EXAMINATION OF PERSONALITY CHARACTERISTICS AMONG CYBERSECURITY AND INFORMATION TECHNOLOGY PROFESSIONALS

By

Sarah Ellen Freed

Bart L. Weathington
UC Foundation Professor of Psychology
(Chair)

Chris J. L. Cunningham
UC Foundation Associate Professor
of Psychology
(Committee Member)

Michael D. Biderman
Salem Carpet Professor of Psychology
(Committee Member)

EXAMINATION OF PERSONALITY CHARACTERISTICS AMONG CYBERSECURITY AND INFORMATION TECHNOLOGY PROFESSIONALS

By

Sarah Ellen Freed

A Thesis Submitted to the Faculty of the University of
Tennessee at Chattanooga in Partial Fulfillment
of the Requirements of the Degree of
Master of Science: Psychology

The University of Tennessee at Chattanooga
Chattanooga, Tennessee

March 2014

ABSTRACT

An influx of cyber-attacks throughout the past decade has resulted in an increase in demand for cybersecurity professionals. However, the rapid growth of this field has led to a general lack of knowledge regarding the characteristics of individuals and job roles of cybersecurity professionals. This study addresses this gap in the existing literature by evaluating personality characteristics among information technology and cybersecurity professionals. Following an analysis of the facets of the IPIP NEO short form, it was discovered that cybersecurity professionals scored significantly different on Trust, Intellect, Vulnerability, Self-Consciousness, Assertiveness, and Adventurousness when compared to other information technology professional indicating the need for specialized training, assessment, and selection procedures for cybersecurity professionals.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF SYMBOLS

M, mean

SD, standard deviation

T, T value

p, p value

r, correlation coefficient

CHAPTER 1

INTRODUCTION

Dependence on cyber infrastructure has risen dramatically in the United States and across the world (Evans & Reeder, 2010). Civilians and governments alike rely on the internet to provide ease of access for many of life's everyday activities such as providing security for private information and actions such as: banking, internet browsing, and storing/accessing private documents. Recognition of the usefulness of the internet has not been limited to those who wish to provide services; there are many who have sought to access this information for personal and/or political gain through various illegal activities, such as hacking and/or identity theft.

These illegal activities are responsible for substantial privacy and financial costs. For example, in June, 2011 a cyber-attack was implemented against the banking corporation Citigroup. Hackers used spyware (software that covertly sends computer activity information from one computer to another) to copy data from customers as they logged into their banking accounts. This resulted in a loss of $2.7 million and affected approximately 3400 customers (Lee, 2011). During the same year the Sony PlayStation Network was hacked by the group Lulzsec. This hacking group used elementary cyber-attacks to get past the security defenses of the PlayStation network and effectively obtained massive amounts of private data including usernames, passwords, addresses, and credit card information (Smith, 2011). Over 100 million accounts are estimated to have been affected by this attack. A loss of $170 million was reported

in relation to the cyber-attack due to expenses for identity theft insurance, customer support, legal investigations, lawsuits, etc… (Yamaguchi, 2011). Not only have these corporations taken huge losses in regard to income, but the negative attention in the media effectively harmed the public relations of both companies. In both instances customers complained of the lack of interest in the protection of their private information (Yamaguchi, 2011).

During the 2013 holiday season a cyber-attack was launched against Target. Officials reported that there had been a data breach and hackers were able to extract personal information (e.g. telephone numbers and addresses) for approximately 70 million customers (Rochan, 2014). Also during 2013, the largest cyber-attack in history targeted an international nonprofit organization called Spamhaus, whose primary goal is to battle spam. This was a DDoS attack which focused on slowing the servers utilized by Spamhaus by clogging their processing ability with large amounts of pointless emails and file loads (Vaas, 2013). The attack peaked at 300 gigabits per second and was reported to have had enough force to possibly cause worldwide disruption of the internet (Vaas, 2013). It is important to keep in mind that the incidents provided here are only four representative examples and there are a plethora of other cyber-attacks that occurred before and after these.

Cybersecurity threats are not limited to private businesses and industry. In addition to attacking corporations, governments also find themselves subject to thousands of cyber-attacks focused on financial gain or to prove a political point (known as hacktivism). As a specific example, the Pentagon reported in March, 2012 that it suffers from an estimated ten million cyber-attacks every day (Biggs, 2012). According to the Pentagon's annual report to congress, "In 2012, numerous computer systems around the world, including those owned by the U.S.

government, continued to be targeted for intrusions" (Office of the secretary of defense, 2013). The Pentagon's annual report continues to recognize that this is problematic as these actions may have provided other nations with information to assist in "building a picture of U.S. defense networks, logistics, and related military capabilities that could be exploited during a crisis" (Office of the secretary of defense, 2013). Not only have cyber-attacks provided threats for civilians and corporations, but the government also experiences uncertainty with these attacks. In order to provide a better protection for national security a call for research on the field of cybersecurity has been made (Sullivan, 2013).

In reaction to an estimated $400 billion in intellectual property lost to cyber espionage president Obama proposed an increase in the budget for cybersecurity spending by $4.7 billion (Sullivan, 2013). The funding was specifically geared towards cybersecurity information sharing and research between private businesses; and the government, with the ultimate goal of expanding the currently limited knowledge about cybersecurity professional's job roles and tasks. This spending and collaboration has been undertaken with the hope that information found from future research will assist in bolstering the defenses of both the U.S government and businesses. (Sullivan, 2013).

By some estimates (Evans & Reeder, 2010), there are only 1000 cybersecurity specialists capable of effectively operating in cyberspace. In comparison, it is predicted that there is a need for 10,000 to 30,000 of these professionals. For clarification, the cybersecurity professionals that are being considered as effective operators "consists of those who self-identify as cybersecurity specialists as well as those who build and operate our systems and networks. That workforce includes not only workers on government payrolls, but also those contractors who operate as part of the extended government workforce. It also includes those who build and maintain the critical

infrastructure on which the public and private sectors have come to rely." (Evans & Reeder, 2010, p. 6).

At the 2013 Society of Industrial Organizational Psychologists (SIOP) annual conference, representatives from a branch of Homeland Security called the National Initiative for Cybersecurity Education (NICE) reiterated this need by holding a panel meeting with other professionals to discuss the necessity for research on the professionals that perform cybersecurity functions (Smith, Yankelevich, Ascione, Maxson, & Tobey, 2013). The dramatic and continuing increase in need for cybersecurity professionals calls to attention the lack of information available on the actual job role. The extreme lack of research on cybersecurity professionals is of concern for organizations looking to effectively select, train, and assess cybersecurity personnel (Smith et al., 2013). Accordingly, the purpose of this study is to assist in creating the preliminary stepping stones to understanding the cybersecurity job role by focusing on the individuals that take up the profession. This will be accomplished by examining the differences between the personality characteristics of cybersecurity professionals and other Information Technology (IT) employees.

CHAPTER II

LITERATURE REVIEW

Personality and Job Roles

Attempting to identify why people behave in their own unique ways continues to be a goal of many psychologists (Barrick & Mount, 2013). The majority of answers to this search are related to individual characteristics (e.g. personality), environmental/situational factors, and ability (Barrick & Mount, 2013). Personality, specifically, has gained in popularity over the years for various human resource processes including: assessment, selection, and training.

While limited empirical work has examined the specific characteristics of cybersecurity professionals, some extrapolations can be made based on the existing literature. Cybersecurity professionals can be considered the police officers of the information technology field. Therefore, a consideration of both law enforcement and information technology provide a basis for consideration of those characteristics most relevant to cybersecurity.

Personality and Law Enforcement

Detrick and Chibnall (2006) conducted an evaluation of 100 field training officers using the NEO PI – R. Results indicated that the highest performers scored low when compared to the general population on the facets: Angry Hostility, Depression, and Vulnerability. The highest

performers also scored high on: Assertiveness, Excitement Seeking, Achievement Striving, and Self Discipline (Detrick & Chibnall, 2006). The results from this study assisted in creating a schematic for future psychologists to use when screening for police applicants. In addition, knowledge of the ideal recruit can give supervisors an idea of how to train employees so they can develop similar values.

Garbarino, Chiorri, Magnavita, and Cuomo (2012) furthered personality research on job roles and conducted a comparative personality study between special force police officers and other officers. Their goal was to determine whether special force police officers had significantly different personality characteristics. Participants consisting of all 289 officers of an Italian police force in Genoa (excluding two female officers and one male that could not complete all tests) were assessed on the Big Five Personality characteristics of openness to experience, conscientiousness, extraversion, agreeableness, and emotional stability (Garbarino et al., 2012). Results indicated that as a whole police officers reported higher emotional stability, slightly-to-moderately more extraversion, agreeableness conscientiousness, and openness as compared to the general population. A significant difference was also found between special force police officer and regular officers, however, rather than identifying with one particular personality profile Special Forces were divided into two groups. Group A scored higher in Emotional Stability (ability to regulate emotions) and Self Deceptive Enhancement (denial of personal defects) and Group B scored higher in all five domains and lower in Depression (extreme sadness), Exhaustion (overworking), and Loss of Empathy (apathy) when compared to regular police officer scores, (Garbarino et al., 2012).

