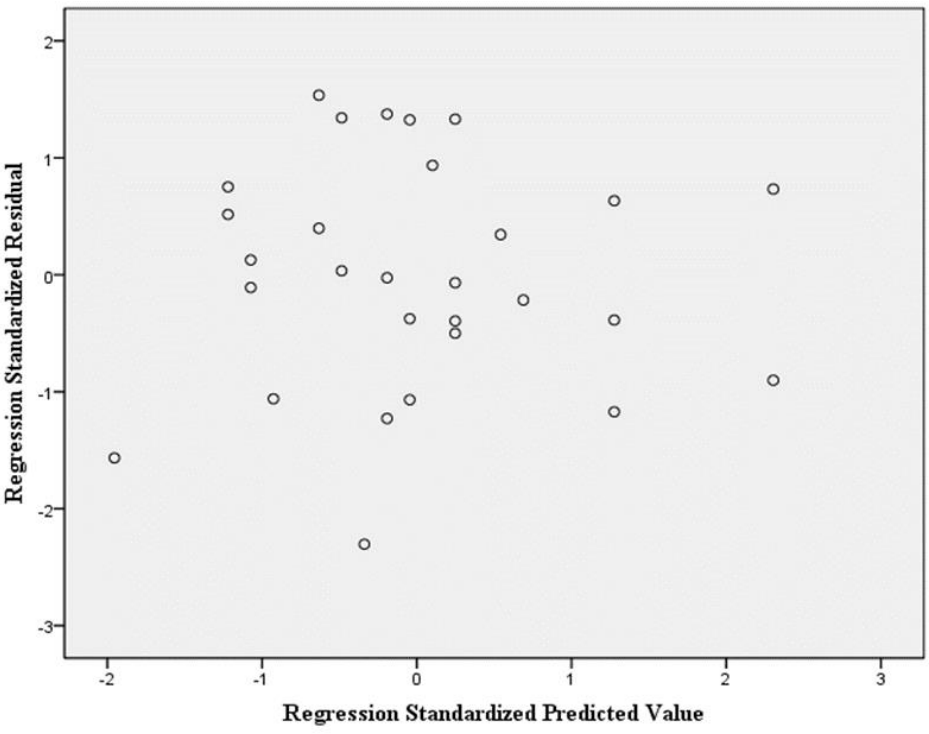

Figure 12. H3A Residuals Scatterplot

Table 10. H3A Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.812	.990		1.829	.078
	Self-Efficacy	.721	.265	.464	2.718	.011

a. Dependent Variable: Job Satisfaction

H3B: Self-Efficacy has a positive relationship with Perceived VR Training Benefits

As shown in Figures 13 and 14, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did not have a significant relationship in Table 11 with a p-value of 0.335, with a value greater than 0.05 not being significant, and was also not supported via the previous correlation table.

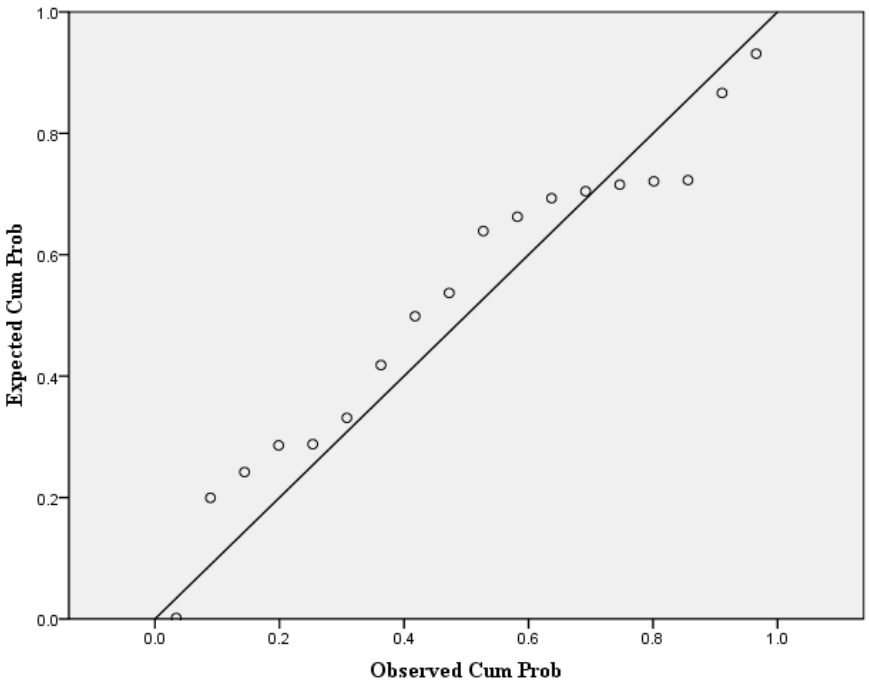

Figure 13. H3B Normal P-P Plot

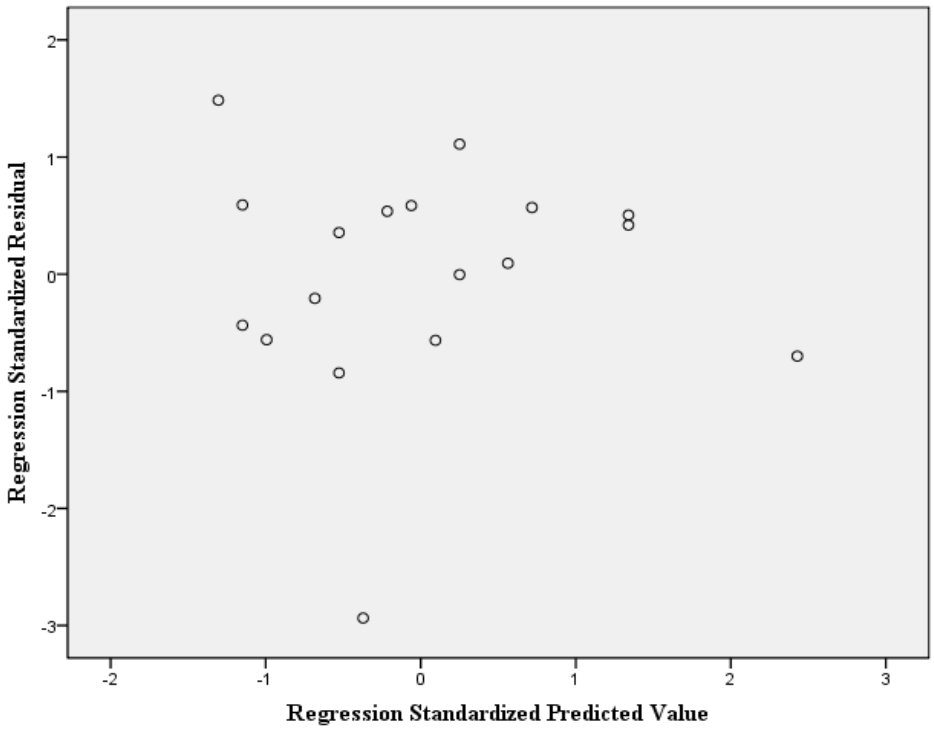

Figure 14. H3B Residuals Scatterplot

Table 11. H3B Regression

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.876	2.194		1.311	.208
	Self-Efficacy	.584	.587	.241	.994	.335

a. Dependent Variable: Perceived VR Benefits

H4A: Job Satisfaction has a negative relationship with Turnover Intentions

As shown in Figures 15 and 16, this linear regression meets all assumptions of a linear regression model. It appears to follow a normal distribution on the p-p plot since the residuals are relatively normal along the plotted line and is relatively homoscedastic in the residuals scatterplot. This hypothesis did have a significant relationship in Table 12 with a p-value of 0.000, with a value less than 0.05 being significant, and was also supported via the previous correlation table.

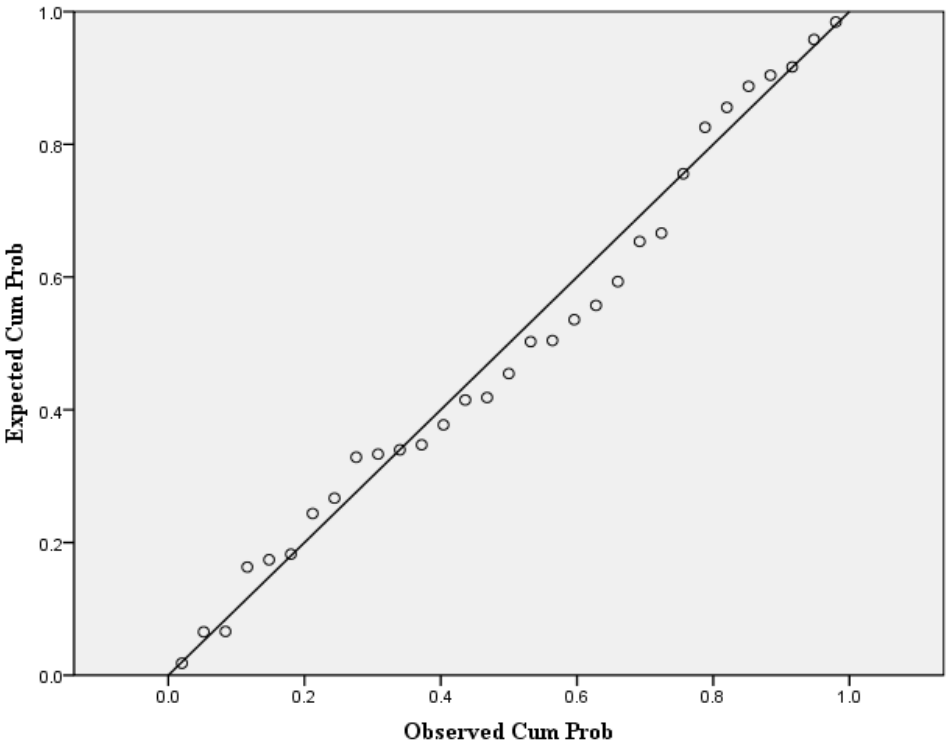

Figure 15. H4A Normal P-P Plot

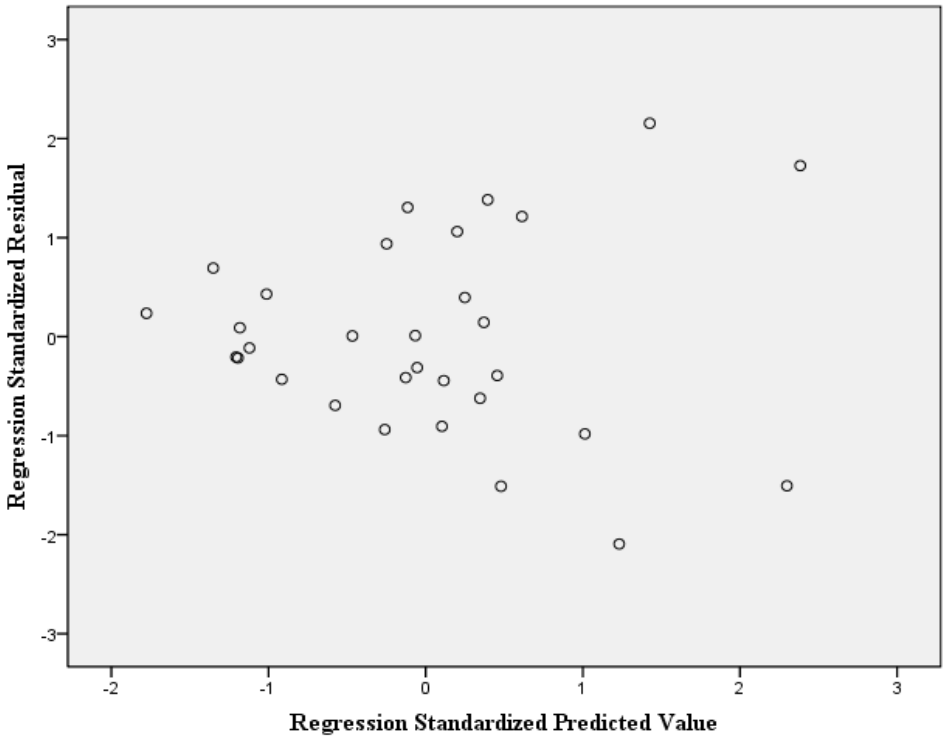

Figure 16. H4A Residuals Scatterplot

Table 12. H4A Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	7.588	1.232		6.157	.000
	Job Satisfaction	-1.148	.271	-.619	-4.241	.000

a. Dependent Variable: Turnover Intentions

Post Hoc Analysis

After primary analysis of the hypotheses was complete, a more exploratory analysis was conducted. This was conducted in order to determine if other variables measured might further inform AFCEC and the fire department's decision making. A post hoc analysis was conducted and found several additional interesting significant relationships in the data collected. These relationships are summarized below with the pertinent figures and tables being provided in Appendix B.

