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# Pre-Training Cognitive and Non-Cognitive Psychological Predictors of U.S. Air Force Pararescue Training Outcomes

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# 1.0 SUMMARY

The present study investigated predictive validities of cognitive ability (Armed Services Vocational Aptitude Battery) and non-cognitive functioning (NEO Personality Inventory – 3rd Edition) for differentiating those who successfully complete versus fail U.S. Air Force pararescue training. The Air Force pararescue candidates enroll in a high-risk, high-demand training program. Due to the physically and psychologically demanding and unique stressors that candidates must adapt to, there is a significant amount of early attrition (86-90%). Although there are multiple potential causes for this attrition, a salient issue for consideration is the aspects of emotional, social, and behavioral functioning (i.e., personality traits) that may have an impact on training outcomes. The purpose of this study is to identify pre-training areas of psychological functioning affecting one's ability to adapt to the demands of training and the individual's readiness for such training. Cox proportional hazards survival analysis procedure was performed to identify psychological test scores predictive of outcomes, employing day of training elimination as a time to failure variable. Variables were identified specific to success in training. The results of analyses demonstrate the incremental validity and utility of personality-based testing in addition to measures of general cognitive aptitude. Results have direct implications for improving selection and aeromedical screening procedures for training candidates seeking entry into this special operations career field.

# 2.0 INTRODUCTION

Throughout recent history, the pararescue (PJ) career field has made immeasurable contributions to our nation's welfare in both military and civil operations. Their exceptional skills in combat search and rescue and trauma medicine, coupled with advanced employment methods and direct combat training, provide a distinctive capability to the U.S. Air Force (USAF) and the Department of Defense (DoD) that is not replicated in any other community [1]. Pararescue is one of seven USAF specialties identified in Air Force Policy Directive 10-35, *Battlefield Airman*, responsible for optimizing the air, space, and cyber domains with the land domain [2]. To meet this responsibility, the USAF recognizes the need to organize, train, and equip a force of Battlefield Airmen capable of delivering distinctive capability and expertise in any operating environment with unequaled lethality, accuracy, responsiveness, flexibility, and persistence. Operational demand for these unique capabilities skyrocketed following the terrorist attacks on September 11, 2001, and continues at an ever-increasing rate. Future requirements are expected to remain very robust, and the Air Force is committed to growth and development of these forces. However, recruiting and training sufficient quantities of personnel to meet this demand have been an enduring challenge because of the rigorous training necessary for the high-risk mission sets assigned to these personnel. Recognition of the valuable contribution PJ makes is not new and has been documented frequently, including the following statement from General Goldfein, Air Force Chief of Staff.

> *"Our nation requires that we send our Battlefield Airmen into harm's way and calls for them to operate in some of the most dangerous places on the planet," said Air Force Chief of Staff Gen. David L. Goldfein. "Their training is extensive and grueling, and they maintain the skills that our Air Force and joint force rely on" (Gen Goldfein, June 2017, AFNS).*

The primary PJ mission is to perform as the essential surface and aerial link in personnel and material recovery by functioning as the rescue and recovery specialist as mission crew or surface elements and provide emergency trauma and field medical care. This includes the ability to provide day or night rapid response in friendly, denied, hostile, or sensitive areas in the six geographic disciplines: mountain, desert, arctic, urban, jungle, and water. These capabilities have been widely employed in both humanitarian and combat operations [3-5]. PJ forces can deploy in any available manner to include air, land, and sea and into restricted environments to authenticate, extract, treat, stabilize, and rescue injured, wounded, isolated, or captured military and civilian personnel, as well as to recover the fallen. The physical and psychological demands in PJ are substantial, requiring an uncommon level of tenacity, dedication, and commitment for success. PJ's motto, "That Others May Live," reaffirms their commitment to saving lives, as well as their rigorous self-sacrifice and dedication to the combatant rescue/recovery missions.

The PJ career field is a combined collective force of approximately 600 active duty and 280 Air Force Reserve Component and Air National Guard personnel assigned to the United States and worldwide. They are employed unilaterally or as part of an Air Force, joint, interagency, or multinational force. However, all PJ personnel are trained and equipped through their completion of a 2-year training program. Given the rigorous nature of training and operations, the identification of a core set of physical and psychological traits is essential to identifying young, adult civilians who are capable and aeromedically suited for such a demanding career field. Moreover, ascertaining a core set of psychological traits that complement current classification strategies is essential to identifying those capable of thriving in such a unique career field.

Operational PJ missions are typically nonstandard, with unconventional demands (often in denied or hostile environments) that present many unknown and uncontrollable factors. Success in these circumstances depends upon an extraordinary level of physical and psychological functioning. Many within the military community perceive that those who become pararescuemen possess high levels of courage, perseverance, tenacity, self-discipline, self-confidence, assertiveness, emotional stamina, and a strong desire to master the challenges common to high-risk activities (Schultz R. Personal communication; 2017 Sep. Carpenter T. Personal communication; 2017 Apr). These traits are believed to accompany superior levels of physical strength, endurance, intelligence, and reflexes, along with a high level of resilience and motivation to excel (Schultz R. Personal communication; 2017 Sep). This perception of pararescuemen is common among military leadership and civilians.

However, having an empirical and evidence-based assessment of the psychological attributes that influence training success and adaptation to operational rigors is important to USAF career field managers, personnel selection agencies, and aeromedical providers. Tasked with evaluating training applicants and operators, aeromedical providers make decisions about physical and psychological suitability for pursuing challenging and high-risk occupations.

## 2.1 Current Selection Standards and Requirements

According to the USAF Medical Standards Directory [6], all training candidates must meet special duty aeromedical flying class III standards. These standards are higher than the traditional medical fitness-for-duty standards. The training candidates must not have any current (or historical) medical and/or psychiatric illness or injury that would interfere with their ability to reliably sustain high levels of physical and psychological functioning. Attention is given to physical (e.g., cardiovascular, musculoskeletal, neurological, ophthalmological) and psychiatric functioning, e.g., determining that the candidate does not suffer from any diagnosable pathology. A physically and psychologically healthy candidate without any history of illness or injury can still be disqualified if he or she is perceived to be at an elevated risk for problems if placed in conditions that are continuously physically and psychologically taxing.

In addition to a thorough medical examination, every non-prior-service direct accession candidate selected for this career field must pass a physical fitness screening called the Physical Ability and Stamina Test (PAST). This involves administration of a series of events with brief, standardized rest periods between each event. The fitness events involve two untimed 25-meter underwater swims, a timed 500-meter freestyle swim, a timed 1.5-mile run, timed pull-ups, timed sit-ups, and timed push-ups. All training candidates complete each event to the point of muscle failure or time completion, whichever occurs first. Training candidates must meet minimum cutoff scores for each timed event, demonstrating a reasonable level of fitness (Table 1).