Personality and Information Technology

As stated previously, personality has been used to identify various job roles, especially with police officers. Previous personality research has even been used to differentiate between subgroups as described in the study conducted by Garbarino et al., (2012). However, only a limited number of studies have been conducted specifically on Information Technology professionals and any research in this area on cybersecurity professionals is nearly non-existent. One study, however, conducted by Rosenbloom, Ash, Dupont, and Coder (2008) evaluated the personality and career choice of women in IT. Information Technology students were asked to complete a personality assessment related to six General Occupational Themes (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional). Men in the study scored significantly higher in the Investigative and Realistic dimensions while women scored significantly higher in the Artistic and Social dimensions. These differences in values were thought to explain the different choices in career paths for both genders. Since the vast majority of IT employees are male the Investigative dimensions are particularly interesting. Investigative is defined as a person's preference for activities that entail the systematic or creative investigation of physical, biological, and cultural phenomena. Larson, Rottinghaus, and Borgen (2002) conducted a meta-analysis comparing personalities domains from the Big Five with the General Occupational Themes and revealed a significant relationship between Openness and Investigative.

More support for the relationship between Openness and individuals in information technology positions was found in a study conducted by Mastor and Ismail (2004). These researchers studied the personality and cognitive differences between information technology students and engineers. The NEO PI-R was used to measure personality differences while the

Group Embedded Figures Test (GEFT) was implemented for assessing cognitive ability. Results revealed that prospective information technology students were likely to score higher in the broad domain Openness. In addition, they also scored higher in the facets of Openness: actions and aesthetics (Mastor & Ismail, 2004).

Narrow Traits

The majority of these studies have been focused primarily on the broad domains of personality assessments. However, as stated by Garbarino et al., (2012), narrow traits may be preferable when evaluating a specialized group within a larger one. Although broad domains have been found to provide useful information on the personality characteristics of individuals it has been found that narrow traits add incremental validity (Christiansen & Robie, 2011). In addition to increasing the validity of this study, cybersecurity professionals are considered to be a specialized group within an IT department, which makes the focus on the facets of the personality assessment appropriate.

A large portion of personality research has been conducted using the Five Factor Model, also known as The Big Five (Costa&McCrae, 1992a; Digman, 1990; Goldberg, 1993; John & Srivastava, 1999). The Big Five consists of five broad domains: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism (Bennet-Martinez & John, 1998; John, Donahue, & Kentle, 1991; John, Naumann, & Soto, 2008). These domains subsume narrower traits called "facets" at a second level (Deyoung, Quilty, & Peterson, 2007).This can be exemplified by the largely used Revised NEO Personality Inventory, which breaks the personality domains into six facets (NEO-PI-R; Costa & McCrae, 1992b; Deyoung et al., 2007).

Paunonen, and Ashton, (2001) found that not only did the Big Five domains predict a substantial amount of criteria, but the facets were found to have additional predictive abilities further supporting Christiansen & Robie (2011). Acknowledging the success of the NEO PI R Johnson (2000) succeeded in creating what is now known as the NEO IPIP, which is provided for access on the International Personality Item Pool (http://ipip.ori.org/), also known as the IPIP (Goldberg, Johnson, Eber, Hogan, Ashton, Cloninger, & Gough, 2006). Eventually, this measure was shortened to what is now known as the IPIP NEO Short Form (Johnson, 2011). This measure has been found to have high correlations with the successful NEO PI R (.91 when corrected for attenuation) and is provided for public use on the free domain website (Johnson, 2011). The facets of the NEO IPIP Short Form have been chosen as the focus of this study.

Openness to experience describes the breadth, depth, originality, and complexity of one's ideas with those who score high in the domain being described as curious, original, and imaginative. Openness to experience includes facets such as: Adventurousness, Artistic Interests, Emotionality, Intellect, Imagination, and Liberalism (Baer, Oldham, Jacobson, & Hollingshead, 2008; Costa & McCrae, 1992; Garbarino et al., 2012; Johnson, 2011). Conscientiousness involves impulse control that facilitates task and goal oriented behavior which can include delaying gratification, following norms and rules, and planning, organizing, and prioritizing tasks. Conscientiousness includes facets such as: Achievement Striving, Cautiousness, Dutifulness, Orderliness, Self-Discipline, and Self-Efficacy (Baer et al., 2008; Costa & McCrae, 1992; Garbarino et al., 2012; Johnson, 2011). Extraversion implies a more energetic approach to life with those who score high in the domain exhibiting sociability, talkativeness, and self-assuredness. Extraversion includes facets such as: Activity Level, Assertiveness, Cheerfulness, Excitement Seeking, Friendliness, and Gregariousness (Baer et al., 2008; Costa & McCrae,

1992; Garbarino et al., 2012; Johnson, 2011). Agreeableness is associated with a prosocial and communal orientation towards others with those who score high in the domain being described as helpful, trusting, and friendly. Agreeableness includes facets such as: Altruism, Cooperation, Modesty, Sympathy, Morality, and Trust (Baer et al., 2008; Costa & McCrae, 1992; Garbarino et al., 2012; Johnson, 2011), Finally, Neuroticism involves tension, vulnerability, and irritability towards stress with those who score high in the domain being described as more hostile and less able to control impulses. Neuroticism includes facets such as: Anger, Anxiety, Depression, Immoderation, Self-Consciousness, and Vulnerability (Baer et al., 2008; Costa & McCrae, 1992; Garbarino et al., 2012; Johnson, 2011). The facets this study will focus on are: Trust, Sympathy, Dutifulness, Cautiousness, Anxiety, and Intellect.

Trust

Previous studies on police officers discovered that police officers scored higher than the average population on the domain Agreeableness (Garbarino et al., 2012). This indicates that it is likely that cybersecurity specialists may score differently on select facets within the domain due to their likeness with police officers. Trust is a facet from the domain Agreeableness and can be broken down into two categories: interpersonal and propensity to trust. Interpersonal trust is defined by Mayer (1995) as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform to a particular action important to the trustor, irrespective of the ability to monitor or control that other party". This type of trust is understood to be situational in nature and applies to specific people such as managers or peers. Propensity to trust, on the other hand, is distinctly different and described by Johnson (2011) as "an enduring predisposition that is neither focused on specific others nor dependent on specific

contexts, and which may be related to lifetime experiences but also to temperament, and thereby to genetics and biophysiological structure." For the purpose of this personality assessment the propensity to trust will be evaluated since we will be looking at the traits of individuals participating in the study. Johnson (2011) describes individuals that score high on the facet Trust to be likely to assume that most people are fair, honest, and have good intentions. Individuals that score low on this facet are described to be expected to see others as selfish, devious, and potentially dangerous.. Cybersecurity professionals are constantly thinking of new ways to protect and defend security networks from outside sources. Therefore, it is likely that they have a low Trust in the general population since any person could be a threat. Considering this information the first hypothesis is: cybersecurity professionals will score significantly lower in Trust than regular Information Technology employees.

Sympathy

In addition to Trust, Sympathy was also selected out of the facets of Agreeableness to be studied due to the similarities between cybersecurity specialists and police officers (Garbarino et al., 2012). People who score high on the Sympathy facet are described by Johnson (2011) as "tenderhearted and compassionate. They feel the pain of others vicariously and are easily moved to pity". Low scorers, on the other hand, are understood "to not be affected strongly by human suffering. They pride themselves on making objective judgments based on reason. They are more concerned with truth and impartial justice than with mercy." This explanation of sympathy divides the facet into two areas: tender mindedness and tough mindedness. Tough mindedness is understood to be the process of making decisions based on logic, facts, and data as opposed to feelings. Tender mindedness, on the other hand, typically relies on making decisions based off of

emotion or feelings and less on logic (Landers & Lounsbury, 2006). Cybersecurity professionals need to rely on facts and data in order to make accurate decisions. Careful planning and analysis are necessary for this as opposed to reacting off of pure emotion as a simple mistake could be catastrophic for an organization. This leads to hypothesis 2: Cybersecurity professionals will score lower on the Sympathy facet as opposed to regular Information Technology employees.

Dutifulness

Garbarino et al., 2012 discovered that police officers scored moderately higher than the average population in the domain Conscientiousness. Due to their similarities it is likely that cybersecurity specialists will score differently than information technology employees on facets in the domain Conscientiousness. Dutifulness, a facet of Conscientiousness, refers to an individual's tendency to be dependable and reliable (Johnson, 2011). According to Johnson (2011) Dutifulness reflects the strength of a person's sense of duty and obligation. An individual that scores high on this facet is likely to have a strong sense of moral obligation. Low scorers find contracts, rules, and regulations overly confining. Often, cybersecurity professionals are compared to police officers and considered the security of the internet. A recent study on the personality and physiological profiles of police officer and firefighters found that police officer applicants had much higher scores in the facet of dutifulness (Pedneault, Reuf, & Orr, 2010). It is likely that cybersecurity professionals will score similarly since it is their responsibility to protect people and organizations from hidden threats. This leads to the third hypothesis: cybersecurity professionals are likely to score higher than regular information technology employees in dutifulness.