First, the relationship of Leader-Member Exchange (LMX) theory was explored. LMX theory describes how leader-member relationships develop over time and explains the extent to which subordinates have a relationship with their supervisor or leader (Colquitt et al., 2016). This measure was comprised of a total of seven questions, which produced a Cronbach's alpha of 0.91. These questions, derived from the literature published by Graen & Uhl-Bien (1995), utilized a seven-point Likert scale. With LMX being the independent variable, bivariate correlations and linear regressions were conducted in SPSS to test if there was a positive relationship between perceived VR training benefits, job satisfaction, and self-efficacy.

For the bivariate correlations, LMX had a significant positive relationship with all three of these variables. To further test these relationships, three linear regression models were constructed with LMX and each of the different dependent variables. The

assumptions of linear regressions were tested, with all appearing to be normal and homoscedastic. All three of the regression models produced statistically significant positive relationships with LMX, in agreement with the bivariate correlations. These findings are in line with Colquitt et al. (2016), who concluded that employees with higher levels of LMX have higher levels of job performance and organizational commitment. While the relationship of LMX and perceived VR training benefits was not reviewed in literature or studied in the primary hypotheses, this conclusion makes logical sense based on LMX theory and could be further explored in future studies. The relationship between LMX and turnover intentions was also explored but was not statistically significant. This contrasted with Colquitt et al. (2016), who concluded that employees with a high level of LMX will be less likely to leave an organization. The lack of a significant relationship with LMX and turnover intentions, as well as the difference in findings with H3B, may be due to the limitations discussed in Chapter 5. In conclusion, firefighters who have higher positive relationships with their leaders have higher perceived VR training benefits, job satisfaction, and self-efficacy. The SPSS results are shown in the tables and figures in Appendix B.

Second, the relationships between the Big Five personality traits and turnover intentions were explored. The Big Five and turnover intention questions were derived from the literature and had produced Cronbach's alphas greater than 0.70, previously discussed in Chapter 3. This included the other personality traits not discussed in Chapter 3 or in the proposed hypothesized relationships: neuroticism, openness to experience, and agreeableness. The questions measuring these traits also produced acceptable Cronbach's alphas of 0.90 for neuroticism, 0.73 for openness to experience, and 0.80 for

agreeableness. With each of the Big Five traits as the independent variable and turnover intentions as the dependent variable, bivariate correlations and linear regressions were conducted in SPSS to test if there were significant relationships.

For the bivariate correlations, the Big Five personality traits had multiple relationships present. Conscientiousness and agreeableness both had significant negative relationships and neuroticism had a positive relationship with turnover intentions; additionally, extraversion and openness to experience did not have significant correlations. To further test these relationships, three linear regression models were constructed for the significant relationships from the bivariate correlations. The assumptions of linear regressions were tested, with all appearing to be normal and homoscedastic. The results of these models also concluded that conscientiousness and agreeableness are negatively related to turnover intentions and neuroticism is positively related to turnover intentions. Similar to the bivariate correlations, extraversion and openness to experience did not have significant relationships with turnover intentions. In conclusion, firefighters who have greater levels of conscientiousness and agreeableness are less likely to have turnover intentions, with those who have higher levels of neuroticism being more likely to have turnover intentions. The SPSS results are shown in the tables and figures in Appendix B.

Summary

This chapter provided an overview of the analysis and results of the study. Descriptive statistics were discussed, as well as the correlations between the hypothesized variables. The initial analysis of the correlation table found that H1B, H3A, and H4A

were supported by significant relationships. Further analysis was conducted using linear regression models for each of the hypotheses, with significant relationships supporting H1B, H3A and H4A. A post hoc analysis was conducted finding additional significant relationships in the data.

V. Discussion and Conclusions

This chapter outlines the conclusions drawn from the research. First, the results of the hypotheses tests are discussed. Next, the implications of these results are detailed and explained, linking them to the context of United States Air Force firefighting. After that, the limitations of the research are outlined, followed by areas for improvement and future research.

Discussion

This research examined the possible relationships between the perceptions of VR training benefits and several personality traits and organizational commitment variables such as job satisfaction, turnover intentions, the Big Five traits of extraversion and conscientiousness, and self-efficacy. The study of these variables allows for a better understanding of which individuals perceive VR training as beneficial and how this links to organizational commitment. In this study, organizational commitment was not measured directly, however, based on the literature organizational commitment is the strongest predictor of turnover. Therefore, turnover intentions was utilized as an indicator of levels of commitment by proxy. After the analysis of the data collected, three out of eight of the hypotheses were supported.

The first hypothesis (H1A) predicted that perceived VR training benefits has a negative relationship with turnover intentions. This hypothesis was not supported in the findings. This relationship did not have a strong statistical significance in the correlation table and the linear regression model showed a significant relationship but in the positive direction. These findings contrast the conclusions of Alfes et al. (2013), Glaveli and

Karassavidou (2011), Karatepe (2013), and Newman et al. (2011) whose results show that as an organization invests in their employees through beneficial training like the VR training used in these squadrons, the employee will reciprocate by demonstrating higher levels of organizational commitment, therefore exhibiting less of a desire to leave the organization. This contrast with the results in literature may be because the sample size is too small, so the lack of significant negative relationship is due to random error. Alternatively, these results may be accurate and firefighters who view the training as valuable are more likely to use their new skills and experience to leave the Air Force in search of a job elsewhere.

The second hypothesis (H1B) predicted that perceived VR training benefits has a positive relationship with job satisfaction. This hypothesis was supported in the findings. This relationship had a strong statistical significance in both the bivariate correlation and the linear regression model. Similar to H1A, these findings are in line with social exchange theory and the results of Alfes et al. (2013), Glaveli and Karassavidou (2011) Karatepe (2013), and Newman et al. (2011), and Bartlett (2001). These results show that as an organization invests in their employees through beneficial training like the VR training used in these squadrons, the employee will reciprocate by demonstrating higher levels of organizational commitment and increased levels of job satisfaction.

The third hypothesis (H1C) predicted that job satisfaction mediates the relationship between perceived VR training benefits and turnover intentions. This hypothesis was not directly supported in the findings. This relationship was unable to be tested with the data collected since it would require structural equation modeling and the current data's sample size is not big enough for this type of analysis. However, since the

individual paths in H1A and H1B were supported, this relationship appears to have the potential to be supported. Based on the literature reviewed, social exchange theory, and the support for H1A and H1B, it is hypothesized that with a larger sample size H1C would be supported; however, this cannot be claimed in this study.

The fourth and fifth hypotheses both involved different variables of the Big Five personality traits. The fourth hypothesis (H2A) predicted that conscientiousness has a positive relationship with perceived VR training benefits and the fifth hypothesis (H2B) predicted that extraversion has a positive relationship with perceived VR training benefits. These hypotheses were not supported in the findings. The lack of statistical significance with these relationships in any direction (positive or negative) contrasts with the conclusions of Wirth et al. (2020), Aranha et al. (2018), and Falcão et al. (2018) who found that personality traits impact VR user experiences in different ways and that an individual's personality traits can predict their behavior in the VR training environment, especially conscientiousness and extraversion of the Big Five. These results show that the individual's personality traits of conscientiousness and extraversion do not have a relationship with how they perceive the benefits of VR training.

The sixth hypothesis (H3A) predicted that self-efficacy has a positive relationship with job satisfaction. This hypothesis was supported in the findings. This relationship had a strong statistical significance in both the bivariate correlation and the linear regression model. These findings are in line with the previously reviewed literature including Judge et al. (2001). These results show that individuals at these fire departments who have higher levels of self-confidence also have higher levels of job satisfaction.

The seventh hypothesis (H3B) predicted that self-efficacy has a positive relationship with perceived VR training benefits. This hypothesis was not supported in the findings. The lack of statistical significance with this relationship contrasts with the conclusions of Hasan (2008), Igbaria and Ivari (1995), Jawahar and Elango (2001), and Jia et al. (2014) who found that the self-efficacy and perceptions of VR training and computer system efficacy were positively related. These results show that the individual's self-efficacy does not have a relationship with how they perceive the benefits of VR training.

The eighth hypothesis (H4A) predicted that job satisfaction has a negative relationship with turnover intentions. This hypothesis was supported in the findings. This relationship had a strong statistical significance in both the bivariate correlation and the linear regression model. These findings are in line with the previously reviewed literature including, Judge et al. (2001). These results show that individuals at these fire departments who have higher levels of job satisfaction, have fewer turnover intentions, and therefore greater organizational commitment.

The post hoc analysis resulted in the finding of several more interesting significant relationships. LMX had a significant positive relationship with perceptions of VR training benefits, job satisfaction, and self-efficacy, but lacked a significant relationship with turnover intentions. Exploring the Big Five personality traits further resulted in conscientiousness and agreeableness having a significant positive relationship with turnover intentions and neuroticism having a significant negative relationship with turnover intentions. Extraversion and openness to experience did not have a significant relationship with turnover intentions.

Implications

There are several implications that can be drawn from the conclusion of this study. Reviewing the supported hypotheses regarding perceptions of VR training benefits from this study, it appears that social exchange theory is an important factor for leadership to consider. When supervision or leadership invests in their employees through valuable training experiences, like VR, the employees are more likely to reciprocate by exhibiting higher job satisfaction, therefore increasing job performance. This could result in a more satisfied fire department with less turnover and greater performance. LMX theory is also important to consider when implementing VR technology. This study supported the correlation between the supervisors and subordinates having significant positive relationships, with the perceptions of VR training benefits. This shows that leadership's support of VR technology, as well as their positive relationships with their subordinates, has the potential to help with the acceptance and effectiveness of the VR training itself. Therefore, a fire department with a strong foundation of leader-member relationships can aid in the implementation of VR training. LMX was also found to have positive significant relationships with self-efficacy and job satisfaction. This shows that not only can LMX help with the perceptions of VR training but also have a relationship with increasing individual's self-efficacy and job satisfaction. When taken into account, this relationship can further aid leadership in building a strong fire department with members who have faith in their leadership, like what they do, and are confident in doing it.

Important relationships not specific to the perceptions of VR training were also highlighted in this research. The significant positive relationship between self-efficacy

and job satisfaction, as well as the significant negative relationship between job satisfaction and turnover intentions, were supported in this study. This is important to note from a leadership perspective, since most leaders want their subordinates to be both confident and satisfied in their job, while also willing to stay in the organization. Based on these results as well as the literature reviewed, there is a possibility that the incorporation of beneficial VR training can help both self-efficacy and job satisfaction, therefore decreasing turnover intentions in individuals.

The literature reviewed also highlighted several key points to consider regarding the implementation of VR. First, many studies concluded that immersive simulation training like VR is as beneficial, if not better, than traditional training methods for increasing self-efficacy, job satisfaction, and job performance. While further studies are necessary for the applicability and efficacy of these simulations in the firefighting community, there is substantial evidence to serve as a proof of concept and advocation for the integration of VR training. Second, the perceptions of VR training efficacy and benefits are also closely linked to organizational commitment and job performance, as well as the employee's willingness to accept the implementation of the new technology. Therefore, careful consideration is necessary when stakeholders are deciding which VR training platform to use and how to incorporate it, since the perceptions of the firefighters using that new technology will greatly impact their organizational commitment, job satisfaction, and job performance.

While personality traits did not have supported relationships with perceptions of VR training benefits, it was revealed in post hoc analysis that significant relationships exist with turnover intentions. The significant positive relationships of conscientiousness

and agreeableness and the negative relationship of neuroticism with turnover intentions can help inform leadership on what type of person is likely to stay with the organization or have higher levels of turnover intentions.