**Table 1. USAF PAST Requirements**

| Fitness Component | Minimum Cutoff Requirement |
|---|---|
| 2 x 25-m underwater | Pass/fail |
| 500-m swim | 10 min 7 s or faster |
| 1.5-mi run | 10 min 10 s or faster |
| Pull-ups (1-min time limit) | 10 or more |
| Sit-ups (2-min time limit) | 54 or more |
| Push-ups (2-min time limit) | 52 or more |

Before arriving at basic military training (BMT), recruits are enrolled in a fitness development program that uses prior special duty operators to help recruits physically prepare for entrance into active duty training. During this development program, instructors will determine a recruit's physical readiness to proceed to active duty and basic training. Throughout basic training, recruits' physical fitness is monitored. Upon graduation from basic training, recruits enter an 8-week preparation course where they receive further physical training; recruits who do not meet the physical requirements will receive remedial training prior to advancing. The fitness test is administered again during the first day and upon exit of the Pararescue Development Training Course, the first of the PJ courses of initial training (day of training (DOT) 1-10). Training candidates must meet superior levels of fitness and physical endurance if they are to have a reasonable chance of graduating the training pipeline. A high level of fitness is critical, given the elevated risk for injury and fitness-related issues during PJ training [7]. Furthermore, applicants are screened using a cognitive skills test known as the Armed Services Vocational Aptitude Battery (ASVAB). The ASVAB (Table 2) is a general cognitive aptitude test that has been well established as a performance measurement tool [8-10]. Direct accession PJ training applicants must meet a General Composite cognitive aptitude composite cutoff (i.e., 44) score from the ASVAB [2]. The ASVAB General Composite score encompasses verbal expression (which includes the scores from word knowledge and paragraph comprehension scales) and arithmetic reasoning subtests. It is important to note that general cognitive aptitude has been established as a significant predictor of training and job performance for civilians [11-16] as well as enlisted USAF and sister service personnel [10,17-22]. In a study conducted by the RAND Corporation, higher ASVAB scores from various subscales (e.g., paragraph comprehension, word knowledge, mechanical comprehension, electronic information) were found to be predictive of successful completion of PJ training [23].

**Table 2. ASVAB**

| Composite Indices | Subtests and Aptitude Measured |
|---|---|
| **General** | **Word Knowledge, Paragraph Comprehension, Arithmetic Reasoning** |
| Electronic | Arithmetic Reasoning, Mathematical Knowledge, Electrical Information, General Science |
| Administrative | Numerical Operations, Word Knowledge, Paragraph Comprehension |
| Mechanical | General Science, Auto/Shop, Mechanical Comprehension |

The mission of the Air Force Recruiting Service is to ensure airmen recruited for this career field have met the established fitness and cognitive aptitude standards based on the screening requirements for this career field. These cutoff standards are set in coordination with manpower and personnel organizations within the Air Force Personnel Center and USAF Headquarters at the Pentagon, in collaboration with PJ career field leadership, to ensure training candidates are physically and cognitively suited for adapting to the physical and psychological rigors of training.

## 2.2 Brief Description of Training Pipeline

As a result of the requirements of their operational duties [2,24], PJ training candidates must overcome some of the most rigorous and "toughest" training offered in the USAF, and arguably among military career fields across the DoD. Their training pipeline takes approximately 2 years to complete and is composed of several courses briefly described below [25].

**2.2.1 Battlefield Airman Preparatory Course.** Battlefield Airman Preparatory Course (BA Prep) was implemented for all non-prior-service Battlefield Airmen in June 2017. BA Prep is a no-failure course for candidates entering the BA training pipeline. This course is 8 weeks and provides developmental training to personnel selected for the PJ career field prior to admission to the course of initial entry. The training accomplished at this course includes physical training, psychological enhancement training, exercise physiology, sports nutrition, career field knowledge, water confidence, and fin swim training.

**2.2.2 USAF Pararescue Development Course.** This course is 2 weeks (DOT 1-10) and trains candidates in introductory principles and strategies of physical and psychological conditioning and development [26]. The training accomplished at this course includes calisthenics training, run training, water training, and additional academics in PJ career field history, nutrition, physiology, and stress resilience. The development course orients, prepares, and transitions candidates for the challenges of the Indoctrination Course (DOT 11-55).

**2.2.3 USAF Pararescue Indoctrination Course.** This course is 9 weeks (DOT 11-55) and includes physiology, dive physics, dive tables, metric manipulations, medical terminology, cardiopulmonary resuscitation, weapons qualification, additional history of the PJ career field, as well as leadership reaction strategies and development. This course includes intensive fitness training and field exercises. This is where the majority of training attrition occurs, which is perceived to be due to multiple factors, such as low motivation, inadequate personality trait levels, and fitness-related injury.

**2.2.4 Airborne (Parachutist) School.** This course is 3 weeks and focuses on developing basic parachuting skills required to infiltrate an objective area by static line airdrop. The course consists of three phases: "Ground Week," "Tower Week," and "Jump Week." The purpose of the Basic Airborne Course is to qualify the student in the use of the parachute as a means of combat deployment to austere and remote environments. Rigorous physical training is emphasized throughout the entire course. The psychological demands of the course challenge individual courage and fortitude as well as capability to promote and sustain group cohesion. The goals of this course are to develop leadership, self-confidence, and an aggressive "spirit" through mental and physical conditioning.

**2.2.5 Air Force Combat Dive Open and Closed-Circuit Courses.** This course is 6 weeks and focuses on development of combat diver skills. This includes learning to use scuba and closed-circuit diving equipment to covertly infiltrate denied areas; conduct subsurface searches and basic recovery operations, operating at depths from the surface to 130 feet below surface; and develop maximum underwater mobility in various operating conditions. The course is designed to be mentally and physically rigorous, as students develop skills for operating in covert and austere water operations. Training candidates are routinely challenged in situations related to loss of breath, long distance navigation dives, and demanding physical requirements. Mental stamina is challenged by emergency scenarios that demand quick thinking and problem solving under taxing conditions and operations that pose a high risk to personal safety.

**2.2.6 Air Force Underwater Egress Training Course.** This is a brief course that teaches how to safely escape from an aircraft that has crash landed or ditched in the water. The instruction includes learning about the principles, procedures, and techniques necessary to get out of a sinking aircraft. High levels of emotional and physical stress tolerance, as well as self-discipline, are critical to successfully passing this course and effectively learning the protocols (Schultz R. Personal communication; 2015 Sep. Carpenter T. Personal communication; 2015 Apr).