Cautiousness

In addition to Dutifulness, Cautiousness will also be examined as another facet of Conscientiousness due to the differences found between police officers and the average population (Garbarino et al., 2012). Cautiousness is understood to be "the tendency to behave in a manner designed to avoid potential failure or disapproval experiences, and this goal is achieved often at the expense of other satisfactions" (Moss, 1961). Johnson (2011) goes on to describe those who score high in Cautiousness as the type of individual that thinks through possibilities before acting. Low scorers on Cautiousness are more likely to say or do the first thing that comes to mind without considering alternatives and the consequences of those alternatives. Cybersecurity professional cannot afford to take part in extreme risk taking practices due to their responsibility for their organization. Therefore, it is likely that they are prone to higher levels of Cautiousness. The fourth hypothesis: Cybersecurity professionals will score higher on Cautiousness when compared to regular Information Technology employees.

Anxiety

A common saying in an IT department is that cybersecurity professionals are paid to be anxious. Their job revolves around constantly thinking about new different ways their organization can be attacked. Anxiety is a facet in the domain Neuroticism. Those who score high in anxiety are likely to often feel like something dangerous is about to happen. They may be afraid of specific situations or just generally fearful. Those who score low on Anxiety are generally calm and fearless (Johnson, 2011). Due to the nature of the cybersecurity professional's job it is likely that these individuals may be more anxious than their regular IT

counterparts. Therefore, hypothesis five: Cybersecurity professionals will score higher on Anxiety than regular Information Technology employees.

Intellect

Intellect is one of the six facets of Openness. Individuals who score high on Intellect are likely to be open to new and unusual ideas and may enjoy debating intellectual issues and solving complex problems or puzzles. Low scorers are likely to prefer to deal with people rather than ideas and may regard intellectual activities as a waste of time. It is important to note that Intellect is a measure of intellectual style and not capacity (Johnson, 2011). Previously, Song and Wood, (2010) produced results showing a strong correlation between Investigative (from the GEFT model) and computer science professions. In addition they reported a strong correlation between Investigative and Openness/Intellect. Since computer science is one of the most common degrees for someone in information technology it is probable that they would score high on Intellect. The research mentioned previously has already supported the relationship between Openness and information technology (Rottinghaus & Borgen, 2012). Cybersecurity professionals, however, may score higher on Intellect than regular information technology employees due to the adaptive nature of their work. Their roles require quick thinking and imaginative ways to solve problems on a daily basis. Therefore, hypothesis six: Cybersecurity professionals are likely to score higher on Intellect than information technology employees.

Self-Reported Performance

While assessing the typical schematic of a cybersecurity professional it is important to understand if the participant has adequate performance on the job. Evidence that supports the use of self-report has been found in various studies. Lerner, Amick, Lee, and Rooney (2003) demonstrated a strong correlation between objective and self-reported measures when conducted on a monthly basis. Additionally, Draper, Dickson, Blackwell, Fryer, Priestly, Winter, and Ellis (2011) conducted a study evaluating the relationship between rock climbers' self-reported climbing ability and an objective assessment. Their results indicated that there was no statistically significant difference between the self-report and on site assessment of the participants' climbing abilities.

Summary of Hypotheses

In summary, hypothesis 1 suggests that cybersecurity professionals are likely to score lower in the facet Trust when compared to other information technology professionals. Hypothesis 2 suggests that cybersecurity professionals will score lower in the facet Sympathy when compared to other information technology professionals. Hypothesis 3 suggests that cybersecurity professionals will score higher in the facet Dutifulness when compared to other information technology professionals. Hypothesis 4 suggests that cybersecurity professionals will score higher in the facet Cautiousness when compared to other information technology professionals. Hypothesis 5 suggests that cybersecurity professionals will score higher in the facet Anxiety when compared to other information technology professionals. Lastly, Hypothesis

6 suggests that cybersecurity professionals will score higher on the facet Intellect when compared to other information technology professionals.

CHAPTER III

METHODOLOGY

Participants

Participants were 118 cybersecurity and IT professionals recruited through the professional social networking website LinkedIn as well as via a snowball, word of mouth, strategy. Seventy-two (61%) of the participants identified themselves as cybersecurity professionals and 46 (39%) identified themselves as information technology employees. Participants were gathered from the following LinkedIn groups: Information Technology: IT networking forum, IT Specialist – Information Technology Network, Information Technology: Audit Governance Group, Cybersecurity: Law, Policy, and Technology, and Cybersecurity Community. Participants' ages range from 22 to 67 years (M = 42, SD = 11.12). Ninety-five (81%) of the participants were male and 23 (19%) were female. In regard to education 53 (45%) reported that they were four year college graduates while 37 (31%) reported having an advanced degree, 22 (19%) reported 1 to 3 years of college, and 6 (5%) reported a high school/GED diploma. A total of 117 participants reported information on race with 85 (73%) reporting to be White, 16 (14%) reporting to be Multiracial, 7 (6%) reporting to be Pacific Islander, 4 (3%) reporting to be African American, 3 (3%) reporting to be Native American, and 2 (1%) reporting to be Hispanic. No compensation was provided for this assessment

Measures

IPIP NEO Short Form

The personality measure IPIP NEO Short Form was adopted from the International Personality Item Pool (IPIP) provided on as public domain at http://ipip.ori.org/ (see Appendix A). As mentioned previously, this measure has been found to have high correlations with the successful NEO PI R (.91 when corrected for attenuation) (Johnson, 2011). The IPIP NEO Short Form consists of all five domains of the Big Five: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. Each domain consists of six facets (Openness: Imagination, Artistic Interests, Emotionality, Adventurousness, Intellect, and Liberalism. Conscientiousness: Self-Efficacy, Orderliness, Dutifulness, Achievement-Striving, Self-Discipline, and Cautiousness. Extraversion: Friendliness, Gregariousness, Assertiveness, Activity Level, Excitement-Seeking, Cheerfulness. Agreeableness: Trust, Morality, Altruism, Cooperation, Modesty, and Sympathy. Neuroticism: Anxiety, Anger, Depression, Self-Consciousness, Immoderation, Vulnerability). Each facet is assessed via four items.

Self-Report and Social Desirability

Skill was evaluated using seven self-report questions. These questions are written on a seven point Likert scale (see Appendix A). These questions were created by the researchers and then presented to an SME, with more than ten years of experience in computer science, in order to ascertain accuracy. Additionally, a short ten item version of the Marlow-Crowne social

desirability scale was included (see Appendix A) to assist with the validity of the self-report by highlighting individuals that may exhibit conforming behaviors (Strahan & Gerbasi, 1972).

Procedure

Participants were recruited through LinkedIn professional groups and snowballing techniques. By updating an informative comment on LinkedIn through various professional groups online participants were able to see the study and volunteer to participate. Participants were also gathered through contacts known by the researchers via snowballing techniques. Those who participated in the study were encouraged to pass it along to others that were employed in information technology or cybersecurity related positions. The procedure consisted of providing a link through either e-mail or social media comments that connected the participant to the questionnaire on Survey Monkey (ttps://www.surveymonkey.com). The participant was then presented with an informed consent form approved by the Institutional Review Board (IRB) at The University of Tennessee at Chattanooga (approval letter provided in Appendix D) where he/she also verified that he/she was at least of eighteen years of age. The participant then completed the personality measure on either a personal computer or computer provided by their company. Completion of the personality measure took fifteen to twenty minutes. Immediately after the personality questionnaire was completed the participant was provided with the social desirability and self-report measures which took an additional five to ten minutes to complete. Finally the demographics were presented (see Appendix A) resulting in a total testing time of approximately thirty minutes. Upon completion of the survey participants were thanked for their

contribution and given an e-mail connected to the researcher in order to answer any additional questions. No compensation was offered for participation in this study.

CHAPTER IV

RESULTS

Evaluation of descriptive statistics and specific hypotheses are presented in the following sections. The section on descriptive statistics presents the means, standard deviations, and correlations among the measured variables. Following this section, hypothesis-specific analyses are discussed. All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS). The Marlow-Crowne social desirability scale did not detect any participants that were prone to exaggeration after analyzing the results.

Differences in Professions

Before assessing the data it was necessary to decipher which participants were cybersecurity professionals or information technology professionals. This was done through the demographics questionnaire by asking the participants directly "Do you consider yourself a cybersecurity professional". Answers consisted of yes, no, and maybe. For those who answered "maybe" further analysis was required. This entailed assessing their rating of skill and their current profession. Those who claimed to have various cybersecurity positions and/or rated their skill in cybersecurity with a 5 or higher (on a 7 point Likert scale) were placed into the cybersecurity category.