Limitations

This research had several limitations which can be improved upon in future research. First, the data collected may have lacked the necessary power to prove the true nature of all the relationships between variables. Per Cohen (1992), in order to have enough power, a sample size of 85 would have been needed. This is with using an alpha value of 0.05 with a medium effect size. With the sample being 48, this could have caused some of the hypothesized relationships to not have enough power to show significance. With a larger sample size of 85 or more, there may have been enough power to show significant relationships between the variables in the hypotheses not supported, which would be closer in line with results from the literature reviewed. Another limitation is the small number of United States Air Force fire departments with VR simulator trainers. This limitation contributed to the prior one mentioned since the survey was only able to be sent to the three installations with the VR FLAIM trainer. If more installations had firefighting VR capabilities, then a study would have a better chance of collecting more data from a larger volunteer pool. This would also help correct for individuals who skip questions or start and do not complete the survey. The survey had a 67% completion rate, as reported by SurveyMonkey.com, and some questions had many individuals skip the question entirely. This further decreased the power of the data since some questions had a larger number of responses than others. A larger population to

gather a sample from would make these instances have less of an effect on the data, which would allow for more people to take the survey and further help increase the power.

Future Research

There are several areas for future research in order to further inform AFCEC and the firefighting community in making the decision to fully implement VR training. First, a design of experiments study could be conducted specifically comparing how firefighters learn and perform in VR training versus real-world training or traditional classroom training. Assessing the user's task performance post training is an extensively used method for evaluating VR based training efficacy, which could be incorporated in future studies (Renganayagalu et al., 2021). This would allow the authors to draw conclusions about that specific VR platform and how well individuals in their profession performed in each training medium. This would help stakeholders study if a specific VR platform were worthwhile to use for a type of training objective by analyzing if performance in and out of the VR training is higher versus other methods. Other variables such as self-efficacy and job satisfaction could be compared between the two training modes as well.

Second, a study like this one could be conducted in the future if more fire departments acquire the VR trainer, and a larger sample size is able to be captured. This would enable a comparison of results between this and a newer study with a larger sample, but it also could use different measures to collect data on the variables of interest, incorporate different VR perception questions based on new research or stakeholder

input, and utilize a shorter survey for increased likelihood of completion. A similar survey could also investigate the different components of organizational commitment such as affective, continuance, and normative commitment. This would inform AFCEC if perceptions of VR are changing over time.

Third, as more platforms for firefighting training emerge, a study could be conducted comparing individual perceptions of the training between different company's simulations in order to gain a better understanding of the preferred training platform. This would help stakeholders identify which trainer was preferred by the firefighting community at the installations for a clearer picture of what the end user prefers.

Conclusion

As the United States Air Force looks towards new technology for innovative solutions to modern-day challenges, VR training simulations may aid the installation's fire departments in achieving training requirements, which are costly, risky, and difficult to conduct. This research has shown that several factors contribute to the successful implementation of VR training programs, as well as theoretical explanations as to why these relationships exist. Furthermore, this research has the potential to aid leadership in gaining a better understanding of their airmen, by exploring the relationships between perceived VR training benefits, job satisfaction, self-efficacy, Big Five personality traits, turnover intentions, and leader-member exchange.

Appendix A: Survey

USAF Firefighter Virtual Reality (VR) and Personality Study

You are being asked to participate in a research study. Key study information you should know:

• The purpose of the study is to research what variables may affect virtual reality (VR) training for U.S. firefighters and how this training may affect performance and readiness. If you choose to participate, you will be asked to complete this confidential online survey when it is most convenient and comfortable for you to do so.

• Risks or discomforts from this research are minimal and are similar to what you would experience in an everyday office environment. All survey data will be coded with volunteer's names removed and kept behind locked office doors on a secure computer. **The data and survey results will be kept confidential and will not be shared with your leadership or coworkers.**

• The study will have no direct benefits to those who volunteer.

• Taking part in this research project is voluntary. You can discontinue participation at any time without penalty or loss.

• By taking this survey, you are signifying you are in agreement with the above consent information.

Any questions or concerns can be sent to Capt Dylan A. Gagnon at dylan.gagnon@afit.edu.

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1. Which base are you stationed at?

- RAF Lakenheath
- McConnell AFB
- Kunsan AB

2. What is your time in service? Round to the nearest year.

3. What is your current rank if Active Duty or pay grade if Civilian?

4. What level of CDCs have you completed?

- None
- 3 level
- 5 level
- 7 level
- 9 level

5. What is your age?

6. Select your highest level of education.

- High School Diploma
- Associate's Degree
- Bachelor's Degree
- Master's Degree
- Doctoral Degree

7. Have you used the VR FLAIM trainer?

- Yes
- No

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8. How long ago was your first VR training experience? Round to nearest day.

9. How many total training sessions have you had in the VR FLAIM trainer?

- 1-5
- 6-10
- 11-20
- 21-25
- More than 25

10. How many total hours have you spent training in the VR FLAIM trainer? Round to nearest hour.

11. How much do you agree or disagree with each of these statements?

	1-Strongly disagree	2-Disagree	3-Slightly disagree	4-Neither	5-Slightly agree	6-Agree	7-Strongly Agree
The VR training allows for the transfer of timely feedback	○	○	○	○	○	○	○
The VR training allows for tailorable scenarios	○	○	○	○	○	○	○
The VR training scenarios resemble real-world problems	○	○	○	○	○	○	○
The VR training is easy to use	○	○	○	○	○	○	○
I feel comfortable using the VR training	○	○	○	○	○	○	○
I feel I am a novice using the VR training	○	○	○	○	○	○	○
The VR training environment resembles the real-world environment	○	○	○	○	○	○	○
The VR training will help me perform my job better	○	○	○	○	○	○	○

12. Select the best choice based on how you personally feel.

	0-I have not trained in a VR scenario using foam	1-Strongly disagree	2-Disagree	3-Slighly disagree	4-Neither	5-Slight agree	6-Agree	7-Strongly agree
Does the VR scenarios for fighting fires with foam application provide a better learning environment than traditional classroom training methods?	○	○	○	○	○	○	○	○

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13. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
I feel I am being paid a fair amount for the work I do	○	○	○	○	○	○
Raises are too few and far between	○	○	○	○	○	○
I am unappreciated by the organization when I think about what they pay me	○	○	○	○	○	○
I feel satisfied with my chances for salary ○ increases	○	○	○	○	○	

14. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
Communications seem good within this organization	○	○	○	○	○	○
The goals of this organization are not ○ clear to me	○	○	○	○	○	
I often feel that I do not know what is going on with the organization	○	○	○	○	○	○
Work assignments are often not fully explained	○	○	○	○	○	○

15. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5-Agree moderately	6-Agree very much
I sometimes feel my job is meaningless	○	○	○	○	○	○
I like doing the things I do at work	○	○	○	○	○	○
I feel a sense of pride in doing my job	○	○	○	○	○	○
My job is enjoyable	○	○	○	○	○	○

16. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5-Agree moderately	6-Agree very much
I like the people I work with	○	○	○	○	○	○
I find I have to work harder at my job than I should because of the incompetence of the people I work with	○	○	○	○	○	○
I enjoy my co-workers	○	○	○	○	○	○
There is too much bickering and fighting at work	○	○	○	○	○	

17. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5-Agree moderately	6-Agree very much
Many of our rules and procedures make doing a good job difficult	○	○	○	○	○	○
My efforts to do a good job are seldom blocked by red tape	○	○	○	○	○	
I have too much to do at work	○	○	○	○	○	○
I have too much paperwork	○	○	○	○	○	○

18. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
When I do a good job, I receive the recognition for it that I should receive	○	○	○	○	○	○
I do not feel that the work I do is appreciated	○	○	○	○	○	○
There are few rewards for those who work here	○	○	○	○	○	○
I don't feel my efforts are rewarded the way they should be	○	○	○	○	○	

19. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
I am not satisfied with the benefits I receive	○	○	○	○	○	○
The benefits we receive are as good as most other organizations offer	○	○	○	○	○	
The benefit package we have is equitable	○	○	○	○	○	○
There are benefits we do not have which we should have	○	○	○	○	○	

20. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2-Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
My supervisor is quite competent in doing his/her job	○	○	○	○	○	○
My supervisor is unfair to me	○	○	○	○	○	○
My supervisor shows too little interest in the feelings of subordinates	○	○	○	○	○	○
I like my supervisor	○	○	○	○	○	○

21. How much do you agree or disagree with each of these statements?

	1-Disagree very much	2- Disagree moderately	3-Disagree slightly	4-Agree slightly	5- Agree moderately	6- Agree very much
There is really too little chance for promotion on my job	○	○	○	○	○	○
Those who do well on the job stand a fair chance of being promoted	○	○	○	○	○	○
People get ahead as fast here as they do in other places	○	○	○	○	○	○
I am satisfied with my chances for promotion	○	○	○	○	○	○

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22. Select the best choice based on how you personally feel

	1-Rarely	2-Occassionally	3-Sometimes	4-Fairly often	5-Very often
Do you know how satisfied your leader is with what you do?					

23. How much do you agree or disagree with each of these statements?

	1-Not at all	2-A little	3-A fair amount	4-Quite a bit	5-A great deal
How well does your leader understand your job problems and needs?					
How well does your leader recognize your potential?					

24. How much do you agree or disagree with each of these statements?

	1-None	2-Small chance	3-Moderate chance	4-High chance	5-Very high chance
What are the chances that your leader would use his/her power to help you solve problems in your work?					
What are the chances that he/she would “bail you out,” at his/her expense?					

25. Select the best choice based on how you personally feel

	1-Extremely ineffective	2-Worse than average	3-Average	4- Better than average	5- Extremely effective
How would you characterize your working relationship with your leader?					

26. Here are some things that could happen to people if they do their jobs especially well. How likely is it that each of these things would happen if you performed your job especially well?

	1-Not likely	2	3-Somewhat likely	4	5-Quite likely	6	7-Extremely likely
You will feel better about yourself as a person	○	○	○	○	○	○	○
You will have an opportunity to develop your skills and abilities	○	○	○	○	○	○	
You will have better job security	○	○	○	○	○	○	○
You will have more freedom on your job	○	○	○	○	○	○	○
You will be respected by the people you work with	○	○	○	○	○	○	○
Your supervisor will praise you	○	○	○	○	○	○	○

27. Different people want different things from their work. Here is a list of things a person could have on his or her job. How important is each of the following to you?

	1-Moderately important or less	2	3	4-Quite important	5	6	7-Extremely important
The amount of pay you get	○	○	○	○	○	○	○
The opportunity to develop your skills and abilities	○	○	○	○	○	○	
The chances you have to learn new things	○	○	○	○	○	○	○
Your chances for getting a promotion or a better job	○	○	○	○	○	○	
The respect you receive from the people you work with	○	○	○	○	○	○	○
The praises you get from your supervisor	○	○	○	○	○	○	○

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28. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future and be as honest as you can.

	1-Very inaccurate	2-Moderately inaccurate	3- Neither inaccurate or accurate	4- Moderatly accurate	5-Very accurate
Often feel blue	○	○	○	○	○
Dislike myself	○	○	○	○	○
Am often down in the dumps	○	○	○	○	○
Have frequent mood swings	○	○	○	○	○
Panic easily	○	○	○	○	○
Seldom feel blue	○	○	○	○	○
Feel comfortable with myself	○	○	○	○	○
Rarely get irritated	○	○	○	○	○
Am not easily bothered by things	○	○	○	○	○
Am very pleased with myself	○	○	○	○	○

29. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future and be as honest as you can.

	1-Very inaccurate	2-Moderately inaccurate	3- Neither inaccurate or accurate	4- Moderatly accurate	5-Very accurate
Feel comfortable around people	○	○	○	○	○
Make friends easily	○	○	○	○	○
Am skilled in handling social situations	○	○	○	○	○
Am the life of the party	○	○	○	○	○
Know how to captivate people	○	○	○	○	○
Have little to say	○	○	○	○	○
Keep in the background	○	○	○	○	○
Would describe my experiences as somewhat dull	○	○	○	○	○
Don't like to draw attention to myself	○	○	○	○	○
Don't talk a lot	○	○	○	○	○

30. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future and be as honest as you can.