**2.2.7 Combat Survival Training Course.** This course is 2.5 weeks and teaches basic survival techniques for remote areas. Instruction includes learning the principles, procedures, equipment, and techniques that enable individuals to survive, regardless of climatic conditions or unfriendly environment, and return home. Due to the very nature of survival under duress, completing this program demands training candidates have an optimal level of fitness and mental perseverance for enduring the rigors of this course.

**2.2.8 Military Free Fall Parachutist Course.** This course is 4 weeks and focuses on the development of free fall parachuting skills and procedures. This course provides wind tunnel training, as well as "in-air" instruction for learning techniques to sustain stability during free fall, aerial maneuvers for controlling descent, air awareness, and parachute pre- and post-opening procedures. This course is distinguished from traditional parachute training in that PJ training candidates perform at altitudes exceeding 20,000 feet. This training also includes low opening of parachute during free fall jumps and requires specialized training in the management of oxygen use and specialized jump suits. Training candidates learn to fall at terminal speed. Participants complete several jumps per day that employ emergency procedures and protocols that challenge the mental and physical stamina of training candidates.

**2.2.9 USAF Paramedic Emergency Medical Technician Course.** This course is 35 weeks and focuses on skill development for managing patients prior to evacuation and providing emergency medical treatment. Upon graduation, a National Registry of Emergency Medical Technician-Paramedic certification is awarded. This is likely the most academically rigorous course in the training pipeline.

**2.2.10 USAF Pararescue Recovery Specialist Course.** This course is 24 weeks and involves the development of skills for engaging enemy combatants on the battlefield using weapons and strategic maneuvers while performing combat casualty rescue and extraction, field tactics, mountaineering, combat tactics, advanced parachuting, and helicopter insertion/extraction.

As can be surmised from above, the requirements to become a pararescueman involve physically and psychologically strenuous training. In addition to developing a unique set of skills as a combatant and personnel recovery/rescue specialist, a pararescueman must adapt to a special operations social milieu and atmosphere, as well as constantly evolving group dynamics that encompass the myriad military teams and operations they support. The requirement to effectively operate in teams with a wide range of missions and with personnel from diverse DoD and government agencies requires a high level of flexibility, resilience, and interpersonal functioning.

However, training attrition for direct accession, non-prior-service training candidates does not occur at a progressive rate. The vast majority of attrition occurs within the first 2 months of training after BMT (during the Development and Indoctrination Courses). Although some attrition may occur at later stages of training due to injury or unforeseen circumstances, there are relatively few performance failures or self-initiated eliminations at later stages of training (i.e., less than 2%).

Currently, the overall attrition rate during the early stages of training is approximately 86-90%. The high rates of attrition come at significant costs to training resources and economic resources. An additional consequence of this high attrition is the increased risk of failure to meet trained manpower requirements necessary for operational readiness. As USAF leadership expands its special operations agencies, failure to train the required number of PJ candidates limits the rate of expansion.

## 2.3 Reasons for Non-Cognitive Aptitude and Personality Testing of Training Candidates

It is evident that training attrition is affected by recruiting and training processes, as well as unforeseen life events and injury. Improvements to these areas may help to increase training production rates. However, it is also reasonable to perceive that a reduction in training attrition may be influenced by improvements to personnel selection and aeromedical screening processes.

Current selection standards already screen for fitness and cognitive aptitude. However, there remains a high level of attrition based upon self-induced eliminations and failure of physical evaluations. Additionally, the average PJ recruit scores almost twice as high (77) on the General Composite test requirement of 44 necessary for entrance into the PJ career field. Yet, an area that has not been fully employed or optimized by AF recruiting and personnel center agencies is the utilization of commercially available and widely accepted cognitive aptitude and non-cognitive aptitude tests.

These tests are commonly used by special duty military agencies as well as civilian agencies for screening and assessing suitability and "organizational fit" of candidates for high-demand, high-risk duty positions [25,27-44]. There is a growing body of research indicating that non-cognitive aptitudes and traits significantly influence training and performance outcomes; non-cognitive traits should be considered when improving selection and classification processes [13,14,42,45-49]. Specifically, the Five Factor Model of personality has provided a common taxonomy and language in conceptualizing non-cognitive aptitude and defining the variables to be studied. The Five Factor Model posits that individual non-cognitive aptitude informs one or more of five domains of personality: Neuroticism, Extraversion, Openness to Experience, Conscientiousness, and Agreeableness. This framework of classification of universal traits has been a valuable construct for implementing non-cognitive aptitude-based selection measures that predict work-related behavior and performance outcomes [42,45,46,50-57] to include high-risk operators such as police officers [36,37], air traffic controllers [40], astronauts [41,58], and general military personnel [59,60].

Additional research supports the hypothesis that a person's psychological functioning in emotional, behavioral, and social domains (e.g., stress tolerance, general mood, self-confidence, assertiveness, understanding oneself and others, relating and interacting with others) is key to successfully responding and adapting to the rigors of U.S. special operations [33,52,59,61-65], as well as international special operations [35,38,66-70]. These studies provide empirical evidence of various indicators of non-cognitive psychological functioning with regard to successfully adapting to the demands of special duty military training and operations.

Furthermore, several studies conducted by the USAF School of Aerospace Medicine with USAF special duty training candidates included trainees from the following career fields: tactical air party control [28], combat control [29,32], explosive ordnance disposal [30], and air traffic control [31,34]. The outcomes across these studies indicated that non-cognitive aptitudes and traits (predictable, stable patterns of emotional, social, and behavioral functioning) significantly influence training outcomes, above and beyond measures of general cognitive functioning and fitness. Such studies revealed that, in general, candidates who passed training were psychologically ready and equipped to adapt to nonstandard, unconventional demands in which the risks and consequences of mission failure were substantial. Such airmen could respond functionally to unknown, unpredictable, uncontrollable training events in which successful completion of the training mission and interaction within a team environment depended upon the cognitive (e.g., intellectual aptitude) and non-cognitive (emotional resilience, stress tolerance, self-confidence) aptitudes.

A study completed by researchers within the USAF School of Aerospace Medicine assessed the pre-training, non-cognitive aptitudes of 635 non-prior-service PJ training candidates during BMT [25]. Testing included administration of the Emotional Quotient Inventory (EQ-i) assessing non-cognitive aptitudes prior to technical training. The results of the study revealed that those who passed training scored higher in 15 different areas of interpersonal and intrapersonal functioning, adaptability, stress tolerance, and general mood [71]. Furthermore, results of the study revealed the combination of stress tolerance, problem solving, positive mood, assertiveness, and interpersonal functioning was predictive of successful completion of training and that non-cognitive aptitudes increased the incremental validity of pass vs. fail classification outcomes beyond measures of fitness and cognitive aptitude.