Descriptive Statistics and Correlations

Correlations were ran between demographic information (Age, Sex, Education, and Employment) and both the domains and facets of the personality characteristics included in IPIP NEO Short Form (see Appendix B). When comparing the domains of the Big Five only Age was found to have any moderately strong correlation with Conscientiousness $r(116) = .201$, $p < .030$ and Neuroticism $r(116) = .331$, $p < .000$.

When comparing the demographic information with the facets of each domain a few weak correlations were found. Age was found to have weak correlations with Self Consciousness $r(116) = 218$, $p < .018$, Vulnerability $r(116) = -.407$, $p < .000$, Anxiety $r(116) = -.269$, $p < .003$, Achievement Striving $r(116) = .280$, $p < .002$, and Self Discipline $r(116) = .218$, $p < .018$. Sex was found to have weak correlations with Artistic Interest $r(116) = .207$, $p <, .025$, Emotionality $r(116) = .287$, $p < .002$, Sympathy $r(116) = .287$, $p < .021$, and Anxiety $r(116) = .208$, $p < .024$. Education was found to have weak correlations with Modesty $r(116) = -.231$, $p < .012$ and Orderliness $r(116) = .288$, $p < .002$. Employment was found to have weak correlations with Emotionality $r(116) = .296$, $p < .001$, Achievement Striving $r(116) = -.204$, $p < .027$, and Self Efficacy $r(116) = -.248$, $p < .007$.

In addition to examining the relationships between demographics and personality characteristics, the relationships between demographic information were also analyzed. Sex was found to have a weak correlation with Employment $r(116) = .222$, $p < .016$.

Means of combined scores of both cybersecurity and information technology professions for the five domains were calculated (see Table 1). The overall average score for Openness was

3.36 (SD = .527). The overall average score for Conscientiousness was 3.90 (SD = .473). The overall mean score for Extraversion was 3.28 (SD = .520). The overall average score for Agreeableness was 3.52 (SD = .485). The overall average score for Neuroticism 2.64 (SD = .585). Averages for the facets focused on in this study were also calculated with an overall average score of 3.12 (SD = .854) for Trust, 3.63 (SD = .755) for Sympathy, 3.83 (SD = .797) for Intellect, 2.73 (SD = .854) for Anxiety, 3.82 (SD = .865) for Cautiousness, and 4.02 (SD = .616) for Dutifulness (see Table 2).

Table 1

Combined Domain Means of Cybersecurity and Information Technology Professionals

Variable	Min	Max	M	St. D
Openness	2.25	4.83	3.3621	0.52721
Conscientiousness	2.63	4.92	3.9041	0.47298
Extraversion	2.00	4.75	3.2808	0.52048
Agreeableness	2.04	4.38	3.5248	0.48528
Neuroticism	1.38	4.00	2.6412	0.58464

Table 2

Combined Hypothesized Facet Means of Cybersecurity and Information Technology Professionals

Facet	Min	Max	M	SD
Intellect	1.7500	5.0000	3.8313	0.7970
Trust	1.0000	5.0000	3.1167	0.8544
Dutifulness	2.2500	5.0000	4.0222	0.6162
Cautiousness	1.7500	5.0000	3.8174	0.8650
Sympathy	1.2500	5.0000	3.6292	0.7552
Anxiety	1.0000	4.7500	2.7271	0.8538

Hypotheses-Related Results

An independent T-test was used to analyze the difference between means in domain and facet scores for cybersecurity professionals and other information technology professionals. Cybersecurity professionals (M =3.44, SD = .550) were found to have significantly higher scores when compared to other information technology professionals (M = 3.25, SD = .478), t(116) = 1.938, p = .028 in the domain Openness. Cybersecurity professionals (M = 3.45, SD = .484) were also found to have significantly lower scores than other information technology professionals (M = 3.62, SD = .474), t(116) = -1.918, p = .029 in the domain Agreeableness (see Table 3).

An independent T-test was also ran on the facets Trust, Sympathy, Intellect, Anxiety, Cautiousness, and Dutifulness. No significance was found between cybersecurity and other information technology professionals for Anxiety, Cautiousness, or Dutifulness. As predicted, Cybersecurity professionals (M = 3.51, SD = .767) had significantly lower scores when compared to other information technology professionals (M = 3.780, SD = .690), t(116) = -1.937 , p = .028 in the facet Sympathy. Cybersecurity professionals (M = 2.97, SD = .852) scored significantly lower than other information technology professionals (M = 3.31, SD = .829), t(116) = -2.162, p = .017, in the facet Trust. Cybersecurity professionals (M = 3.95, SD = .780) also scored significantly higher than other information technology professionals (M = 3.65, SD = .799), t(116) = 1.938, p = .020, in the facet Intellect (see Table 4).

An additional analysis was conducted evaluating all thirty facets in the IPIP NEO short form survey. Surprisingly, cybersecurity professionals (M = 3.893, SD = .730) scored significantly higher than other information technology professionals (M = 3.535, SD = .694), t(116) = 2.691, *p* = .004 in the facet Assertiveness, a facet of the domain Extraversion.

Cybersecurity professionals (M = 3.467, SD = .715) were also found to score significantly higher than other information technology professionals (M = 3.002, SD = .704), t(116) = 3.516, *p* = .001, in the facet Adventurousness, a facet in the domain Openness. Cybersecurity professionals (M = 2.202, SD = .846) were found to score significantly lower than other information technology professionals (M = 2.485, SD = .859), t(116) = -1.783, *p* = .039 in Vulnerability, a facet in the domain Neuroticism. Lastly, cybersecurity professionals (M = 2.915, SD = .937) were found to score significantly lower than other information technology professionals (M = 3.180, SD = .718), t(116) = -1.736, *p* = .043 in Self Consciousness, another facet in the domain Neuroticism (see Table 5).

Table 3

Comparison of Domain Means between Cybersecurity and Information Technology Professionals

	Cybersecurity		Information Technology				
Domain	M	SD	M	SD	T	P Value	Cohens D
Openness	3.4418	0.5506	3.2536	0.4779	1.9380	0.028	0.365
Conscientiousness	3.9322	4.0477	3.8658	0.5546	0.7170	0.238	0.023
Extraversion	3.2849	0.5269	3.2849	0.5170	0.0990	0.461	0.000
Agreeableness	3.4522	0.4838	3.6236	0.4744	-1.9180	0.029	-0.358
Neuroticism	2.5880	0.5516	2.7125	0.6254	-1.1370	0.129	-0.211

Table 4

Comparison of Hypothesized Facet Means between Cybersecurity and Information Technology Professionals

	Cybersecurity		Information Technology				
Facet	M	SD	M	SD	T	P Value	Cohens D
Intellect	3.9522	0.7802	3.6450	0.7987	1.9380	0.020	0.389
Trust	2.9706	0.8525	3.3100	0.8293	-2.1620	0.017	-0.404
Dutifulness	4.0331	0.5696	3.9933	0.6755	0.3460	0.365	0.064
Cautiousness	3.8542	0.8284	3.7600	0.9119	0.5850	0.280	0.108
Sympathy	3.5147	0.7665	3.7800	0.6900	-1.9370	0.028	-0.364
Anxiety	2.6581	0.8160	2.8450	0.9076	-1.1720	0.122	-0.217

Table 5

Comparison of all Facet Means between Cybersecurity and Information Technology Professionals

		Cybersecurity		Information Technology				
Domain	Facet	M	SD	M	SD	T	P Value	Cohen's D
O	Imagination	3.4596	0.9420	3.3450	0.8848	0.6700	0.023	0.125
O	Artistic Interests	3.5956	0.8682	3.4800	0.9242	0.6950	0.244	0.129
O	Emotionality	3.4632	0.7790	3.3700	0.5786	0.7140	0.239	0.136
O	Adventurousness	3.4669	0.7149	3.0017	0.7042	3.5160	0.001	0.656
O	Intellect	3.9522	0.7802	3.6450	0.7987	1.9380	0.020	0.389
O	Liberalism	2.7132	1.0369	2.6800	0.9064	0.1810	0.428	0.034
C	Self-Efficacy	4.2083	0.4770	4.1117	0.5136	1.0530	0.148	0.195
C	Orderliness	3.7300	0.8637	3.4150	0.8959	0.3550	0.362	0.358
C	Dutifulness	4.0331	0.5696	3.9933	0.6755	0.3460	0.365	0.064
C	Achievement Striving	4.3897	0.5622	4.3200	0.6944	0.6020	0.274	0.110
C	Self-Discipline	3.6348	0.5587	3.5950	0.7105	0.3410	0.367	0.062
C	Cautiousness	3.8542	0.8284	3.7600	0.9119	0.5850	0.280	0.108
E	Cheerfulness	3.6103	0.7129	3.7300	0.6109	-0.9570	0.171	-0.180
E	Friendliness	3.4265	0.9503	3.4150	0.8786	0.0670	0.474	0.013
E	Gregariousness	2.6801	0.9618	2.7917	0.9358	-0.6300	0.265	-0.118
E	Assertiveness	3.8934	0.7296	3.5350	0.6944	2.6910	0.004	0.503
E	Activity Level	3.3137	0.6455	3.2750	0.7445	0.3020	0.382	0.056
E	Excitement Seeking	2.7855	0.7314	2.9050	0.7625	-0.8610	0.196	-0.160
A	Trust	2.9706	0.8525	3.3100	0.8293	-2.1620	0.017	-0.404
A	Morality	3.4926	0.5465	3.5767	0.4770	0.8700	0.193	-0.164
A	Altruism	3.9963	0.7149	4.0300	0.5990	-0.2700	0.394	-0.051
A	Cooperation	3.8235	0.7382	3.9450	0.8242	-0.8410	0.201	-0.155
A	Modesty	2.9154	0.8763	3.1000	0.7249	-1.2140	0.114	-0.230
A	Sympathy	3.5147	0.7665	3.7800	0.6900	-1.9370	0.028	-0.364
N	Anxiety	2.6581	0.8160	2.8450	0.9076	-1.1720	0.122	-0.217
N	Anger	2.7218	0.9600	2.7750	0.9453	-0.2990	0.383	-0.056
N	Depression	2.1618	0.8306	2.1150	0.8707	0.2960	0.384	0.055
N	Self-Consciousness	2.9154	0.9370	3.1800	0.7179	-1.7360	0.043	-0.317
N	Immoderation	2.8738	0.4939	2.8750	0.5917	-0.0120	0.495	-0.002
N	Vulnerability	2.2022	0.8456	2.4850	0.8592	-1.7830	0.039	-0.332