	1-Very inaccurate	2-Moderately inaccurate	3- Neither inaccurate or accurate	4- Moderatly accurate	5-Very accurate
Believe in the importance of art	○	○	○	○	○
Have a vivid imagination	○	○	○	○	○
Tend to vote for liberal political candidates	○	○	○	○	○
Carry the conversation to a higher level	○	○	○	○	○
Enjoy hearing new ideas	○	○	○	○	○
Am not interested in abstract ideas	○	○	○	○	○
Do not like art	○	○	○	○	○
Avoid philosophical discussions	○	○	○	○	○
Do not enjoy going to art museums	○	○	○	○	○
Tend to vote for conservative political candidates	○	○	○	○	○

31. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future and be as honest as you can.

	1-Very inaccurate	2-Moderately inaccurate	3- Neither inaccurate or accurate	4- Moderatly accurate	5-Very accurate
Have a good word for everyone	○	○	○	○	○
Believe that others have good intentions	○	○	○	○	○
Respect others	○	○	○	○	○
Accept people as they are	○	○	○	○	○
Make people feel at ease	○	○	○	○	○
Have a sharp tongue	○	○	○	○	○
Cut others to pieces	○	○	○	○	○
Suspect hidden motives in others	○	○	○	○	○
Get back at others	○	○	○	○	○
Insult people	○	○	○	○	○

32. Please use the rating scale below to describe how accurately each statement describes you. Describe yourself as you generally are now, not as you wish to be in the future and be as honest as you can.

	1-Very inaccurate	2-Moderately inaccurate	3- Neither inaccurate or accurate	4- Moderatly accurate	5-Very accurate
Am always prepared	○	○	○	○	○
Pay attention to details	○	○	○	○	○
Get chores done right away	○	○	○	○	○
Carry out my plans	○	○	○	○	○
Make plans and stick to them	○	○	○	○	○
Waste my time	○	○	○	○	○
Find it difficult to get down to work	○	○	○	○	○
Do just enough work to get by	○	○	○	○	○
Don't see things through	○	○	○	○	○
Shirk my duties	○	○	○	○	○

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33. How confident would you feel with the following statements?

	1-Not confident at all	2	3-Neither not confident or confident	4	5-Very confident
Analyzing a long-term problem to find a solution	○	○	○	○	○
Designing new work procedures for your work area	○	○	○	○	○
Making suggestions to leadership about ways to improve the working of your section	○	○	○	○	○
Writing a proposal to spend money in your work area	○	○	○	○	○
Presenting information to a group of colleagues	○	○	○	○	○

34. This part of the survey asks about your role in relation to your work unit. Please focus on the way in which you work with other members of your work unit, not on how much you personally like or dislike other members as friends.

	1-Strongly disagree	2-Disagree	3-Neither	4-Agree	5-Strongly Agree
I try to communicate openly with other members about what I expect from them.	○	○	○	○	○
Other group members usually let me know what they expect from me.	○	○	○	○	○
I usually let other group members know when they have done something that affected my work.	○	○	○	○	○
Other group members usually let me know when I've done something that affected their work.	○	○	○	○	○
I have a clear understanding of the job problems and job needs of other group members.	○	○	○	○	○
Other group members clearly understand my job-related problems and needs.	○	○	○	○	○

35. This part of the survey asks about your role in relation to your work unit. Please focus on the way in which you work with other members of your work unit, not on how much you personally like or dislike other members as friends.

	1-Strongly disagree	2-Disagree	3-Neither	4-Agree	5-Strongly Agree
When I am busy, other group members often volunteer to help me out.					
When other group members are busy, I often volunteer to help them out.					
Other group members are willing to help finish work that was assigned to me.					
I'm willing to help finish work that had been given to other group members.					
Other group members are flexible about switching responsibilities to make things easier for me.					
I will switch responsibilities with other group members in order to make things easier for them.					

36. Answer the following based on your intentions.

	1-Strongly disagree	2-Disagree	3-Slightly disagree	4-Neither	5-Slightly agree	6-Agree	7-Strongly agree
I want to leave the Air Force very much.							
I intend to quit the Air Force someday soon.							
I think about quitting all the time.							
I am thinking about quitting right now.							
I think of quitting every time something goes wrong.							

Appendix B: Post Hoc Tables and Figures

Table 2.1. LMX Correlations

		LMX	Self-Efficacy	Job Satisfaction	Perceived VR Benefits
LMX	Pearson Correlation	(0.91)			
	Sig. (2-tailed)				
	N	34			
Self-Efficacy	Pearson Correlation	.434*	(0.86)		
	Sig. (2-tailed)	.021			
	N	28	29		
Job Satisfaction	Pearson Correlation	.668**	.464*	(0.87)	
	Sig. (2-tailed)	.000	.011		
	N	34	29	39	
Perceived VR Benefits	Pearson Correlation	.660**	.241	.700**	(0.90)
	Sig. (2-tailed)	.001	.335	.000	
	N	23	18	24	27

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

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

Table 2.2. LMX and Perceived VR Training Benefits Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.785	.803		2.223	.037
	LMX	.951	.236	.660	4.024	.001

a. Dependent Variable: Perceived VR Benefits

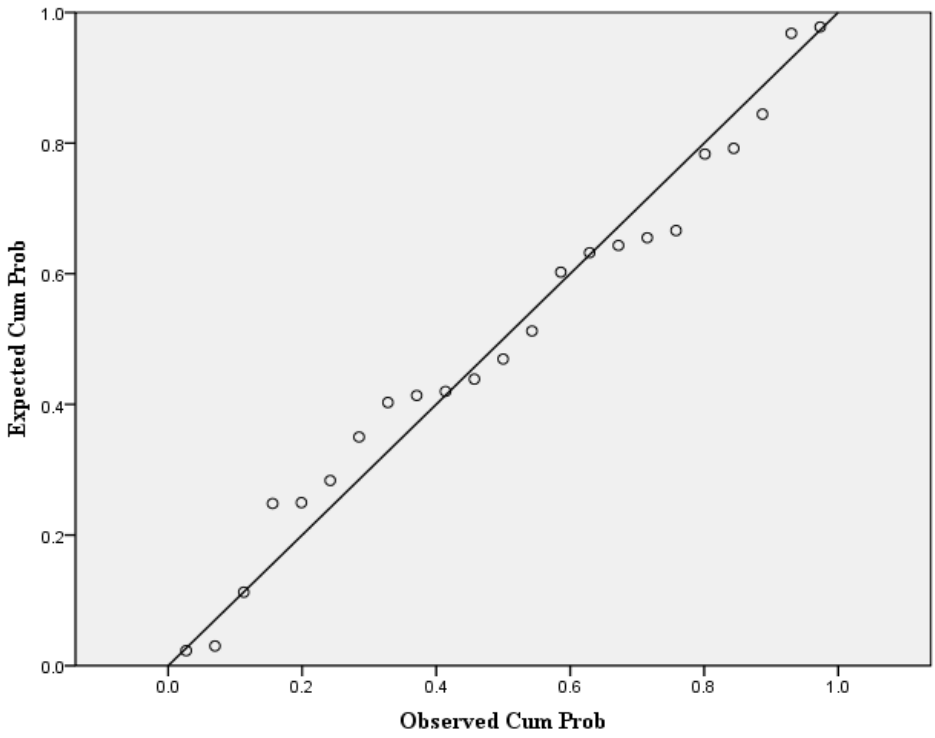

Figure 2.1. LMX/Perceived VR Training Benefits Normal P-P Plot

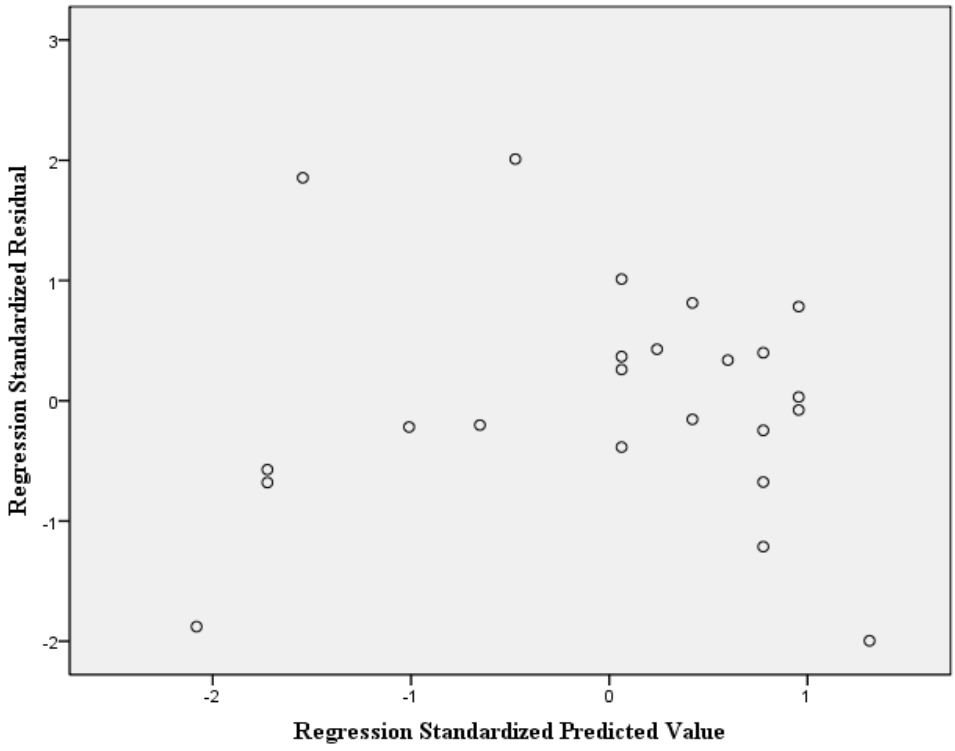

Figure 2.2. LMX/Perceived VR Training Benefits Residuals Scatterplot

Table 2.3. LMX and Job Satisfaction Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.750	.359		7.651	.000
	LMX	.525	.103	.668	5.083	.000