Furthermore, anecdotal discussions between the authors of this study and USAF PJ training instructors and pipeline managers suggest a general consensus that functional operation within this career field requires enlisted airmen to possess a unique set of psychological aptitudes that allow them to operate safely and effectively; however, there is general agreement that these psychological aptitudes are not accounted for in the selection and classification process (Schultz R. Personal communication; 2017 Sep). Specifically, career field managers and trainers have noted that high levels of self-confidence, stress tolerance, assertiveness, maturity, and independence are critical to adaptation. Performance failure rates related to undesirable characteristics (e.g., lack of discipline, complacency, inadequate motivation, behavioral violation of procedures, mistakes in task prioritization, poor judgment, inattention, etc.), as well as incidence of self-initiated eliminations, increase when trainees possess inadequate or sub-optimal levels of those traits.

## 2.4 Adaptability Rating for Military Aviation (ARMA)

Although the literature is limited and there remains empirical uncertainty over non-cognitive psychological attributes that compose the "right stuff," there is little argument about traits that likely represent the "wrong stuff" for this special duty career field. For example, overly anxious and nervous, hostile, socially isolative, highly insecure, and/or highly impulsive persons should not be engaged in special duty military PJ operations. Such functioning conceivably elevates the risk for mistakes and mishaps where the threats to safety and mission completion are already high.

According to USAF medical standards, an "Unsatisfactory ARMA" is a rating that indicates there is a pattern of non-cognitive psychological traits and functioning that significantly interferes with safety, crew coordination, or mission completion [6,72]. It is important to note that an ARMA evaluation is not an assessment of psychopathology. Rather, ARMA refers to an assessment of an airman's psychological disposition that is not well-suited or is considered maladaptive to the high-risk, high-demand nature of the career field, i.e., non-cognitive traits and/or behavioral habits that place a training candidate at high risk for performance problems. Although an ARMA evaluation can be reasonably conceived as a component of personnel selection, it is currently considered a post-accession, medically oriented psychological assessment for aircrew and special duty military personnel.

However, there is significant variability among flight medicine physicians and aeromedical operational psychologists regarding their capability to evaluate a training applicant's non-cognitive attributes for suitability for PJ training and operations. Without having empirical studies delineating key areas of psychological functioning of enlisted airmen who passed versus failed PJ training, it is difficult to accurately assess whether certain non-pathological areas or types of emotional, social, and behavioral functioning are incompatible for this high-risk, high-demand career field. This is a difficult task for any physician who is unfamiliar with normal PJ operational requirements and non-cognitive functioning types. Furthermore, it is unclear if normative personality data based upon the civilian, non-aircrew general population are adequate for evaluating PJ training candidates. Incorrect interpretations of a training applicant's test scores may occur if normative data based upon the civilian general population are substantially different than those who successfully complete the PJ training pipeline. For example, a training candidate's scores assessing emotional resilience may appear normal when compared with the general population; however, his score may be well below expectations when compared with successful PJ training candidates and operators. Empirical studies that clearly delineate the areas of psychological functioning that influence training outcomes (pass vs. fail), as well as functional areas that distinguish successful PJ training candidates from peers in the civilian population, can improve the capabilities of medical and mental health providers tasked with identifying training candidates at high risk for adaptation and/or performance-related problems.

### 2.5 Airmen Lifecycle Aeromedical Capability Gap

The goal of identifying, recruiting, and preserving the health and performance of USAF pararescuemen is met with significant challenges. These challenges are centered on having the capability to acquire psychological data that enable clinical assessment of a candidate's inherent aptitudes and capabilities. The testing must have enough breadth, depth, and granularity to effectively identify the small number of candidates, within a diverse general population, who are suited for the rigorous training and operational demands. Such data are critical to personnel tasked with assessing a candidate's readiness and suitability, as well as risk for failure and adaption problems among the thousands of young adults within the general population seeking entrance into the military.

Additionally, psychological baseline testing is needed that clearly portrays a candidate's strengths and weaknesses in a fashion that allows for comparison to the general population, alongside a cohort of his PJ peers. Such data are critical for understanding how aspects of psychological functioning distinguish an individual from the general population of young adults, as well as how the person compares with those who have successfully completed training. This data-driven ability for individualized conceptualization and understanding of psychological strengths and weaknesses is integral for the development of personalized training and healthcare strategies for optimizing readiness and performance. However, the USAF has not effectively incorporated baseline testing that simultaneously accomplishes both tasks.

At present, USAF personnel selection and aeromedical screening agencies have not adequately investigated nor fully exploited the capability to administer sensitive, highly specific pre-training psychological non-cognitive aptitude testing. Implementing non-cognitive testing may improve processes for identifying those at high risk for performance failure and for establishing a baseline record to assess for changes in functioning because of injury/illness or psychological trauma, as well as for developing personalized, precision-based training and healthcare strategies. The development of processes and tools to address the challenges of selection and sustainment represents significant USAF special operations human capital acquisition and preservation goals [73].

### 2.6 Purpose of the Study

In this study we evaluated pre-training, standardized non-cognitive testing (in conjunction with cognitive aptitude testing) of enlisted airmen who successfully passed versus failed either PJ development or indoctrination training with the following goals:

1. To assess the distribution of attrition in the training pipeline based on DOT time to attrition to determine if attrition occurs nonlinearly over time rather than linearly over time. Our general expectation was that attrition is a nonlinear function within training based upon time and nature of training in the pipeline.

2. To assess how well pre-training, non-cognitive psychological testing incrementally predicts successful completion of USAF PJ training when compared to a measure of general cognitive aptitude (i.e., ASVAB scores). Our general expectation was those who successfully complete PJ training will have higher levels of emotional, social, and behavioral functioning that enable the candidate to adapt to the rigors of training.
3. To assess the relative importance of various non-cognitive traits with regard to predicting training outcomes as they relate to DOT attrition utilizing a statistical model based on survival analyses.
4. To develop a useful and efficient clinical tool, in the form of a non-cognitive graphical topography, for clinicians to use in assessing an individual's adaptability profile. This tool may be utilized to compare an individual candidate's psychological functioning with a normative baseline of successful PJ trainees. The results of such topographies may be utilized to help shape personnel selection and aeromedical practices by highlighting specific areas of non-cognitive functioning and non-cognitive traits that are key to readiness and performance for this unique military special operations career field.