CHAPTER V

DISCUSSION AND CONCLUSION

The present results indicate that cybersecurity professionals differed from regular information technology professionals on Trust, Intellect, Sympathy, Vulnerability, Self-Consciousness, Assertiveness, and Adventurous at the facet level. Cybersecurity professionals were also found to have significantly different scores from other information technology professionals in the domains Agreeableness and Openness. It is worth noting that facets were found to be significant in both of these domains (Openness: Intellect and Adventurousness, Agreeableness: Trust and Sympathy). This indicates that looking at the facets of domains in personality can provide information that would not initially be found. Cybersecurity professionals scored lower than information technology professionals on the facet Trust supporting hypothesis 1. Due to the need for cybersecurity professionals to protect their companies and loved ones from outside threats it is understandable that they may be less trusting of individuals since anybody can access a computer and pose a threat. Cybersecurity professionals scored higher than information technology professionals on the facet Intellect supporting hypothesis 6. Intellect is a facet in the domain Openness. Previously, high correlations had been found between information technology professionals and Openness. Due to Intellect originating from Openness cybersecurity professionals were already prone to scoring high in this facet (Song & Wood, 2010). Cybersecurity professionals may have scored high on the facet Intellect due to the necessity of adaptability in

their profession. Cybersecurity professionals must be prepared for new types of attacks on their systems every day. This ability to adapt requires a higher level of aptitude possibly resulting in higher scores of Intellect (Mussel, 2013). Cybersecurity professionals scored lower than information technology professionals in the facet Sympathy supporting hypothesis 2. This lower score may have occurred since those who score high in Sympathy tend to make decisions off of an emotional basis (Johnson, 2011). Cybersecurity professionals must rely on logic to make accurate decisions in their field thus resulting in a lower score. Hypotheses 3, 4, and 5 were not supported. This lack of support may be due to the similarities between cybersecurity professionals and regular information technology professionals.

Research on cybersecurity professionals is lacking, and since there has been no previous research on this topic it was thought that it would be useful to analyze the rest of the facets that were not being considered for any significance. Cybersecurity professionals scored significantly higher than information technology professionals in Assertiveness (a facet in the domain Extraversion). This falls in line with the findings of Detrick and Chibnall (2006) where high performing police officers were also found to score higher in Assertiveness when compared to low performers. High scorers in assertiveness are likely to speak out, take charge, and direct the activities of others. Low scorers tend to not talk as much and let others control the group (Johnson, 2011). A study conducted by Woods & Sofat (2013) discovered that high scorers in Assertiveness were likely to be driven, competitive, energetic, and likely to work with greater vigor and purpose. Assertiveness was found to have a significant association with work engagement (Woods & Sofat, 2013). This may help explain why cybersecurity professionals scored higher than regular information technology employees. Their duties will have a larger impact on individuals they know and care about if they fail. Also, due to the constantly changing nature of their jobs it is

necessary for them to remain vigilant in order to keep up with new technology. This leads to a need to be driven and engaged in their work.

Cybersecurity professionals scored significantly higher than information technology professionals in Adventurousness (a facet in the domain Openness). High scorers on adventurousness are eager to try new activities, travel to foreign lands, and experience different things. They find familiarity and routine boring, and will take a new route home just because it is different. Low scorers tend to feel uncomfortable with change and prefer familiar routines (Johnson, 2011). This aversion to routine is a possible explanation for the higher score of cybersecurity professionals since they must be adaptive in order to be effective in their profession.

Cybersecurity professionals scored significantly lower than other information technology professionals in Vulnerability (a facet in the domain Neuroticism). Garbarino et al., (2012) found that police officers scored significantly lower than the average population in the domain Neuroticism. Therefore, it is likely that cybersecurity professionals would also score lower in the facets when compared to other information technology professionals due to their similarities with the police force. In addition, Detrick and Chibnall (2006) found the high performing police officers scored significantly lower than lower performers in this facet. Those who score high in Vulnerability are prone to experiencing panic and helplessness when under pressure or stress while those who score low tend to experience more level headedness and clear thinking (Johnson, 2011). Considering that cybersecurity professionals are responsible for the valuables and safety of many people it seems likely that they would encounter stress frequently on the job. Therefore, it is a necessary trait to have the ability to remain calm under pressure.

Cybersecurity professionals scored significantly lower than other information technology professionals in Self Consciousness (a facet in the domain Neuroticism). As stated

previously, earlier studies have shown that the police force tends to score lower than the average population on the domain Neuroticism (Garbarino et al., 2012). Due to the similarities in stress and responsibility with their careers it is likely that cybersecurity professionals will also score lower in Neuroticism facets. Those who score high in Self Consciousness easily feel embarrassed or ashamed and fear criticisms while high scorers tend to not fear social situations (Johnson, 2011). It is possible that cybersecurity professional's lower score in Self Consciousness reflects their ability to remain calm in stressful situations.

Limitations

There are a few limitations in this study that should be accounted for. Firstly, the personality questionnaire was entirely based on self-report leaving the possibility of participants to inflate/deflate their responses based on how they want to appear. Although a social desirability measure was used to help counter this issue it is still possible that some participants may have slipped through the cracks. Another limitation is that participants were allowed to take the questionnaire online. This means that they were not all specifically selected by the researcher and may have lied about their credentials in order to participate. Since there was no incentive offered it is less likely that unqualified individuals would want to participate, but there are those who may think that they are cybersecurity professionals when they actually are not. Categorical questions were included in the survey to help weed out these individuals but it is possible that they may have still slipped through. Another problem with offering the questionnaire online is that certain personality characteristics are associated with those who would choose to go out of their way to voluntarily participate in a non-incentivized study. It is possible that this may skew the results of the personality assessment. The small sample size of participants may also skew the results. A

lager sample size may have resulted in more/less significance in both the domains and facets analyzed in this study. It is possible that since there is a limited population of cybersecurity professionals (1000) this number is an appropriate representation of their profession (Evans & Reeder, 2010). It is also important to assess the true relationship between police officers and cybersecurity professionals. Future research comparing personality profiles would be beneficial for selection and assessment purposes. Lastly, the facets Assertiveness, Adventurousness, Vulnerability, and Self Consciousness were not a part of the original assessment. Although significance was found, this may be due to "shot gunning" also known as chance. Future analysis with a larger sample size can help determine whether the significance found in this study is supported as valid.

Future Research

Currently, research on cybersecurity professionals is extremely limited. It is hoped that by conducting this study more researchers may be interested in pursuing information on the profession. It would be useful to conduct another personality assessment, but with more participants and an inclusion of the facets Adventurousness and Assertiveness. If results from that study mirror the results currently found it would further support our findings. With more participants it may be possible that other facets also significantly affect cybersecurity professional's personality characteristics. It would also be beneficial to conduct studies to find out why the facets Trust, Intellect, Assertiveness, and Adventurousness were significant. If someone had the opportunity to narrow the study down to specific occupations within information technology departments it would be interesting to see how these individuals would differ across

positions. More research should also be conducted comparing cybersecurity specialists with police officers in order to further verify their similarities.