a. Dependent Variable: Job Satisfaction

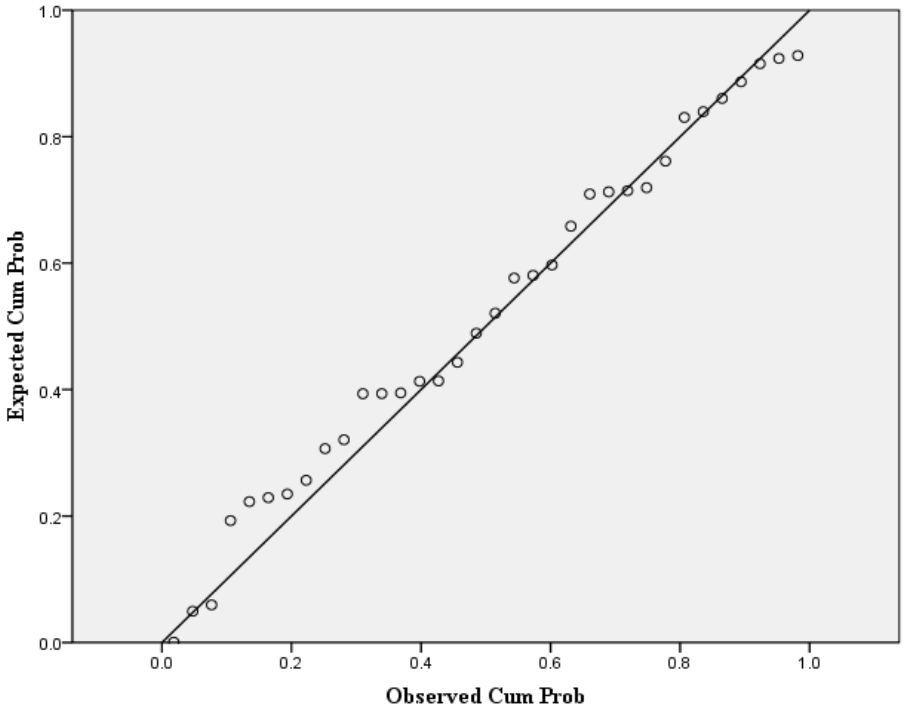

Figure 2.3. LMX/Job Satisfaction Normal P-P Plot

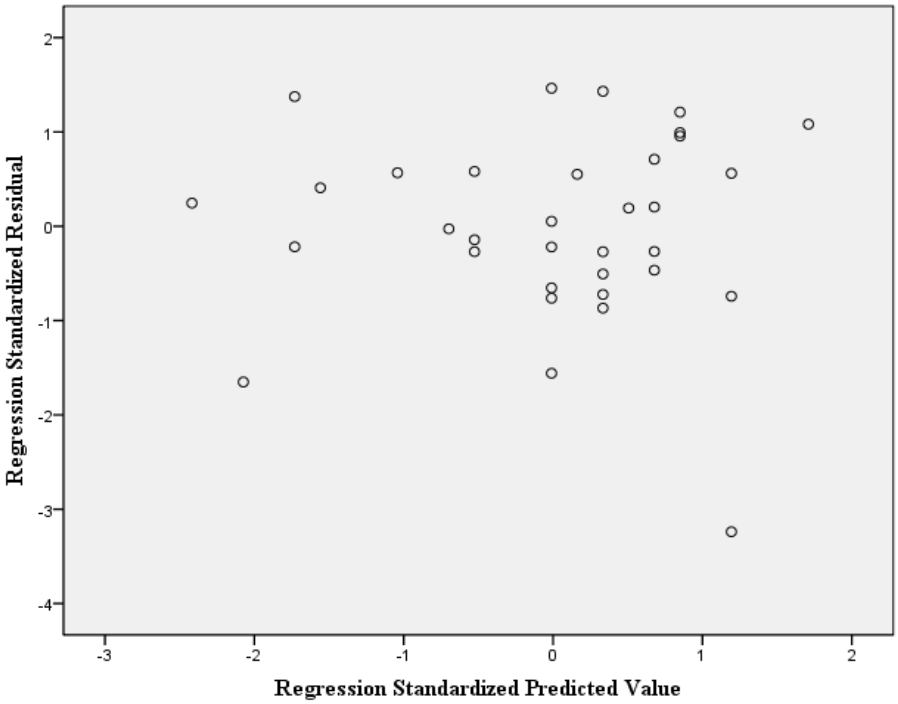

Figure 2.4. LMX/Job Satisfaction Residuals Scatterplot

Table 2.4. LMX and Self-Efficacy Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.887	.356		8.113	.000
	LMX	.244	.099	.434	2.459	.021

a. Dependent Variable: Self-Efficacy

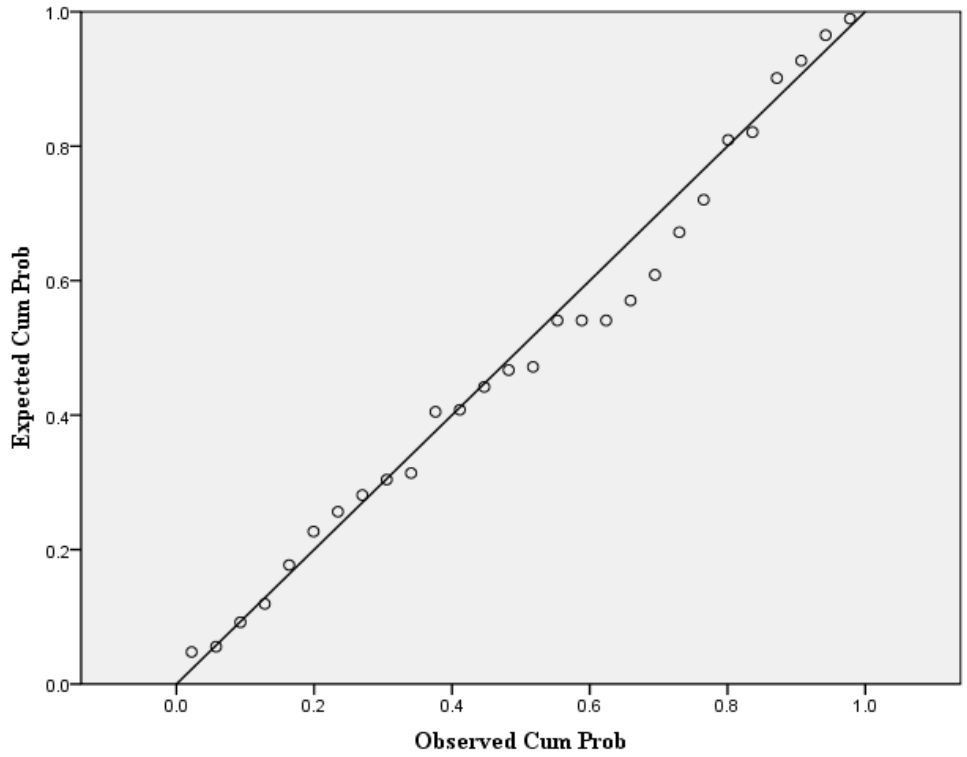

Figure 2.5. LMX/Self-Efficacy Normal P-P Plot

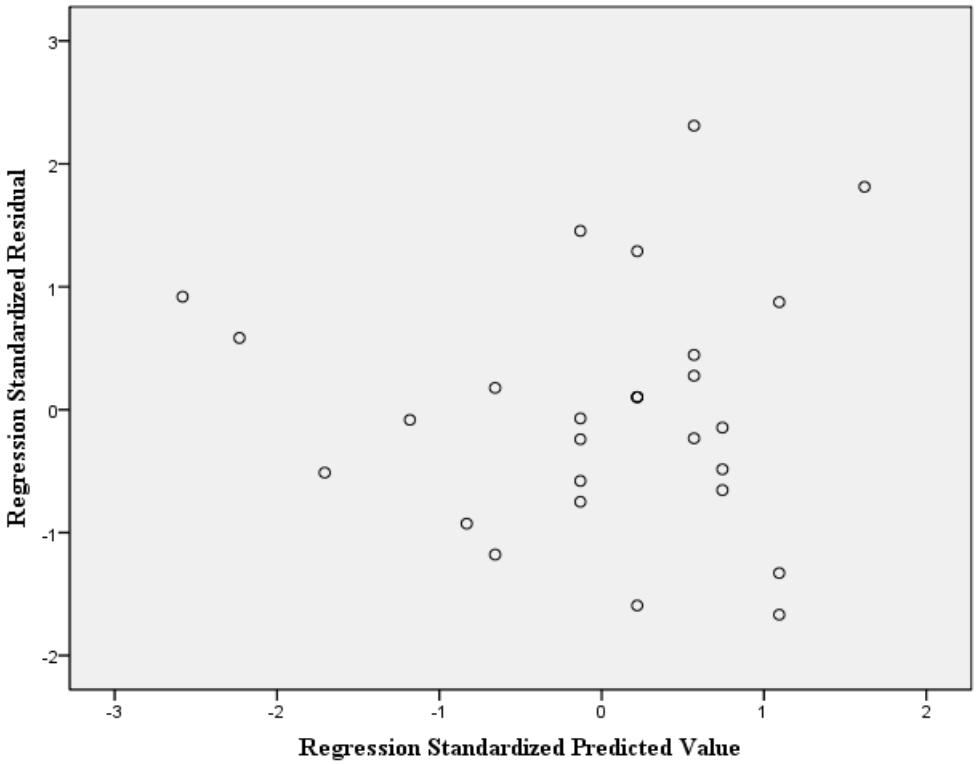

Figure 2.6. LMX/Self-Efficacy Residuals Scatterplot

Table 2.5. Big Five and Turnover Intention Correlations

		Neuroticism	Extraversion	Openness to Experience	Agreeableness	Conscientiousness	Turnover Intentions
Neuroticism	Pearson Correlation	(0.90)					
	Sig. (2-tailed)						
	N	33					
Extraversion	Pearson Correlation	-.274	(0.86)				
	Sig. (2-tailed)	.129					
	N	32	32				
Openness to Experience	Pearson Correlation	-.002	.260	(0.73)			
	Sig. (2-tailed)	.993	.157				
	N	32	31	32			
Agreeableness	Pearson Correlation	-.539**	.492**	.261	(0.80)		
	Sig. (2-tailed)	.001	.005	.157			
	N	32	31	31	32		
Conscientiousness	Pearson Correlation	-.464**	.334	.022	.710**	(0.89)	
	Sig. (2-tailed)	.007	.062	.906	.000		
	N	32	32	31	31	33	
Turnover Intentions	Pearson Correlation	.680**	-.171	-.112	-.521**	-.480**	(0.93)
	Sig. (2-tailed)	.000	.375	.562	.004	.007	
	N	30	29	29	29	30	31

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

Table 2.6. Neuroticism and Turnover Intentions Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.011	.507		-.021	.983
	Neuroticism	1.118	.228	.680	4.909	.000

a. Dependent Variable: Turnover Intentions

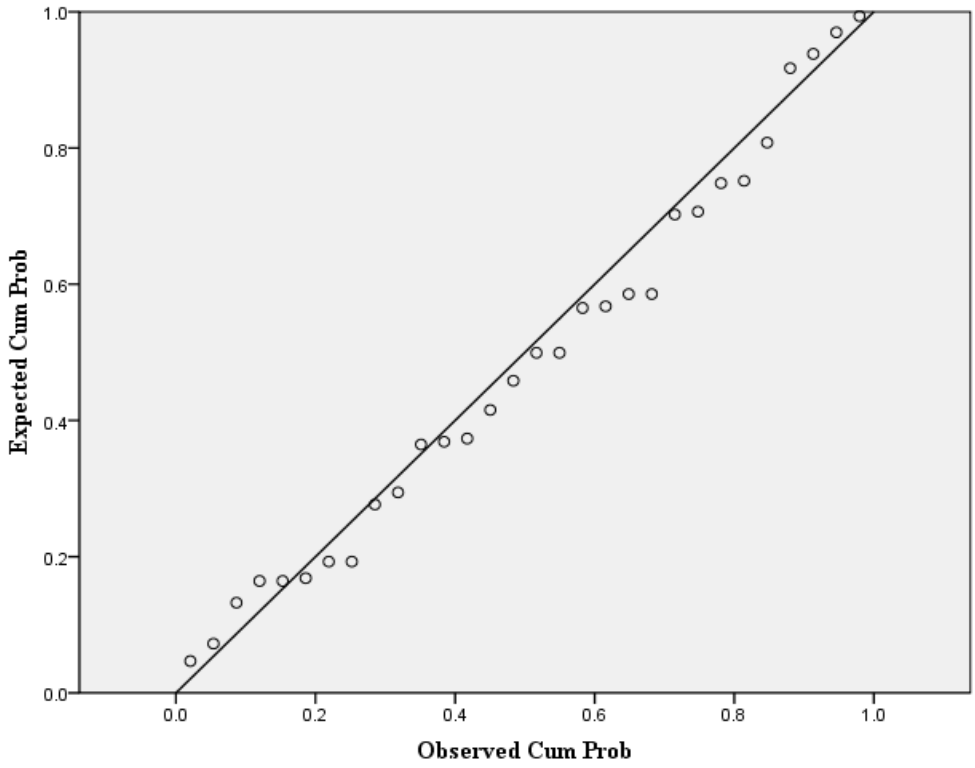

Figure 2.7. Neuroticism/Turnover Intentions Normal P-P Plot

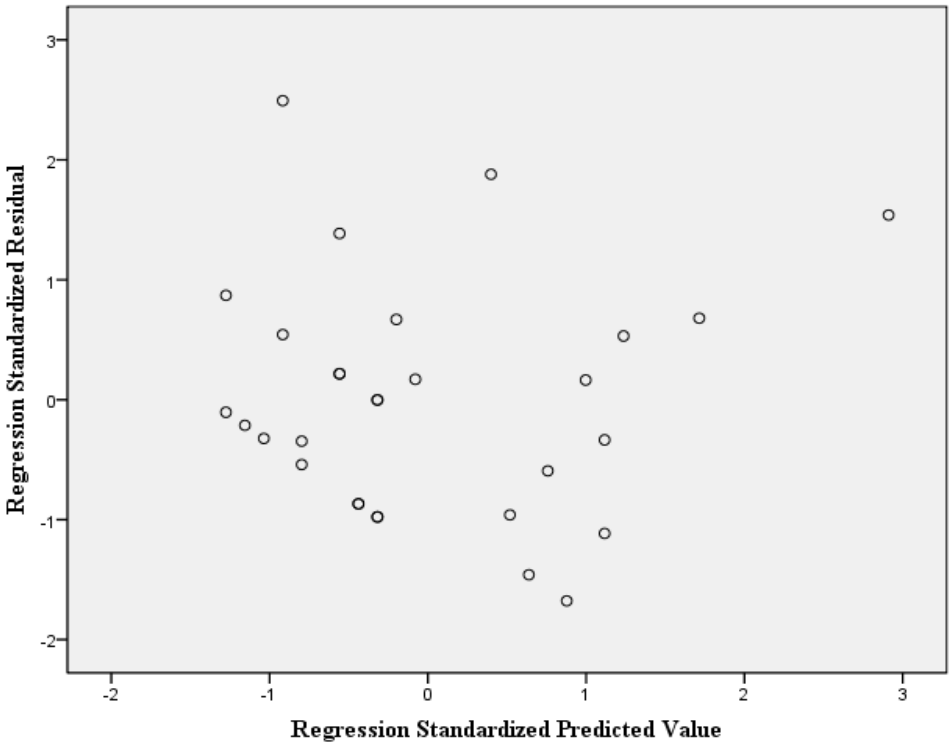

Figure 2.8. Neuroticism/Turnover Intentions Residuals Scatterplot

Table 2.7. Agreeableness and Turnover Intentions Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	7.714	1.707		4.518	.000
	Agreeableness	-1.350	.426	-.521	-3.171	.004