# 3.0 METHODS

## 3.1 Participants

In total, 1140 recruit PJ training candidates between 2014 and 2017 were included in this study. Although the PJ career field is open to women as of 2016, there were no female candidates. Training candidates who successfully completed the first 55 days of training (n = 160, 14%) had a mean age of 21.7 (standard deviation (*SD*) = 2.9) and those who failed within the first 55 days of training (n = 980, 86%) had a mean age of 20.9 (*SD* = 2.9). Demographic data such as race, educational level, and marital status were not available for inclusion in this study. Data were collected for this study on training candidates between 2014 and 2017. Because the clear majority (86-90%) of training attrition occurs within the first 55 days of training (Indoctrination and Development Courses), training outcomes were based on pass versus fail during this time.

The protocol submission originally titled "Battlefield Airman Selection Model" was initially submitted for Institutional Review Board (IRB) review. Upon said review, an IRB determination noted that the designed activity did not constitute human use research. Moreover, given the activity was deemed to address specific programmatic purposes, and was never intended to be generalized beyond specified programmatic parameters, no additional IRB involvement occurred nor was it ever sought during the period of the identified activity.

## 3.2 Measures

**3.2.1 Armed Services Vocational Aptitude Battery.** Testing from the ASVAB was used as a measure of cognitive aptitude [9]. The ASVAB is completed by all individuals seeking to enlist in the military and is used to assist with occupational assignment selection (Table 2). The four composite scores used by the USAF for occupational assignment are the Mechanical Composite, which assesses knowledge of physical and biological sciences, knowledge of mechanical and physical properties, and skills related to automobile technology; Administrative Composite, which assesses verbal expression skills and knowledge of mathematical principles; General

Composite, which assesses verbal expression and arithmetic reasoning skills; and Electrical Composite, which assesses knowledge of electricity and electronics, mathematic principles, and physical and biological sciences. The four composite scores, known as the MAGE, are based on weighted combinations of the following subtests: General Science, Arithmetic Reasoning (some versions include numerical operations and coding speed), Electrical Information, Auto Shop, Mathematical Knowledge, Mechanical Comprehension, Assembly Objects, and Verbal Reasoning (a combination of paragraph comprehension and word knowledge). The ASVAB composite and subscale scores have good reliability, correlate with academic achievement, and are predictive of subsequent military performance [10,74-76]. Composite and subtest scores are standardized with a mean score of 50 and an *SD* of 10. USAF PJ training candidates must achieve a General Composite score of 44 to enter training.

However, as previously mentioned, PJ training candidates routinely score almost twice the pre-requisite General Composite score of 44, providing little discriminator value in assessing PJ trainees' cognitive aptitude when comparing successful trainees to those who fail training. Therefore, this study assessed the subscales of the ASVAB for comparison among cohorts. The subscales are those subtests that, in various combinations, are used to create the requirements of the Composite MAGE scores (Table 2).

**3.2.2 NEO Personality Inventory – 3rd Edition (NEO PI-3).** The NEO PI-3 measure of non-cognitive functioning was utilized in the present study [77,78]. This instrument measures five major personality domains and six facets within each domain to yield a total of 30 different measurements of emotional, social, and behavioral functioning. The five domains are as follows:

1. *Neuroticism* – general tendency to experience negative emotions (e.g., anxiety, hostility, depression) and overall susceptibility to psychological distress and impulsiveness
2. *Extraversion* – general interest in social events, group activities, and excitement, and general expressions of warmth, gregariousness, assertiveness, and optimism
3. *Openness* – flexibility with thinking and behaving differently, attentiveness to inner feelings, willingness to entertain novel ideas, and unconventional values
4. *Agreeableness* – general interpersonal tendencies regarding altruism, trust, straightforwardness, interest in avoiding conflict, competitiveness, and tendermindedness
5. *Conscientiousness* – general level of interest in planning, organization and order, carrying out tasks, self-discipline, and competence (Table 3)

The NEO-PI-3 meets professional psychometric reliability and validity qualities and standards for use as a non-cognitive assessment instrument [77,79]. Normative NEO-PI-3 domain scores for the general population have a standard mean score of 50 with an *SD* of 10 points.

The domains and facets within each domain provide a comprehensive measurement of adult personality; as such, the NEO PI-3 serves as a useful multipurpose personality inventory with predictive validity. The NEO PI-3 consists of 240 items. Each item has a 5-point response scale, with responses ranging from *strongly disagree* to *strongly agree*. The reliability coefficients for the 30 facets range from 0.56-0.81 [77]. The computerized version of the NEO PI-3 was used; administration follows a standardized set of instructions, and participant completion is self-paced. Responses are automatically scored via computer.

**Table 3. Brief Description of Personality Domains (with Facets) as Measured by the NEO**

| Index & Description of Personality Trait | Facets |
|---|---|
| ***Neuroticism (N)*** | |
| Indicates level of emotional stability contrasted with level of maladjustment. It indicates the general tendency to experience negative emotional states and irrational ideas and an inability to control impulses and cope poorly with stress. | • Anxiety<br>• Angry Hostility<br>• Depression<br>• Self-Consciousness<br>• Impulsiveness<br>• Vulnerability |
| ***Extraversion (E)*** | |
| Measures an individual's degree of sociability, assertiveness, activity, and talkativeness. It indicates the tendency to seek stimulation or excitement. It may be thought of as an indicator of readiness to experience optimism. | • Warmth<br>• Gregariousness<br>• Assertiveness<br>• Activity<br>• Excitement-Seeking<br>• Positive Emotions |
| ***Openness to Experience (O)*** | |
| Measures the individual's willingness to entertain novelty vs. adherence to conventional thinking. It is also an indicator of how richly the individual experiences emotions. | • Fantasy<br>• Aesthetics<br>• Feelings<br>• Actions<br>• Ideas<br>• Values |
| ***Agreeableness (A)*** | |
| Measures the individual's interest in or ability to relate on an interpersonal level. It is an indicator of the individual's willingness to put others first or to fight for his or her own interests. | • Trust<br>• Straightforwardness<br>• Altruism<br>• Compliance<br>• Modesty<br>• Tendermindedness |
| ***Conscientiousness (C)*** | |
| Measures impulse control. Indicates the individual's ability to plan, organize, and complete tasks; is an indicator of how much attention may be given to detail. | • Competence<br>• Order<br>• Dutifulness<br>• Achievement Striving<br>• Self-Discipline<br>• Deliberation |

Source: Created from content taken from McCrae & Costa (2010) [77].