Implications

The results of the present study indicate that cybersecurity specialists differ from regular information technology employees on six narrow traits from the IPIP NEO Short Form: Trust, Intellect, Vulnerability, Self Consciousness, Assertiveness, and Adventurousness. These results can be useful in creating training programs specifically geared towards cybersecurity professionals' unique personality characteristics. Further studies on personality characteristics with these positions may also help with the selection of effective cybersecurity professionals. In addition to providing an insight to the personality characteristics of cybersecurity professionals and information technology professionals this research also provides a stepping stone towards future research. Currently, knowledge of the field of cybersecurity is extremely limited, and it is pertinent that a better understanding of the job role is developed. The first step in understanding the job is understanding the people.

REFERENCES

Ackerman, P. (2007). New developments in understanding skilled performance. *Current Directions in Psychological Science, 16*(5), 235-239.

Baer, M., Oldham, G., Jacobson, G., & Hollingshead, A. (2008). The personality composition of teams and creativity: the moderating role of team creative confidence. *The Journal of Creative Behavior, 45*(4), 255-282.

Barrick, M., & Mount, M. (2013). The theory of purposeful work behavior: the role of personality, higher-order goals, and job characteristics. *Academy of Management Review, 38*(1), 132-153.

Benet-Martinez, V., & John, O. P. (1998). Los cinco grandes across cultures and ethnic groups: multitrait multimethod analyses of the big five in spanish and english. *Journal of Personality and Social Psychology, 75*(3), 729-750.

Bergerson, G., & Gustafsson, J. (2011). Programming skill, knowledge, and working memory among professional software developers from an investment theory perspective. *Journal of Individual Differences, 32*(4), 201-209.

Berry, C., Carpentar, N., & Barratt, C. (2012). Do other-reports of counterproductive work behavior provide an incremental contribution over self-reports? A meta-analytic comparison. *Journal of Applied Psychology, 97*(3), 613-636.

Biggs, Z. (2012, Mar 24). US military goes on cyber offensive. *DefenseNews.* Retrieved from http://www.defensenews.com/article/20120324/DEFREG02/303240001/U-S-Military-Goes-Cyber-Offensive

Buchanan, T., Johnson, J., & Goldberg, L. (2005). Implementing a five-factor personality inventory for use on the internet. *European Journal of Psychological Assessment, 21*(2), 115-127.

Christiansen, N., & Robie, C. (2011). Further consideration of the use of narrow trait scales. *Canadian Journal of Behavioral Science, 43*(3), 183-194.

Costa Jr, P. T., & McCrae, R. R. (1992). Neo personality inventory–revised (neo-pi-r) and neo five-factor inventory (neo-ffi) professional manual. *Odessa, FL: Psychological Assessment Resources*.

Costa, Jr, P. T., & McCrae, R. R. (1992a). Four ways five factors are basic. *Personality and Individual Differences*, *13*, 653–665.

Detrick, P., & Chibnall, J. (2006). NEO PI-R personality characteristics of high-performing entry-level police officers. *Psychological Services, 3*(4), 274-285.

Digman, J. M. (1990). Personality structure: Emergence of the five-factor model. *Annual Review of Psychology, 41*(1), 417–440.

Evans, K., & Reeder, F. (2010). A human capital crisis in cybersecurity: technical proficiency matters. *Center for Strategic and International Studies,* ISBN: 978-0-89206-609-4.

Garbarino, S., Chiorri, C., Magnavita, N., Piattino, S., & Cuomo, G. (2012). Personality profiles of special force police officers. *Journal of Police and Criminal Psychology, 27*(2), 99-110.

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American Psychologist, 48*(1), 26–34.

Goldberg, L., Johnson, J., Eber, H., Hogan, R., Ashton, M., Cloninger, R., & Gough, H. (2006). The international personality item-pool and the future of public-domain personality measures. *Journal of Research in Personality, 40*(1), 84-96.

International Personality Item Pool: A Scientific Collaboratory for the Development of Advanced Measures of Personality Traits and Other Individual Differences (http://ipip.ori.org/). Internet Web Site

John, O. P., Donahue, E. M., & Kentle, R. L. (1991). The Big Five Inventory – Versions 4a and 54. Berkeley, CA: University of California Berkeley, Institute of Personality and Social Research.

John, O. P., & Srivastava, S. (1999). The big five trait taxonomy: history, measurement, and theoretical perspectives. In L. A. Pervin & O. P. John.

John, O. P., Naumann, L. P., & Soto, C. J. (2008). Paradigm shift to the integrative big-five trait taxonomy: history, measurement, and conceptual issues. In O. P. John, R. W. Robins, &

L. A. Pervin (Eds.), Handbook of personality: Theory and research (pp. 114-158). New York, NY: Guilford Press.

Johnson, J. A. (2000). Developing a short form of the IPIP-NEO: A report to HGW Consulting. Unpublished manuscript. Department of Psychology, University of Pennsylvania, DuBois, PA.

Johnson, J. A. (2011, June). *Development of a short form of the IPIP-NEO Personality Inventory*. Poster presented at the 2nd Biennial Meeting of the Association for Research in Personality, Riverside, CA.

Landers, R., & Lounsbury, J. (2006). An investigation of Big Five and narrow personality traits in relation to internet usage. *Computers in Human Behavior, 22*(2), 283-293.

Lee, A. (2011, Aug 8). Citigroup: $2.7 million stolen from customers as a result of hacking. *The Huffington Post.* Retrieved from http://www.huffingtonpost.com/2011/06/27/citigroup-hack_n_885045.html

Mastor, K., & Ismail, A. (2004). Personality and cognitive style differences among matriculation engineering and information technology students. *World Transactions on Engineering and Technology Education, 3*(1), 101-105.

Mayer, R. C., Davis, J. H., and Schoorman, F. D. (1995). An integrative model of organizational trust, *Academy of Management Review, 20*(3), 709-734.

Moss, H. (1961). The influences of personality and situational cautiousness on conceptual behavior. *Journal of Abnormal and Social Psychology, 63*(3), 629-635.

Mussel, P. (2013). Intellect: a theoretical framework for personality traits related to intellectual achievements. *Journal of Personality and Social Psychology, 104*(5), 885-905.

Office of the secretary of defense. (2013). Annual report to congress. Retrieved from http://www.defense.gov/pubs/2013_china_report_final.pdf.

Paunonen, S., & Ashton, M. (2001). Big five factors and facets and the prediction of behavior. *Journal of Personality and Social Psychology, 81*(3), 524-539.

Pedneault, K., Reuf, A., & Orr, S. (2010). Personality and psychophysiological profiles of police officer and firefighter recruits. *Personality and Individual Differences, 49*(3), 210-215.

Rochan, S. (2014, Jan 13). Several US retailers suffered cyber-attacks over 2013 holiday shopping season report. *International Business Times*. Retrieved from http://www.ibtimes.co.uk/several-us-retailers-suffered-cyber-attacks-over-2013-holiday-shopping-season-report-1432021

Rosenbloom, J., Ash, R., Dupont, B., & Coder, L. (2008). Why are there so few women in information technology? Assessing the role of personality in career choices. *Journal of Economic Psychology, 29*(4), 543-554.

Smith, C. (2011, Aug 2). Hackers lulzsec say sony pictures attacked, 1 million users compromised (UPDATE). *The Huffington Post.* Retrieved from http://www.huffingtonpost.com/2011/06/02/sony-pictures-hacked-lulzsec_n_870615.html

Smith, K., Yankelvich, M., Ascione, D., Maxson, P., & Tobey, D. (2013, April 12) Cybersecurity: a national imperative and challenge for I-O psychology. *SIOP (conference)* Houston, TX.

Strahan, R., & Gerbasi, K. (1972). Short homogenous versions of Marlowe-Crowne social desirability scale. *Journal of Clinical Psychology, 28*(2), 191-193.

Sullivan, A. (2013, April 10) Obama budget makes cybersecurity a growing U.S priority. *Reuters.* Retrieved from http://www.reuters.com/article/2013/04/11/us-usa-fiscal-cybersecurity-idUSBRE93913S20130411

Vaas, L. (2013, Sep 27). Schoolboy arrested over Spamhaus DDoS, world's biggest cyber-attack. *NakedSecurity*, Retrieved from http://nakedsecurity.sophos.com/2013/09/27/schoolboy-arrested-over-spamhaus-ddos-worlds-biggest-cyber-attack/

Woods, S., & Hampson, S. (2010). Predicting adult occupational environments from gender and childhood personality traits. *The Journal of Applied Psychology, 95*(6), 1045-57.

Woods, S., & Sofat, J. (2013). Personality and engagement at work: the mediating role of psychological meaningfulness. *Journal of Applied Social Psychology, 43*(11), 2203-2210.