a. Dependent Variable: Turnover Intentions

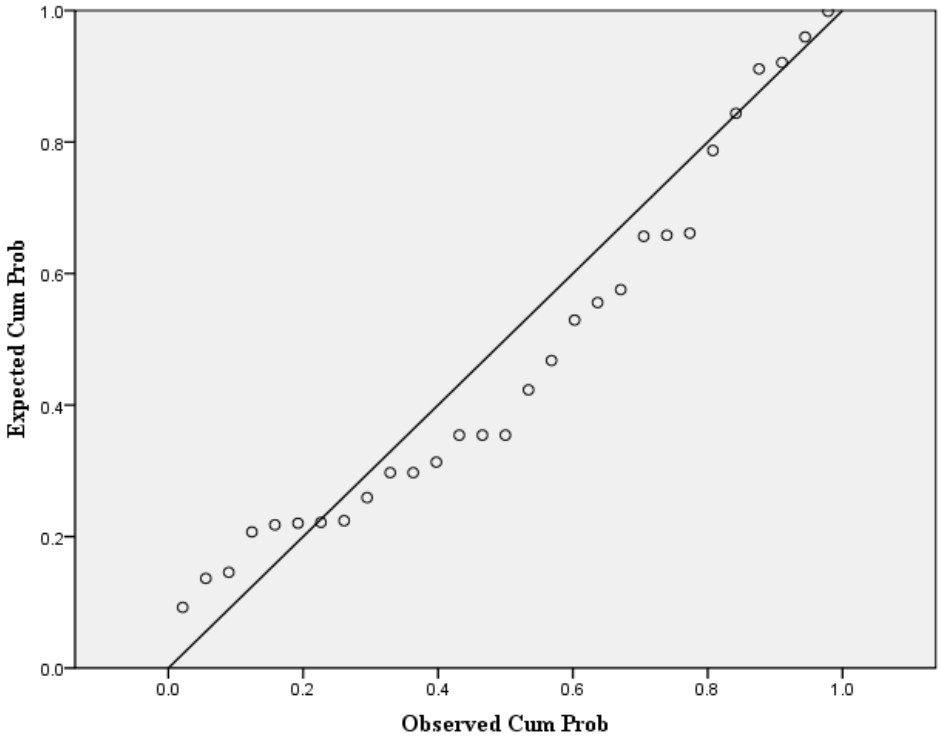

Figure 2.9. Agreeableness/Turnover Intentions Residuals Scatterplot

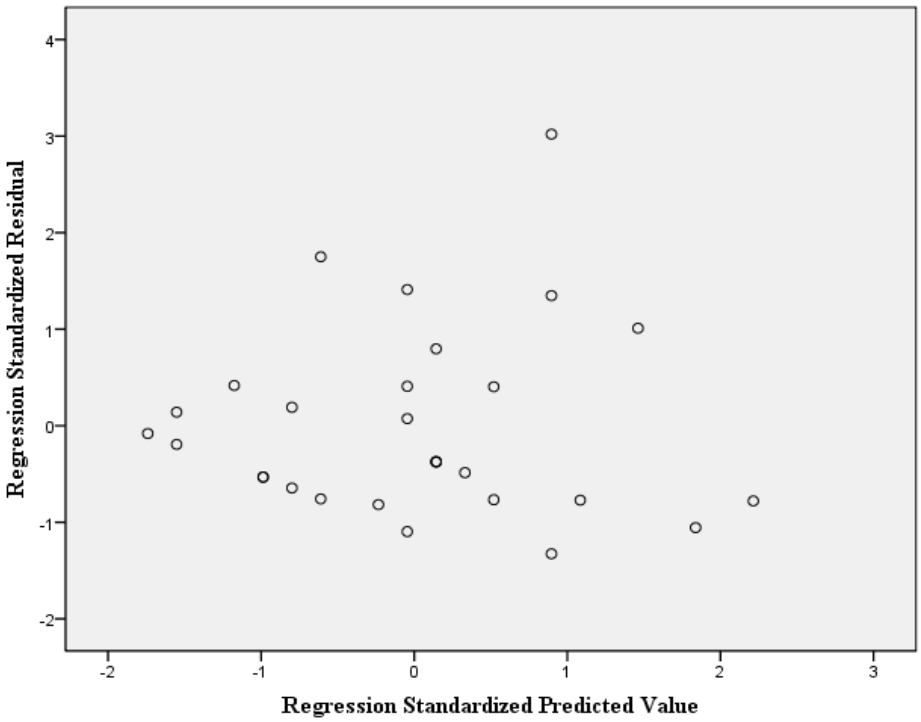

Figure 2.10. Agreeableness/Turnover Intentions Residuals Scatterplot

Table 2.8. Conscientiousness and Turnover Intentions Regression

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.284	2.055		4.032	.000
	Conscientiousness	-1.410	.487	-.480	-2.896	.007

a. Dependent Variable: Turnover Intentions

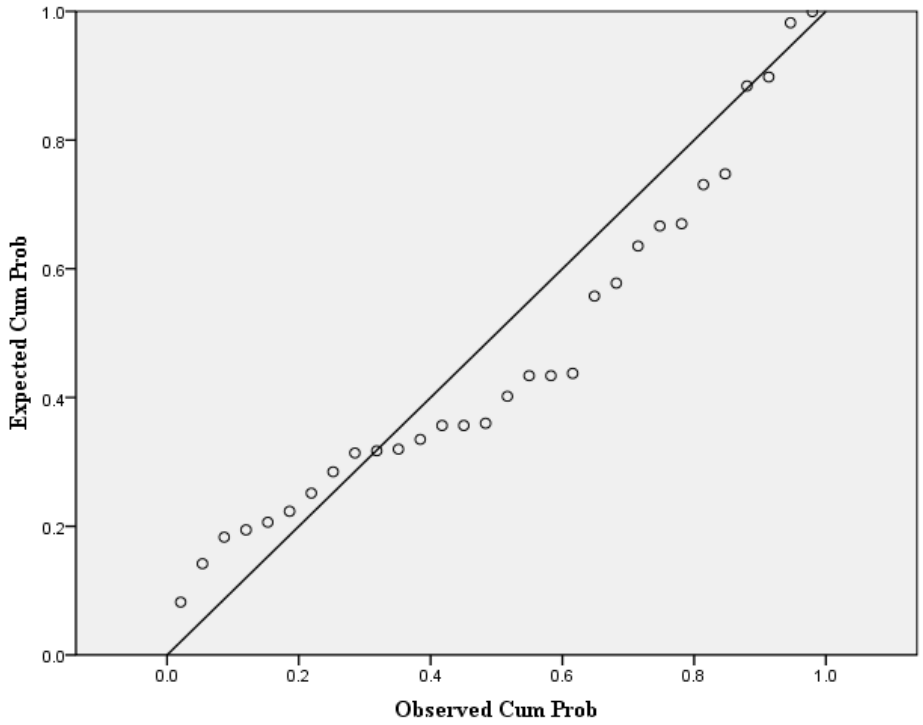

Figure 2.11. Conscientiousness/Turnover Intentions Normal P-P Plot

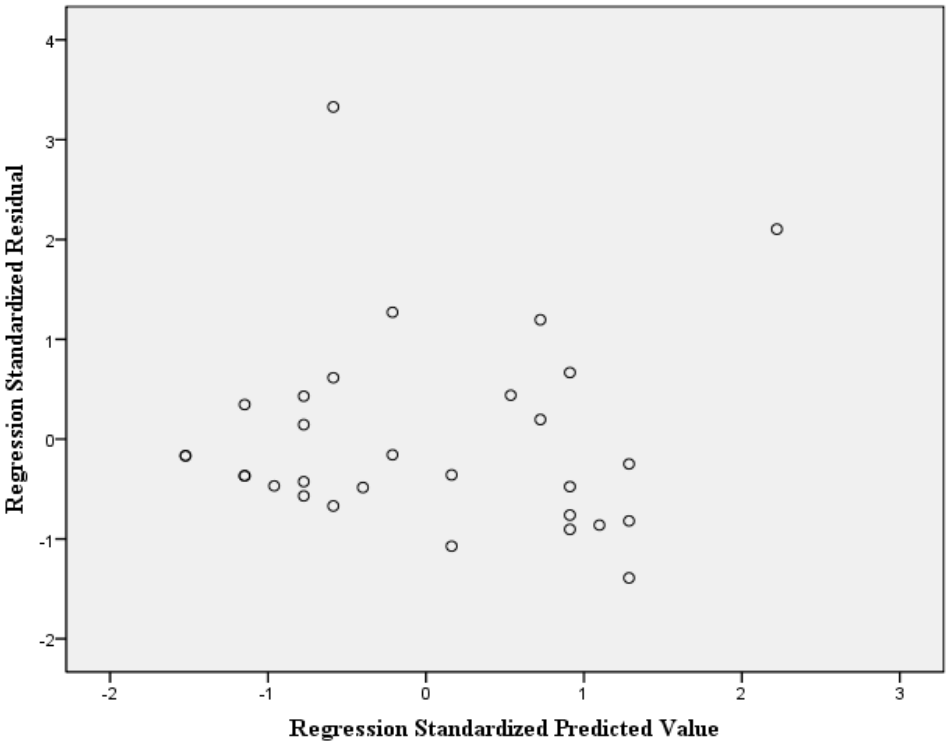

Figure 2.12. Conscientiousness/Turnover Intentions Residuals Scatterplot

Appendix C: Institutional Review Board Documents

The following pages are comprised of the IRB package that was submitted for review and approval prior to the distribution of the survey.

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY (AETC)

12 July 2021

MEMORANDUM FOR AFIT HUMAN RESEARCH PROTECTION PROGRAM (HRPP), OFFICE OF SPONSORED PROGRAMS AND RESEARCH (ENR)

FROM: GRADUATE SCHOOL OF ENGINEERING & MANAGEMENT/ENV

SUBJECT: Principal Investigator Cover Letter for Exempt Determination Request for Firefighter Virtual Reality Study

1. Request AFIT HRPP review and approval of the Exempt Determination Request protocol named above which should be considered as a freestanding protocol.