The NEO PI-3 is a common component of job selection programs [27,40,41,58,80,81] primarily because it captures dimensions of healthy functioning. Personnel selection for high-functioning special duty operations requires a tool that is relevant to healthy high-performance achievers, i.e., individuals whose traits promote exceptional functioning. The NEO PI-3 is particularly suited for use in special duty selection programs given that it was designed to help assess dimensions of normal, non-clinical personality and functioning. The NEO PI-3 has demonstrated the ability to predict adaptability and performance within specified occupational contexts and special duty positions [27,34,36,37,40,41,58,80,82].

**3.2.3 Training Outcomes.** Trainees were classified as either 0 = failure or 1 = graduate using a variable labeled “status.” Each trainee’s ASVAB scores, NEO-PI-3 scores, and status were associated with “day of training” elimination if the trainee left the program through self-elimination or were removed for performance insufficiencies. Administrative and medical eliminations were not included in this cohort [23]. We utilized program attrition (i.e., removal from the program by training staff or self-selected elimination) within the first 55 days of pipeline training as our “failure” outcome; DOT elimination of each failure between day 1 through day 55 (DOT 1-55) was also utilized to calculate the survival outcome. A candidate who remained in the training after DOT 55 was considered a “graduate.” DOT 1-10 comprised the Development Course, followed immediately by 45 days of the Indoctrination Course, for a total of 55 possible days of training and potential elimination. PAST fitness evaluation was administered on DOT 1. We did not assess PAST scores within the overall graduate/failure analysis of this study; former research assessing the characteristics of a highly similar group of PJ candidates sufficiently demonstrated that trainees must enter the program already performing at an elite level of physical fitness to “survive” the physically demanding training [25]. Passing this physical exam battery is required to remain in PJ training. Candidates who fail the PAST may be sent to remediation to build their strength, reclassified into an alternative career field, or discharged from the USAF.

### 3.3 Procedures

ASVAB testing was completed during the recruiting phase as a screening tool, prior to the start of BMT. The NEO PI-3 testing was administered to candidates in the first week of BMT. Candidates were informed that testing was voluntary and would not affect their training. Volunteers were informed about the purpose and methods of the study and asked to sign a provided consent document; this constituted informed consent sufficient for the purposes of this human-subjects study. Participants were informed that assessment measures would not be used in the selection or aeromedical screening processes. They were also informed individual test scores were confidential and would not be released to military training cadre, to provide an atmosphere that would maximize self-disclosure. Participants then completed their proctored NEO PI-3 electronically in the computer lab or using hard copy paper-and-pencil forms when computer testing was unavailable. Upon completion of testing, participants’ scores were uploaded into an electronic database and linked with their ASVAB scores. Scores were subsequently analyzed with training outcomes from the PJ courses.

**3.3.1 Data Analysis.** Initially, summary statistics including means and *SDs* were computed and stratified by group status (i.e., graduated from training vs. failed training) for each of the individual ASVAB composite indices and subtests and NEO domains and facets. A two-sample t-test was used to determine if the two-group means were equal for each ASVAB and NEO measure. Both unadjusted p-values and adjusted p-values using Simes’ procedure to account for multiple comparisons were computed.

**3.3.2 Multivariable Analysis.** A goal of the study was to identify cognitive aptitude and non-cognitive traits that influence training outcomes. The event of interest in this study was modeling the time until candidates dropped out of training during the first 55 days of the training program. We developed three separate Cox proportional hazard (PH) models: 1) ASVAB subscales only, 2) NEO facets only, and 3) ASVAB subscales and NEO facets. Those candidates who completed 55 days of training and graduated were censored. We did not use the ASVAB composite indices or the NEO domain scores in the final analyses since the subscales and facets were more correlated with the primary outcome and provided better overall model fit. For each of the Cox PH models, we initially assessed model fit based on the Akaike information criterion (AIC), which is a statistic that trades off a model's likelihood against its complexity and can be used to compare both nested and non-nested models. Additionally, for nested models, we compared the full and reduced model using a likelihood ratio test (LRT). We computed a generalized $R^2$ based on the likelihood-ratio statistic to assess the predictive power of each Cox PH model. While the generalized $R^2$ does not provide the same interpretation for ordinary least squares regression, it does provide some indication of association among the set of covariates with the response variable [83]. We also assessed each variable's contribution within each Cox PH model. We calculated the decrease in generalized $R^2$ after each variable was removed from the model to apportion the amount of information accounted for to each variable. We then divided each individual generalized $R^2$ by the generalized $R^2$ for the full model. This gave the percentage contribution of each variable in the regression model. This percentage is, therefore, homologous to the percent contribution of each of the Cox PH models. Although these percentage contributions are not directly comparable across the three Cox PH models, they allowed us to determine what variables were driving each model.

After assessing general goodness-of-fit of each Cox PH model, we obtained each candidate's predicted survival probability of remaining in training up to DOT 10. The predicted survival probability at DOT 10 was then used of classify candidates as graduates or failures. For each survival model, probability threshold was determined based on maximizing the trade-off between sensitivity and specificity using receiver operating characteristic analysis. The area under the curve (AUC) was used as an overall indicator of model performance. Validation of each model's predictive power was assessed using leave-one-out cross-validation (LOOCV).

# 4.0 RESULTS

## 4.1 Descriptive Statistics for Training Candidates

Among the 1140 PJ training candidates in this study, 160 candidates (14%) completed the 55 days of training and subsequently graduated and 980 candidates (86%) failed or self-eliminated from training. Researchers tracked candidates through PJ training (post-BMT) from day 0 (arrival) through DOT 55 (the PJ Development and Indoctrination Courses, inclusive). Training candidates who were still in the program after DOT 55 "graduated" while those who failed at any point in these 55 days of training "failed."

Table 4 presents the summary statistics for each ASVAB composite index and subtest along with the NEO domains and facets stratified by group status. In general, the means of each of the ASVAB subscales were larger among the graduates when compared with those who failed. Among the NEO facets, graduates on average scored higher in terms of Actions and Modesty but score lower on the Compliance and Deliberation facets.