Yamaguchi, M. (2011, May 5). Sony playstation network hack to cost $170 million. *HuffPost Tech.* Retrieved from http://www.huffingtonpost.com/2011/05/23/sony-playstation-network-hack-cost_n_865432.html

APPENDIX A

MEASURES

IPIP NEO SHORT FORM

Item #	NEO Domain	NEO Facet	Item Direction	Question
1	N	Anxiety	+	I worry about things
2	E	Friendliness	+	I make friends easilty
3	O	Imagination	+	I have a vivid imagination
4	A	Trust	+	I trust others
5	C	Self-Efficacy	+	I complete tasks successfully
6	N	Anger	+	I get angry easily
7	E	Gregariousness	+	I love large parties
8	O	Artisitc Interests	+	I believe in the importance of art.
9	A	Morality	-	Use others for my own ends
10	C	Orderliness	+	I like to tidy up
11	N	Depression	+	I often feel blue
12	E	Assertiveness	+	I take charge
13	O	Emotionality	+	I Experience my emotions intensely
14	A	Altruism	+	Love to help others.
15	C	Dutifulness	+	Keep my promises.
16	N	Self-Consciousness	+	Find it difficult to approach others
17	E	Activity Level	+	Am always busy.
18	O	Adventurousness	+	I prefer variety to routine
19	A	Cooperation	-	Love a good fight.
20	C	Achievement Striving	+	I work hard
21	N	Immoderation	+	Go on binges.
22	E	Excitement Seeking	+	I love excitement
23	O	Intellect	+	Love to read challenging material
24	A	Modesty	-	Believe that I am better than others
25	C	Self Disciipline	+	Am always prepared.
26	N	Vulnerability	+	I panic easily
27	E	Cheerfulness	+	I radiate joy
28	O	Liberalism	+	Tend to vote for liberal political candidates.
29	A	Sympathy	+	Sympathize with the homeless.
30	C	Cautiousness	-	Jump into things without thinking
31	N	Anxiety	+	Fear for the worst.
32	E	Friendliness	+	Feel comfortable around people
33	O	Imagination	+	Enjoy wild flights of fantasy
34	A	Trust	+	Believe that others have good intentions.
35	C	Self-Efficacy	+	Excel in what I do.
36	N	Anger	+	Get irritated easily
37	E	Gregariousness	+	Talk to a lot of different people at parties.
38	O	Artisitc Interests	+	See beauty in things that others might not notice

39	A	Morality	+	Cheat to get ahead
40	C	Orderliness	-	Often forget to put things back in their proper place.
41	N	Depression	+	Dislike myself.
42	E	Assertiveness	+	Try to lead others.
43	O	Emotionality	+	Feel others' emotions.
44	A	Altruism	+	I am concerned about others
45	C	Dutifulness	+	Tell the truth.
46	N	Self-Consciousness	+	Am afraid to draw attention to myself
47	E	Activity Level	+	Am always on the go.
48	O	Adventurousness	-	Prefer to stick with things that I know.
49	A	Cooperation	-	Yell at people.
50	C	Achievement Striving	+	I do more than what is expected of me
51	N	Immoderation	-	Rarely overindulge.
52	E	Excitement Seeking	+	Seek adventure.
53	O	Intellect	-	Avoid philosophical discussions
54	A	Modesty	-	Think highly of myself
55	C	Self Disciipline	+	Carry out my plans.
56	N	Vulnerability	+	Become overwhelmed by events
57	E	Cheerfulness	+	Have a lot of fun.
58	O	Liberalism	+	Believe that there is no absolute right and wrong
59	A	Sympathy	+	Feel sympathy for those who are worse off than myself
60	C	Cautiousness	-	Make rash decisions
61	N	Anxiety	+	Am afraid of many things.
62	E	Friendliness	-	Avoid contacts with others.
63	O	Imagination	+	Love to daydream
64	A	Trust	+	Trust what people say.
65	C	Self-Efficacy	+	Handle tasks smoothly
66	N	Anger	+	I lose my temper
67	E	Gregariousness	-	I prefer to be alone
68	O	Artisitc Interests	-	I do not like poetry
69	A	Morality	-	Take advantage of others
70	C	Orderliness	-	Leave a mess in my room.
71	N	Depression	+	Am often down in the dumps
72	E	Assertiveness	+	Take control of things.
73	O	Emotionality	-	Rarely notice my emotional reactions.
74	A	Altruism	-	Am indifferent to the feelings of others.
75	C	Dutifulness	-	Break rules.
76	N	Self-Consciousness	+	Only feel comfortable with friends.
77	E	Activity Level	+	Do a lot in my spare time.
78	O	Adventurousness	-	Dislike changes.
79	A	Cooperation	-	Insult people.
80	C	Achievement Striving	-	I do just enough work to get by

81	N	Immoderation	-	Easily resist temptations
82	E	Excitement Seeking	+	Enjoy being reckless.
83	O	Intellect	-	Have difficulty understanding abstract ideas
84	A	Modesty	-	Have a high opinion of myself
85	C	Self Disciipline	-	Waste my time.
86	N	Vulnerability	+	Feel that I'm unable to deal with things.
87	E	Cheerfulness	+	I love life
88	O	Liberalism	-	Tend to vote for conservative political candidates
89	A	Sympathy	-	Am not interested in other people's problems.
90	C	Cautiousness	-	I rush into things
91	N	Anxiety	+	I get stressed out easily
92	E	Friendliness	-	Keep others at a distance.
93	O	Imagination	+	Like to get lost in thought.
94	A	Trust	-	Distrust people.
95	C	Self-Efficacy	+	Know how to get things done.
96	N	Anger	-	Am not easily annoyed.
97	E	Gregariousness	-	Avoid crowds.
98	O	Artisitc Interests	-	Do not enjoy going to art museums
99	A	Morality	-	Obstruct others' plans
100	C	Orderliness	-	I leave my belonging around
101	N	Depression	-	Feel comfortable with myself.
102	E	Assertiveness	-	Wait for others to lead the way.
103	O	Emotionality	-	Don't understand people who get emotional.
104	A	Altruism	-	I take no time for others
105	C	Dutifulness	-	Break my promises.
106	N	Self-Consciousness	-	Am not bothered by difficult social situations.
107	E	Activity Level	-	Like to take it easy
108	O	Adventurousness	-	I am attached to conventional ways
109	A	Cooperation	-	I get back at others
110	C	Achievement Striving	-	I put little time and effort into my work
111	N	Immoderation	-	I am able to control my cravings
112	E	Excitement Seeking	+	Act wild and crazy.
113	O	Intellect	-	Am not interested in theoretical discussions
114	A	Modesty	-	I boast about my virtues
115	C	Self Disciipline	-	I have difficulty starting tasks
116	N	Vulnerability	-	Remain calm under pressure.
117	E	Cheerfulness	+	Look at the bright side of life.
118	O	Liberalism	-	Believe that we should be tough on crime
119	A	Sympathy	-	I try not to think about the needy
120	C	Cautiousness	-	I act without thinking

(Johnson, 2011)

SELF REPORT

1. What is your job title?
2. Do you consider yourself to be a cybersecurity professional?
    a. Yes
    b. No
    c. Maybe
3. If maybe/no please identify your profession.
4. Does your job entail tasks related to cybersecurity?
    a. Yes
    b. No
    c. Maybe
5. If yes/maybe please provide a short list of relevant job tasks.
6. How would you rate your skills in cybersecurity compared to your colleagues? Please rate in terms of percentages. Ex: top 10%, 20%, 30%, etc…
7. Rate the level of cybersecurity skill that you currently have
    a. Very Unskilled
    b. Blank
    c. Blank
    d. Neither Unskilled nor Skilled
    e. Blank
    f. Blank
    g. Very Skilled
8. Rate the level of cybersecurity skill that you would like to have.

9. In your own words, please define the role of cybersecurity

SOCIAL DESIRABILITY SCALE

Short Form Marlowe-Crowne Social Desirability Scale Items

1. (T) I am always willing to admit it when I make a mistake
2. (T) I always try to practice what I preach
3. (T) I never resent being asked to return a favor
4. (T) I have never been irked when people expressed ideas very different from my own
5. (T) I have never deliberately said something that hurt someone's feelings
6. (F) I like to gossip at times
7. (F) There have been occasions when I took advantage of someone
8. (F) I sometime try to get even rather than forgive and forget
9. (F) At times I have really insisted on having things my own way
10. (F) There have been occasions when I felt like smashing things.