2. As principal investigator (PI), the undersigned affirms that the protocol complies with the requirements for exempt research set forth in Federal code and the DoD, Air Force, and AFIT instructions implementing it. In addition, the undersigned agrees to:

   a. Ensure that all exempt research conducted under this protocol will conform to the written, approved document, including any restrictions imposed during the approval process. The funding and resources for this research have been procured/acquired to conduct this project as submitted in the protocol. The funding source is:

Funding Agency/Organization:	
Funding Amount:	JON#:

   b. Personally conduct and supervise the study and be responsible for the conduct of all persons acting on behalf of the Principal Investigator.

   c. Monitor the progress of this research and notify the AFIT HRPP in writing within 24 hours of any unexpected event, unanticipated problem, safety concern or medical misadventure.

   d. Promptly notify AFIT HRPP, if either the risk or the benefit of the research appears substantially different from those represented in the protocol, or if early results clearly resolve the hypothesis.

   e. Ensure all individuals assisting in the study are adequately trained, and aware of their responsibilities.

   f. Maintain and retain all study and protocol documents as required by the protocol and DoD regulations.

   g. Conduct this research in compliance with the principles of Human Subjects Research found in the Belmont Report: 1. Respect for Persons requires that subjects, to the extent they are capable, be given the opportunity to choose what will or will not happen to them. The informed consent process contains three elements: information, comprehension and voluntariness. 2. Beneficence closely relates to the risk/benefit assessment which is concerned with the probabilities and degree

of possible harm and anticipated benefits. 3. Justice addresses moral requirements that there be fair procedures and outcomes in the selection of research subjects. Individual justice ensures that the selection of subjects is done in fairness. Social justice requires that distinction be drawn between who should and who shouldn't participate in any particular kind of research based on the ability of individuals to bear burdens and on the appropriateness of placing further burdens on already burdened persons.

3. As the Principal Investigator of this research study I assume responsibility for the overall management of this protocol and ensuring each investigator meets the reporting requirements of the attached Conflict of Interest Disclosure Checklist. I agree to notify AFIT HRPP in writing if any conflict of interest within the research team exists or arises during the project.

4. In accordance with DoD 8520.02, only Principal Investigators with a CAC card may provide an electronic signature as permitted on this template. For Principal Investigators who do not have a CAC card, please print the completed application, provide a handwritten signature, and scan the document so that it may be attached to an email for submission.

JOHN J. ELSHAW, Ph.D.
Associate Professor of Systems Engineering
Principal investigator

Reference: Conflict of Interest Checklist

COI disclosure form.pdf

HRPP Exempt Determination Request Form

General Instructions

NOTE Contact AFIT HRPP office (ENR) **before** completing this worksheet with questions and submit this form to: HumanSubjects@AFIT.edu. If you know your activity is not exempt, OR if the activity involves any of the following products:

a. An experimental product (any medical device, vaccine, drug, nutritional supplement or laboratory assay (In Vitro Diagnostic (IVD)) that has not been approved by the Food and Drug Administration (FDA).
b. An FDA approved product* used in accordance with its FDA approved purpose
c. An FDA approved product* NOT used in accordance with its FDA approved purpose
d. For details and guidance on appropriate Distribution Statement, please refer to: https://afit.libguides.com/STINFO

Your Exempt Determination Package must include:

1. Principal Investigator Cover Letter
2. HRPP Exempt Determination Request Form
3. CITI Training Course Complete Records for all researchers
4. CBT Training Certificate for all researchers. (Refer to AFIT HRPP Exemption Package Instructions and Checklist for links to CITI and CBT training sites.)
5. Vita / Resume for each researcher; this must include: "Last Updated DD Month YYYY" within the document, *not* the title.
6. Attach any data collection tools (e.g. surveys, questionnaires, focus group questions). If this activity is a survey, attitude or opinion poll, questionnaire, or interview, it might require approval by the Air Force Survey Office (HQ AFPC/DSYS); AFI 38-501. Contact ENR if you will be conducting a survey.

Definitions

Human Subject means a living individual about whom an investigator conducting research: (i) Obtains information or biospecimens through intervention or interaction with the individual, and, uses, studies, or analyzes the information or biospecimens; or (ii) Obtains, uses, studies, analyzes, or generates identifiable private information or identifiable biospecimens.

Research means a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge. Activities that meet this definition constitute research for the purposes of this policy, whether or not they are conducted or supported under a program that is considered research for other purposes. For example, some demonstration and service programs may include research activities. For the purpose of this part, the following activities are deemed not to be research:

- Scholarly and journalist activities, including the collection and use of information, that focus directly on the specific individuals about whom the information is collected.
- Public health surveillance activities, including the collection and testing of information or biospecimens, conducted, supported, requested, ordered, required, or authorized by a public health authority. Such activities are limited to those necessary to allow a public health authority to identify, monitor, assess or investigate potential public health signals, onsets or disease outbreaks, or conditions of public health importance. Such activities include those associated with providing timely situational awareness and priority setting during the course of an event or crisis that threatens public health.
- Collection and analysis of information, biospecimens or records by or for a criminal justice agency for activities authorized by law or a court order solely for criminal justice or criminal investigative purposes.
- Authorized operational activities (as determined by each agency) in support of intelligence, homeland security, defense, or other national security missions.
- If your proposal falls within this bulleted list, please use the Not Human Subject Research Checklist for your submission.

HRPP Exempt Determination Request Form

Researcher Assigned Distribution Statement:	

Section 1: Study and Contact Information

Study Information			
Project Title:	Firefighter Virtual Reality Study		
Funding Source:		Amount:	
Principal Investigator			
Name:	John J. Elshaw	Rank/Title:	CIV/Associate Professor
Supporting Organization:	ENV	Official E-mail:	john.elshaw@afit.edu
Commercial Phone:	937-255-3636 ext 4650	DSN:	785-3636 ext 4650
Alternate Study Contact			
Name:	Dylan A. Gagnon	Rank/Title:	Capt/Student
Supporting Organization:	ENV	Official E-mail:	dylan.gagnon@afit.edu
Commercial Phone:	716-930-2102	DSN:	

Section 2: Purpose

2.1 Briefly (3-5 sentences) describe the purpose of the activity and intended use of results. What will the data be used for? To whom will data be reported? What is the military relevance? Please use lay terms. Include sufficient detail to allow the IRB to make its determination.

This study is intended to aid the sponsor organization, Air Force Civil Engineer Center (AFCEC), with understanding if virtual reality (VR) is an effective platform to train U.S. Air Force firefighters. The data will be used to understand what variables affect the VR training outcomes and performance of the users, as well as how using VR may or may not affect unit readiness. The data will be utilized for a master's thesis and will be presented to a committee for defense. The results of this study will be shared with AFCEC and other stakeholders which will help with future decisions of if the firefighting career-field should widely adapt VR or not.

Section 3: Generalizability

3.1 Will the results be generalizable beyond the specific group being targeted in this project?

Yes

Section 4: Description

Instruction: Provide a detailed description of the activity using the following headings.

4.1 Methods and Procedures

The subject population will complete the attached survey questions and return to the investigators. The investigators will then use computer programs to study how certain variables affect VR training and performance and summarize these findings in a thesis.

4.2 Equipment and Facilities

The work will be completed remotely with online surveys and all information collected will be secured in the principal investigator's office behind locked doors.
4.3 Subject Population (describe inclusion/exclusion criteria, number to be included & source)
The subject population will be composed of U.S. Firefighters from Lakenheath AB, McConnell AFB, and Kunsan AB. It will be composed of government personnel assigned to these base's fire departments and will not include foreign civilians. The subject population will include no more than 300 individuals.
4.4 Subject Recruitment Plan
The subject recruitment plan will be the investigators emailing the subject population at the above bases the link to the survey and asking for volunteers to complete the survey. The subjects will have at least four weeks to complete the survey and will not be asked by their leadership/supervision to volunteer. The investigators will send out occasional reminder emails asking for additional volunteers
4.5 Activity Duration
The survey will take no more than 20 minutes and the subjects will have at least four weeks to complete the survey.
4.6 Location
The subjects will be able to take the survey wherever they feel most comfortable and have internet connection.
4.7 Data (type, source, related processes (e.g., proposed use and maintenance))
The data will be Likert scale survey data. See attached.
4.8 Description of Reasonably Foreseeable Risks
The investigators plan on collecting PII but this information will only be disclosed to the research team. Once the data is collected, it will be coded to remove names and only the research team will have access to the code information. The data will be stored in the principal investigator's office on government computer, which will remained locked at all times.

Section 5: Exempt Categories

Check all that apply.

For entities outside of AFRL using this form, an Exempt Determination Official (EDO) may make the determination, unless otherwise noted that limited IRB review is required.

32 CFR 219.104(d)(1) Exempt Category 1	
☐	Research, conducted in established or commonly accepted educational settings that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
32 CFR 219.104(d)(2) Exempt Category 2	
☐	Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:

	☐	(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
	☒	(ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
	☐	(iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review. Complete Section 6.
32 CFR 219.104(d)(3)(i) Exempt Category 3		
☐	Research involving benign behavioral interventions in conjunction with the collection of information from an adult subject through verbal or written responses (including data entry) or audiovisual recording if the subject prospectively agrees to the intervention and information collection and at least one of the below criteria are met. Please provide sufficient detail in section 4.1 to ensure the criteria has been met. Please refer to the Investigator Guidance on this topic.	
	☐	(A) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;
	☐	(B) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or
	☐	(C) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review. Complete Section 6.
	Note: Benign behavioral interventions are brief in duration, harmless, painless, not physically invasive, not likely to have a significant adverse lasting impact on the subjects, and the investigator has no reason to think the subjects will find the interventions offensive or embarrassing. If the research involves deceiving the subjects regarding the nature or purposes of the research, this exemption is not applicable unless the subject authorizes the deception through a prospective agreement to participate in research in circumstances in which the subject is informed that he or she will be unaware of or misled regarding the nature or purposes of the research.	
32 CFR 219.104(d)(4) Exempt Category 4		
☐	Secondary research for which consent is not required: Secondary research uses of identifiable private information or identifiable biospecimens, if at least one of the following criteria is met:	
	☐	(i) The identifiable private information or identifiable biospecimens are publicly available;
	☐	(ii) Information, which may include information about biospecimens, is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained directly or through identifiers linked to the subjects, the investigator does not contact the subjects, and the investigator will not re-identify subjects;
	☐	(iii) The research involves only information collection and analysis involving the investigator's use of identifiable health information when that use is regulated under 45 CFR parts 160 and 164, subparts A and E, for the purposes of "health care operations" or "research" as those terms are defined at 45 CFR 164.501 or for "public health activities and purposes" as described under 45 CFR 164.512(b); (HIPAA Regulations)
		Note: HIPAA applies and includes either an authorization or waiver of authorization. It does not include bio specimens, only protected health information (PHI).

	Note: This does not include primary collection from subjects for the proposed research. It allows both retrospective and prospective secondary use.
32 CFR 219.104(d)(5) Exempt Category 5	
☐	Research and demonstration projects that are conducted or supported by a Federal department or agency, or otherwise subject to the approval of department or agency heads (or the approval of the heads of bureaus or other subordinate agencies that have been delegated authority to conduct the research and demonstration projects), and that are designed to study, evaluate, improve, or otherwise examine public benefit or service programs, including procedures for obtaining benefits or services under those programs, possible changes in or alternatives to those programs or procedures, or possible changes in methods or levels of payment for benefits or services under those programs.
	Note: These must be posted on a federal website.
32 CFR 219.104(d)(6) Exempt Category 6	
☐	Taste and food quality evaluation and consumer acceptance studies, (i) If wholesome foods without additives are consumed or (ii) If a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Section 6: Privacy and Confidentiality

Instruction: Only complete this section if prompted to by the category selected in Section 5.

6.1 Describe how you will ensure individual privacy and the confidentiality of their data.

Note: The terms 'privacy' and 'confidentiality' are often used interchangeably and are not interchangeable. Federal regulations differentiate between privacy & confidentiality. Privacy concerns people. Confidentiality concerns data. PRIVACY refers to a person's desire to control access of others to themselves. CONFIDENTIALITY refers to how the researcher will protect private information provided by a research participant and how the subject's private data will be managed, disseminated and protected by the researcher from release. It is a Federal requirement to describe the extent, if any, to which confidentiality of records identifying the participants will be secured. This section should describe the specific methods for assuring confidentiality;

- Describe how data be maintained (identifiable or de-identified, coded etc.).
- Describe where research study records will be kept (building number, locked files in a secure office).
- Who will have access to the data and for what purposes?
- How will the principal investigator ensure oversight?
- When will data be destroyed, by whom and by what method?
- If data will be transferred, how will this transfer occur?