## Table 4. Comparison of Graduates vs. Failures Based upon t-Test

| Test Measure | Failures (N=980) | | Graduate (N=160) | | p-values | |
|---|---|---|---|---|---|---|
| | Mean | *SD* | Mean | *SD* | Unadjusted | Adjusted |
| **ASVAB Composite Indices** | | | | | | |
| Mechanical | 71.56 | 18.19 | 77.96 | 17.99 | 0.000[a] | 0.001[a] |
| Administrative | 74.74 | 14.90 | 79.39 | 15.17 | 0.000[a] | 0.004[a] |
| General | 73.43 | 15.87 | 78.84 | 15.67 | 0.000[a] | 0.001[a] |
| Electronic | 76.07 | 15.91 | 80.83 | 15.10 | 0.000[a] | 0.004[a] |
| **ASVAB Subtests** | | | | | | |
| General Science | 56.91 | 7.14 | 59.09 | 7.69 | 0.000[a] | 0.005[a] |
| Arithmetic Reasoning | 57.57 | 5.91 | 59.76 | 5.84 | 0.000[a] | 0.001[a] |
| Word Knowledge | 54.61 | 6.27 | 56.07 | 6.90 | 0.013[b] | 0.049[b] |
| Paragraph Comp | 56.70 | 5.75 | 58.41 | 5.85 | 0.001[a] | 0.005[a] |
| Math Knowledge | 58.49 | 5.42 | 60.13 | 5.54 | 0.001[a] | 0.005[a] |
| Electrical Info | 55.16 | 7.52 | 56.35 | 7.79 | 0.072 | 0.186 |
| Auto Information | 51.59 | 7.35 | 53.76 | 7.53 | 0.001[a] | 0.005[a] |
| Mechanical Comp | 58.57 | 6.98 | 60.48 | 7.24 | 0.002[a] | 0.009[a] |
| Object Assembly | 58.96 | 6.52 | 59.79 | 6.97 | 0.171 | 0.349 |
| **NEO-PI-3 Domains and Facets** | | | | | | |
| **Neuroticism** | 41.05 | 9.29 | 39.81 | 9.09 | 0.110 | 0.270 |
| Anxiety | 42.34 | 9.68 | 40.75 | 9.47 | 0.050[c] | 0.137 |
| Anger/Hostility | 37.79 | 9.98 | 36.97 | 9.70 | 0.324 | 0.453 |
| Depression | 40.43 | 8.69 | 40.29 | 7.76 | 0.845 | 0.863 |
| Self-Consciousness | 41.92 | 9.85 | 40.86 | 9.38 | 0.189 | 0.343 |
| Impulsiveness | 37.57 | 10.63 | 38.73 | 10.00 | 0.178 | 0.335 |
| Vulnerability | 37.03 | 8.68 | 36.24 | 7.63 | 0.233 | 0.368 |
| **Extraversion** | 55.39 | 9.28 | 56.19 | 9.22 | 0.314 | 0.452 |
| Warmth | 57.99 | 9.85 | 57.71 | 9.72 | 0.729 | 0.777 |
| Gregariousness | 54.06 | 10.23 | 54.79 | 9.99 | 0.396 | 0.498 |
| Assertive | 58.00 | 10.20 | 58.92 | 8.60 | 0.222 | 0.375 |
| Activity | 60.68 | 10.03 | 59.89 | 8.92 | 0.309 | 0.459 |
| Excitement-Seeking | 57.63 | 9.41 | 58.23 | 8.98 | 0.434 | 0.494 |
| Positive Emotions | 56.48 | 10.59 | 57.66 | 9.55 | 0.156 | 0.332 |
| **Openness** | 54.88 | 10.27 | 55.88 | 9.58 | 0.228 | 0.373 |
| Fantasy | 48.63 | 10.92 | 48.75 | 10.73 | 0.898 | 0.898 |
| Aesthetics | 51.62 | 11.11 | 52.34 | 10.36 | 0.419 | 0.501 |
| Feelings | 48.69 | 11.31 | 48.48 | 12.23 | 0.838 | 0.873 |
| Actions | 58.84 | 11.45 | 61.56 | 10.06 | 0.002[a] | 0.010[b] |
| Ideas | 59.37 | 9.00 | 60.08 | 9.25 | 0.372 | 0.493 |
| Values | 51.88 | 9.99 | 52.56 | 10.14 | 0.432 | 0.505 |
| **Agreeableness** | 54.19 | 9.66 | 53.83 | 9.41 | 0.647 | 0.705 |
| Trust | 53.78 | 10.33 | 54.56 | 10.21 | 0.369 | 0.502 |
| Straightforwardness | 56.33 | 10.64 | 55.16 | 10.68 | 0.198 | 0.347 |
| Altruism | 60.49 | 8.91 | 59.37 | 9.18 | 0.151 | 0.337 |
| Compliance | 53.49 | 10.40 | 51.69 | 10.62 | 0.047[b] | 0.137 |
| Modesty | 53.12 | 10.81 | 55.26 | 9.94 | 0.013[b] | 0.047[b] |
| Tendermindedness | 54.61 | 10.57 | 55.39 | 10.60 | 0.392 | 0.505 |
| **Conscientiousness** | 64.27 | 9.72 | 62.64 | 8.73 | 0.033[b] | 0.100 |
| Competence | 62.71 | 9.89 | 61.63 | 9.10 | 0.172 | 0.338 |
| Order | 57.53 | 9.75 | 56.86 | 9.45 | 0.407 | 0.499 |
| Dutifulness | 63.73 | 9.24 | 62.59 | 8.51 | 0.122 | 0.284 |
| Achievement Striving | 66.66 | 7.41 | 67.36 | 6.97 | 0.248 | 0.380 |
| Self-Discipline | 64.16 | 8.75 | 63.79 | 8.25 | 0.598 | 0.666 |
| Deliberation | 57.83 | 10.36 | 55.71 | 10.17 | 0.016[b] | 0.052 |

[a] $p<0.01$.
[b] $p<0.05$.
[c] With a larger graduate sample, “anxiety” would probably be a significant predictor.

## 4.2 Assessing Distribution of Training Attrition

We evaluated the distribution of the candidates who failed training based upon each day of training throughout the Development and Indoctrination Courses. Figure 1 demonstrates the distribution of trainee elimination based upon DOT. Note that the distribution of failures is heavily skewed toward the earlier days of training. We decided to use DOT 10 as the threshold for classifying trainees relative to success or failure. This skewed distribution can be observed in Figure 1.