(Strahan and Gerbasi, 1972)

APPENDIX B

DEMOGRAPHIC CORRELATION TABLES

DEMOGRAPHIC CORRELATIONS WITH BIG FIVE DOMAINS

Variable	M	SD	1		2		3		4	5	6	7	8	9	10
1. Age	41.91	11.12	___												
2. Sex	1.21	.41	.07		___										
3. Race	1.98	1.80	-.23	**	.09		___								
4. Education	6.02	.84	-.07		-.06		.35		___						
5. Employment	1.36	1.11	.01		.22	**	.08	**	-.08	___					
6. Openness	3.36	.53	.00		.11		.05		.09	.05	___				
7. Conscientiousness	3.90	.47	.20	**	.04		-.14		.10	-.09	.00	___			
8. Extraversion	3.28	.52	-.03		-.01		.10		.07	.00	.14	.10	___		
9. Agreeableness	3.52	.49	-.02		.18		.09		-.07	.09	.27	.26	.09	___	
10. Neuroticism	2.64	.58	-.33	**	.15		.09		-.04	.06	-.01	-.48	-.41	-.22	___

DEMOGRAPHIC CORRELATIONS WITH OPENNESS FACETS

Variable	M	SD	1		2		3		4	5	6	7	8	9	10	11
1. Age	41.91	11.12	___													
2. Sex	1.21	.41	.07		___											
3. Race	1.98	1.80	-.23	**	.09		___									
4. Education	6.02	.84	-.07		-.06		.35	**	___							
5. Employment	1.36	1.11	.01		.22	**	.08		-.08	___						
6. Imagination	3.44	.92	.05		-.05		-.01		.01	.02	___					
7. Artistic Interests	3.55	.89	-.31	**	.21	**	-.01		-.01	.09	.39	___				
8. Emotionality	3.42	.70	.10		.29	**	.13		.10	.30	**	.17	.58	___		
9. Adventurousness	3.30	.74	.02		.01		.03		.03	-.01		.03	.24	.14	___	
10. Intellect	3.82	.80	.11		-.14		-.10		.08	-.13		.37	.45	.21	.28	
11. Liberalism	2.70	.98	-.19		.12		.16		.13	-.03		.29	.20	.17	.25	.28	___

DEMOGRAPHIC CORRELATIONS WITH CONSCIENTIOUSNESS FACETS

Variable	M	SD	1		2		3		4	5	6	7	8	9	10	11
1. Age	41.91	11.12	___													
2. Sex	1.21	.41	.07		___											
3. Race	1.98	1.80	-.23	**	.09		___									
4. Education	6.02	.84	-.07		-.06		.35	**	___							
5. Employment	1.36	1.11	.01		.22	**	.08		-.08	___						
6. Self-Efficacy	4.17	.49	.29		-.12		-.17		.05	-.25	___					
7. Orderliness	3.45	.87	.12		.20		.06		.29	.07	.15	___				
8. Dutifulness	4.02	.61	.10		.02		-.06		.06	.04	.26	.46	___			
9. Achievement Striving	4.36	.62	.28		-.04		-.23		-.10	-.20	.48	.13	.42	___		
10. Self-Discipline	3.62	.62	.22		.07		-.17		.00	-.07	.50	.39	.44	.44	___	
11. Cautiousness	3.81	.61	.09		-.05		-.10		.03	-.05	.21	.34	.69	.28	.45	___

DEMOGRAPHIC CORRELATIONS WITH EXTRAVERSION FACETS

Variable	M	SD	1		2		3		4	5	6	7	8	9	10	11
1. Age	41.91	11.12	___													
2. Sex	1.21	.41	0.07		___											
3. Race	1.98	1.80	-0.23	**	0.09		___									
4. Education	6.02	.84	-0.07		-0.06		0.35	**	___							
5. Employment	1.36	1.11	0.01		0.22	**	0.08		-0.08	___						
6. Friendliness	3.42	.92	-0.01		-0.03		0.09		0.12	-0.01	___					
7. Gregariousness	2.73	.95	-0.08		0.06		0.15		-0.01	0.11	0.70	___				
8. Assertiveness	3.74	.73	0.13		-0.10		-0.07		0.15	-0.17	0.49	0.29	___			
9. Activity Level	3.30	.69	0.08		0.07		-0.03		0.00	-0.04	0.16	0.07	0.32	___		
10. Excitement Seeking	2.84	.74	-0.14		-0.02		0.06		0.01	0.04	0.17	0.33	0.13	0.22		
11. Cheerfulness	3.66	.67	-0.10		-0.01		0.18		0.02	0.03	0.57	0.47	0.23	0.18	0.35	___

DEMOGRAPHIC CORRELATIONS WITH AGREEABLENESS FACETS

`	M	SD	1		2		3		4		5	6	7	8	9	10	11
1. Age	41.91	11.12	___														
2. Sex	1.21	.41	0.07		___												
3. Race	1.98	1.80	-0.23	**	0.09		___										
4. Education	6.02	.84	-0.07		-0.06		0.35	**	___								
5. Employment	1.36	1.11	0.01		0.22	**	0.08		-0.08		___						
6. Trust	3.11	.86	-0.10		0.08		0.20	**	0.17		-0.04	___					
7. Morality	3.53	.52	0.15		0.17		-0.15		-0.10		0.07	0.17	___				
8. Altruism	4.01	.67	0.00		0.08		0.06		-0.06		0.13	0.27	0.37	___			
9. Cooperation	3.88	.77	0.16		0.06		-0.08		-0.09		-0.02	0.15	0.65	0.40	___		
10. Modesty	2.99	.82	-0.13		0.14		0.08		-0.23	**	0.06	-0.01	0.36	0.32	0.41	___	
11. Sympathy	3.63	.74	-0.09		0.21	**	0.16		-0.01		0.17	0.34	0.38	0.60	0.39	0.36	___

DEMOGRAPHIC CORRELATIONS WITH NEUROTICISM FACETS

Variable	M	SD	1		2		3		4		5	6	7	8	9	10	11
1. Age	41.91	11.12	___														
2. Sex	1.21	.41	.07		___												
3. Race	1.98	1.80	-.23	**	.09		___										
4. Education	6.02	.84	-.07		-.06		.35	**	___								
5. Employment	1.36	1.11	.01		.22	**	.08		-.08		___						
6. Anxiety	2.74	.86	-.27		.21		.14		-.03		.11	___					
7. Anger	2.74	.95	-.19		.08		.02		.06		.04	.39	___				
8. Depression	2.14	.84	-.15		.12		-.07		-.08		-.01	.54	.40	___			
9. Self-Consciousness	3.03	.86	-.22	**	.04		.06		-.09		.04	.44	.20	.47	___		
10. Immoderation	2.87	.54	-.16		.03		-.01		-.08		-.04	.30	.24	.37	.18	___	
11. Vulnerability	2.32	.86	-.41	**	.13		.22	**	.00		.07	.67	.45	.48	.49	.36	___

APPENDIX C

DEMOGRAPHICS

1. What is your sex?
    a. Male
    b. Female
2. What is your age?
3. How do you describe yourself? (please check the one option that best describes you)
    a. White
    b. Hispanic
    c. African American
    d. Pacific Islander
    e. Native American
    f. Multiracial (i.e. more than one race)
4. Are you currently:
    a. Employed for wages
    b. Self-employed
    c. Out of work for more than one year
    d. Out of work for less than one year
    e. A homemaker
    f. A student
    g. Retired
    h. Unable to work
5. What is the highest year of school you have completed?
    a. Never attended school or only attended kindergarten Grades 1 through 8 (elementary)

b. Grades 9 through 11 (some high school)

c. Grade 12 or GED (High school graduate)

d. College 1 year to 3 years (some college or technical school)

e. College 4 years (College graduate)

f. Graduate school (advanced degree)

6. If applicable, what is your college major?
7. How many years have you worked in your current field?
8. How many years have you worked in your current job?

APPENDIX D

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

THE UNIVERSITY of TENNESSEE CHATTANOOGA

Institutional Review Board
Dept. 4915
615 McCallie Avenue
Chattanooga, TN 37403-2598
Phone: (423) 425-5867
Fax: (423) 425-4052
instrb@utc.edu
http://www.utc.edu/irb

MEMORANDUM

TO: Sarah Freed **IRB #13-167**

FROM: Lindsay Pardue, Director of Research Integrity

DATE: November 6, 2013

SUBJECT: IRB #13-167: Examination of Personality Characteristics among Information Technology Professionals

The IRB Committee Chair has reviewed and approved your application and assigned you the IRB number listed above. You must include the following approval statement on research materials seen by participants and used in research reports:

The Institutional Review Board of the University of Tennessee at Chattanooga (FWA00004149) has approved this research project #13-167.

Please remember that you must complete a Certification for Changes, Annual Review, or Project Termination/Completion Form when the project is completed or provide an annual report if the project takes over one year to complete. The IRB Committee will make every effort to remind you prior to your anniversary date; however, it is your responsibility to ensure that this additional step is satisfied.

Please remember to contact the IRB Committee immediately and submit a new project proposal for review if significant changes occur in your research design or in any instruments used in conducting the study. You should also contact the IRB Committee immediately if you encounter any adverse effects during your project that pose a risk to your subjects.

For any additional information, please consult our web page http://www.utc.edu/irb or email instrb@utc.edu

Best wishes for a successful research project.

VITA

Sarah Freed was born in Carollton, TX, to the parents of Michael and Joan Freed. She is the third of four children, two brothers and one sister. She attended Manz Elementary and continued to South Middle School in Eau Claire, WI. She then moved to Harvest, AL where she attended Sparkman High School. After graduation she became interested in the field of Psychology and enrolled in the University of North Alabama. She completed her Bachelors of Arts degree in May 2012 before accepting a graduate assistantship at the University of Tennessee at Chattanooga in the Industrial Organizational Psychology Program. Sarah graduated with a Master's of Science degree in Industrial Organizational Psychology in May 2014. Sarah is continuing her education by gaining experience in her field through organizational settings.