Once the data is collected, it will be coded to remove names and only the research team will have access to the code information. No one other than the research team will see the names of the subjects and the data will remain coded. The research records will be kept behind the principal investigator's locked door in building 640 room 105B on a government computer and the data will only be accessed when the principal investigator is in the office. The data will be kept for three years and then destroyed by deleting the survey response files and survey information. Data transfer, if necessary, will be done under the control of the principal investigator and will only be the coded data.

Section 7: Protected Health Information (PHI)

7.1 Does this research involve the use of PHI?	☐ Yes	☒ No
If **Yes**, a HIPAA Authorization should be signed.		

If **Yes**, and you are seeking a waiver of HIPAA Authorization, please refer to this checklist for additional detail on when this applies.
If **No**, Complete Section 8.

Section 8: Samples			
8.1 Will this activity will involve the use of biological samples/tissue?		☐ Yes	☒ No
If **Yes**, Choose one:	☐ Identifiable Specimens	☐ De-identified Specimens	
If **No**, Proceed to Section 9.			
Note: Provide additional detail in Section 4 regarding how samples will be provided to the investigator, labeled, stored, maintained or destroyed, etc.			
8.2 How will samples will be provided to the investigator, labeled, stored, maintained or destroyed, etc.?			
The research records will be completed remotely with online surveys and all information collected will be secured in the principal investigator's office behind locked doors.			
8.3 Do you wish to use blood, cells, bodily fluids, tissues and/or other identifiable health information and personal identifiers from patient records (medical, research, hospital, etc.) for use in more than one protocol?		☐ Yes	☒ No
If **Yes,** a tissue/health information registry must be approved if you intend to collect and use tissue and/or health information outside of the parameters of a single IRB approved protocol.			
8.4 Will you be shipping ANY bodily specimens?		☐ Yes	☒ No
If **Yes** and your protocol includes shipping of blood or other potentially infectious material (OPIM), please ensure that the protocol includes a plan for shipment. Additionally, the protocol and transport plan should be sent to Biosurety (711HPW.IR.Biosurety@us.af.mil) to ensure that it meets all required regulations.			
8.5 Does your protocol include the manipulation of blood or other potentially infectious material beyond collection and/or direct analysis?		☐ Yes	☒ No
If **Yes**, the protocol must also be submitted to Biosurety (711HPW.IR.Biosurety@us.af.mil) for review and approval. If **No**, personnel must complete annual Blood borne Pathogens (BBP) training and the laboratory must have an Exposure Control Plan.			

Section 9: Safety Review		
9.1 Did this study receive a safety review?	☐ Yes	☒ No
If **No**, the PI will submit for safety review in accordance with safety regulations.		
Note: Contact the AFIT Safety Officer, Ms. Kelley Robinson, AFIT/ENR, regarding requirements applicable to test and evaluation: Kelley.Robinson@afit.edu.		

Section 10: Signatures
I affirm that the information provided in this worksheet is complete and accurate.

	7/12/2021
PI	**Date**
Note: To sign this form electronically, please save it as a PDF and follow these instructions.	

Conflict of Interest (COI) Disclosure Checklist

Researcher Assigned Distribution Statement:	

General Instructions

Completion:

- The Principal Investigator (PI) must complete, sign and submit to IR with their submission packet.
- All other research personnel must complete, sign and submit to the Principal Investigator. All COI checklists shall be retained with the research records and will be made available for inspection.
- For details and guidance on appropriate Distribution Statement, please refer to: https://afit.libguides.com/STINFO

Purpose:

- To promote professional research, the integrity of a given research design [to include its resultant data] will be free of conflicts of interest. Research team members will maintain research integrity at all times.
- To timely identify, remove, and/or mitigate conflicts of interest, all members of the research community have a non-delegable duty to report known, or reasonably suspected, conflicts of interest.
- Upon being made aware of a conflict of interest, or a *perception* of a conflict, leadership shall take appropriate remedial measures to ensure the continued integrity of the research environment.

Action: Researchers shall timely disclose, in an ongoing fashion, conflicts of interest that could reasonably be seen to affect the integrity of a proposed [or ongoing] research project. If subsequent facts arise which could alter the response to one or more of the below answers, I will immediately notify the PI of the below-referenced study.

Section 1: Contact Information

Name:	Dylan A. Gagnon	**Official E-mail:**	dylan.gagnon@afit.edu
Study Role:	Secondary Investigator	**Phone/DSN:**	716-930-2102
Rank/Title:	Captain/Student	**Organization:**	ENV
Project Title:	Firefighter Virtual Reality Study		

Section 2: Reportable Interests

Note: Responses reflect my interest(s) along with the interests of my family members, i.e., spouse, children.

Yes	No	Reportable Interest
☐	☒	I have an equity interest, stock, stock options or other ownership interests that conflict with my role in the above-referenced study.
☐	☒	I have, or expect to receive, a gift, gratuity, or compensation from the study sponsor, third party, or agent acting by or through a representative who is external to the study team.
☐	☒	I have, or expect to receive, an agreement for future employment from one or more parties external to my role in the above named study.
☐	☒	I hold a patent, to include intellectual property rights and interest, related to the purpose of this study.
☐	☒	I hold a position as an officer, director, trustee, partner, proprietor or consultant role with a sponsor or entity that is external to the team identified by the above-referenced study.
☐	☒	I have had connections with external partners or related sponsors over the course of the previous 12 months that would alter the answer to one or more of the questions contained herein.

☐	☒	I wish to disclose additional information [not specifically requested herein] but which could, to a neutral third party, be reasonably viewed as being a potential conflict of interest.
If **Yes**, to <u>any</u> item noted above provide additional detail below or attach a separate sheet.		

Section 3: Signature		
I hereby affirm that this submission is complete and accurate. I agree to comply with my ongoing duty to report known, or perceived, conflicts of interest. I understand that additional data may be requested, at the discretion of the PI or team lead, to preserve the integrity of the above-identified research.		
	Dylan A. Gagnon	14 July 2021
Signature	**Printed Name**	**Date**
Note: To sign this form electronically, please save it as a PDF and follow these instructions.		

Conflict of Interest (COI) Disclosure Checklist

Researcher Assigned Distribution Statement:	

General Instructions

Completion:

- The Principal Investigator (PI) must complete, sign and submit to IR with their submission packet.
- All other research personnel must complete, sign and submit to the Principal Investigator. All COI checklists shall be retained with the research records and will be made available for inspection.
- For details and guidance on appropriate Distribution Statement, please refer to: https://afit.libguides.com/STINFO

Purpose:

- To promote professional research, the integrity of a given research design [to include its resultant data] will be free of conflicts of interest. Research team members will maintain research integrity at all times.
- To timely identify, remove, and/or mitigate conflicts of interest, all members of the research community have a non-delegable duty to report known, or reasonably suspected, conflicts of interest.
- Upon being made aware of a conflict of interest, or a *perception* of a conflict, leadership shall take appropriate remedial measures to ensure the continued integrity of the research environment.

Action: Researchers shall timely disclose, in an ongoing fashion, conflicts of interest that could reasonably be seen to affect the integrity of a proposed [or ongoing] research project. If subsequent facts arise which could alter the response to one or more of the below answers, I will immediately notify the PI of the below-referenced study.

Section 1: Contact Information

Name:	John J. Elshaw	**Official E-mail:**	john.elshaw@afit.edu
Study Role:	Principle Investigator	**Phone/DSN:**	937-255-3636 ext 4650/785
Rank/Title:	CIV/Associate Professor	**Organization:**	ENV
Project Title:	Firefighter Virtual Reality Study		

Section 2: Reportable Interests

Note: Responses reflect my interest(s) along with the interests of my family members, i.e., spouse, children.

Yes	No	Reportable Interest
☐	☒	I have an equity interest, stock, stock options or other ownership interests that conflict with my role in the above-referenced study.
☐	☒	I have, or expect to receive, a gift, gratuity, or compensation from the study sponsor, third party, or agent acting by or through a representative who is external to the study team.
☐	☒	I have, or expect to receive, an agreement for future employment from one or more parties external to my role in the above named study.
☐	☒	I hold a patent, to include intellectual property rights and interest, related to the purpose of this study.
☐	☒	I hold a position as an officer, director, trustee, partner, proprietor or consultant role with a sponsor or entity that is external to the team identified by the above-referenced study.
☐	☒	I have had connections with external partners or related sponsors over the course of the previous 12 months that would alter the answer to one or more of the questions contained herein.

☐	☒	I wish to disclose additional information [not specifically requested herein] but which could, to a neutral third party, be reasonably viewed as being a potential conflict of interest.
If **Yes**, to any item noted above provide additional detail below or attach a separate sheet.		

Section 3: Signature		
I hereby affirm that this submission is complete and accurate. I agree to comply with my ongoing duty to report known, or perceived, conflicts of interest. I understand that additional data may be requested, at the discretion of the PI or team lead, to preserve the integrity of the above-identified research.		
	John J. Elshaw	14 July 2021
Signature	**Printed Name**	**Date**
Note: To sign this form electronically, please save it as a PDF and follow these instructions.		

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY (AETC)

Abbreviated Consent
for
Firefighter Virtual Reality (VR) Study

You are being asked to participate in a research study. Key study information you should know:

- The purpose of the study is to research what variables may affect virtual reality (VR) training for U.S. firefighters and how this training may affect performance and readiness. If you choose to participate, you will be asked to complete a confidential online survey when it is most convenient and comfortable for you to do so. This will take approximately 20 minutes and the survey will be open for 4 weeks.

- Risks or discomforts from this research are minimal and are only if survey data is found by members not on the research team. To prevent this, the survey data will be coded with volunteer's names removed and kept behind locked office doors. The data and survey results will be kept confidential and will not be shared with your leadership and coworkers.

- The study will have no direct benefits to those who volunteer.

- Taking part in this research project is voluntary. You can discontinue participation at any time without penalty or loss.

Please take time to read this entire document and ask questions before deciding whether to take part in this research project.

The researchers will take the following precautions to maintain the confidentiality of your data: Once the data is collected, it will be coded to remove names and only the research team will have access to the code information. The research records will be kept behind the principal investigator's locked door on a government computer that is password-protected/encrypted and the data will only be accessed when the principal investigator is in the office. The data will be kept for three years and then destroyed by deleting the survey response files and survey information. Data transfer, if necessary, will be done under the control of the principal investigator and will only be the coded data. The research data will not be shared with your leadership or coworkers and no participant identifiers will be included in any publications. By taking the distributed survey, you are signifying you are in agreement with this consent form.

The data may be accessed by the Department of Defense for auditing purposes.

If you have questions regarding the study, contact the Principal Investigator: Dr. John J. Elshaw at john.elshaw@afit.edu or Captain Dylan A. Gagnon at dylan.gagnon@afit.edu. If you have questions regarding your rights as a research subject, contact the AFIT HRPP: 937-255-3636 x4543 or humansubjects@afit.edu.

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14. ABSTRACT
Immersive simulations such as virtual reality is becoming more prevalent for use in training environments for many professions. United States Air Force firefighters may benefit from incorporating VR technology into their training program to increase organizational commitment, job satisfaction, self-efficacy, and job performance. With implementing a new training platform, it is also important to understand the relationship between these variables and the perceived benefits and efficacy of the VR training, which has not yet been studied in previous research. This study addresses this issue by gathering data from fire departments currently fielding a VR fire training platform. Relationships between several different measures of organization commitment, personality traits, and perceived VR training benefits was studied utilizing bivariate correlations and linear regression models. Results of this study indicated that perceived VR training benefits have a positive relationship with job satisfaction. Self-efficacy was found to have a positive relationship with job satisfaction and job satisfaction had a negative relationship with turnover intentions. Post hoc analysis indicated that leadership-member exchange had a positive relationship with perceptions of VR training benefits, job satisfaction, and self-efficacy. Of the Big Five, conscientiousness and agreeableness had a positive relationship with turnover intentions and neuroticism had a negative relationship with turnover intentions. This research has shown that several factors contribute to the successful implementation of VR training programs, as well as theoretical explanations as to why these relationships exist.

15. SUBJECT TERMS
Virtual Reality, Job Satisfaction, Self-Efficacy, Turnover Intentions, Big Five Personality Traits

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