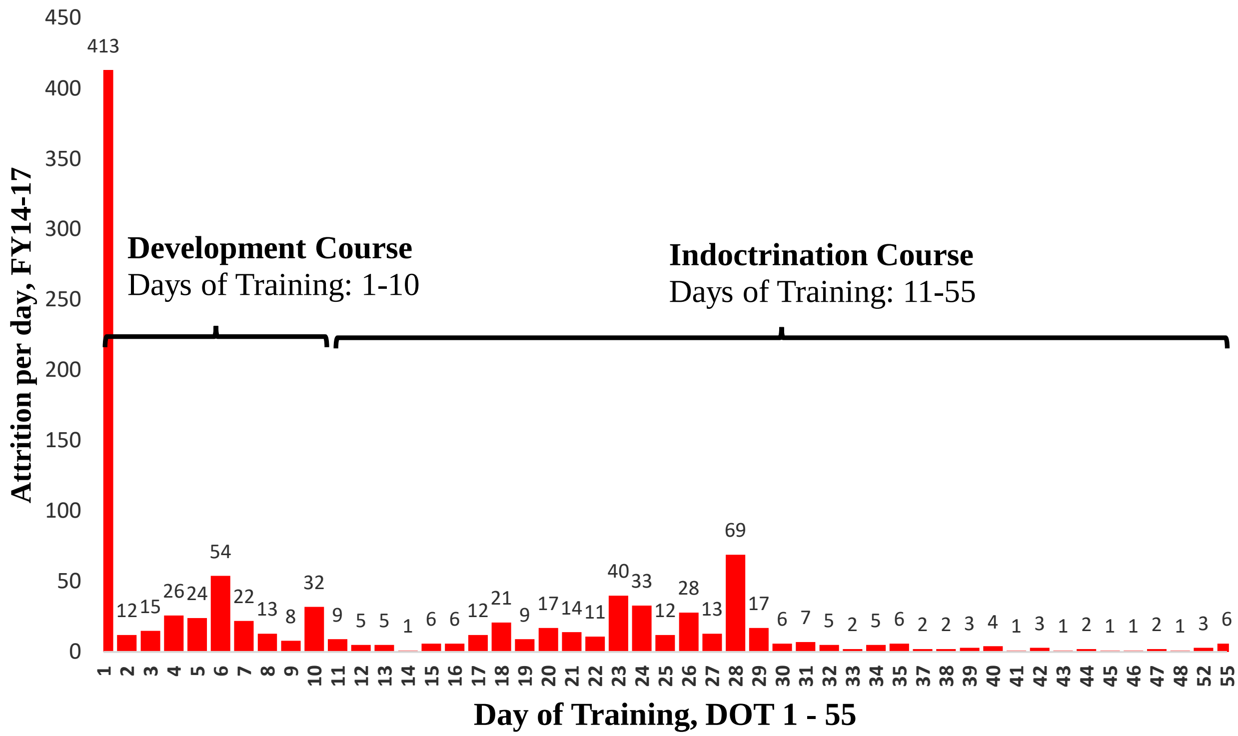


**Figure 1. Trainee elimination as a function of DOT.** The USAF School of Aerospace Medicine retained records for 1140 PJ candidates from FY2014 through FY2017 who trained in the program; 86% of candidate cohort "failed" (i.e., attrited, either through self-elimination or elimination by training cadre) between DOT 1-55, 52% of candidates who failed did so within the first 10 days of training in the Development Course, and of those candidates who failed in the first 10 days, 67% of that number failed on DOT 1. There are many probable explanations for such dramatic DOT 1 attrition. However, not counting DOT 1 attrition, we see a bimodal distribution of attrition between the 2 weeks of the Development Course, peaking on DOT 6 and 10 (i.e., the last day of each of the first 2 weeks of pipeline training), and a 3-week period between DOT 15 and DOT 30, peaking on DOT 28 during the Indoctrination Course.

Note that the distribution reflects that approximately 52% of attrition occurred during the first 10 days, which was the entire Development Course. Beyond DOT 10 (DOT 11-55), candidates entered the Indoctrination Course. Attrition during Indoctrination was more widely distributed across training days compared to attrition during the Development Course. We theorized that a trainee had a high probability of graduating PJ training if he survived beyond DOT 10. Using the Cox PH models, we assigned an estimated DOT survival rating to each trainee. Trainees with an estimate greater than 0.50 were considered to have the highest probability of "surviving" to DOT 11 (the first day of Indoctrination). Since our objective was to model likelihood of attrition, we used probability of failure of 0.50 as the probability for cutoff occurring at or by DOT 10. Note that the survival prediction was only that a given trainee was likely to survive to DOT 11. Trainees who "survived" to DOT 11 were considered to have a reasonable probability of success in the Indoctrination Course.

### 4.3 Development of the Predictive Model

The results from the multivariable Cox PH models are presented in Tables 5 and 6. These results examine the relationship between cognitive aptitude and non-cognitive traits with days until dropping out of PJ training. For the ASVAB subtests only model, Arithmetic Reasoning, Paragraph Comp, Electronics Info, and Auto Information were statistically significant at the 0.05 significance level. The complete regression coefficients ($\hat{\beta}$), standard errors (SE), and percent reduction in generalized $R^2$ are presented in Table 5. The regression coefficients are difficult to interpret in a Cox PH model, but the hazard ratios (HR = exp(β)) can be interpreted in a similar manner as odds ratios in logistic regression. For this study, we compute the HR based on a 10-unit change in the quantitative covariates (i.e., HR = exp(β x 10)). The HRs and p-values are presented in Table 6. Since all the predictors are quantitative, it is helpful to interpret HRs in the following way: subtract 1.0 from the HR and multiply by 100. This gives the estimated percent change in the hazard for each 10-unit increase in the covariate. Positive values represent an increase in the risk of dropping out and negative values represent decrease in the risk of dropping out. For example, the HR for Arithmetic Reasoning was 0.85; therefore, PJ trainees with a 10-unit increase in Arithmetic Reasoning have a 15% decrease in the risk of dropping out of training.

For the NEO-facets-only model, warmth, gregariousness, positive emotions, actions, altruism, compliance, modesty, and achievement-striving reached statistical significance with $p<0.05$. Increases in recruits' warmth, altruism, and compliance scores meant that the recruits were at risk of dropping out of training. For example, for each 10-unit increase in warmth, we expect to see a 15% increase in the risk of dropping out of PJ training. Conversely, increases in gregariousness, positive emotions, actions, modesty, and achievement-striving implied that a recruit had a decreased risk of dropping out of training. Specifically, for each 10-unit increase in achievement-striving, we expect to see an 18% decrease in a recruit's risk of dropping out of PJ training. Finally, for the full model, which included both cognitive aptitude and non-cognitive traits, most measures from the individual models remained statistically significant at the 0.05 level except Arithmetic Reasoning, Paragraph Comp, actions, and altruism. Additionally, the directionality in the relationship between each significant cognitive aptitude and non-cognitive traits with risk of dropping out of training remained unchanged.

Next, we examined variable importance for each Cox PH model based on the percentage contribution of each variable in the regression model. Based on the ASVAB-subscale-only model, Electronics Info and Auto Information had the most significant impact in the reduction in generalized $R^2$ at 15% and 17%, respectively. Within the NEO-facets-only model, modesty was considered the most important measure in the regression model, with approximately a 13% reduction in generalized $R^2$. Finally, for the full model, modesty and achievement-striving were the most impactful measures, with a 9% and 6% reduction in generalized $R^2$, respectively.

## Table 5. Cox PH Modeling PJ Candidate Training Duration

| Test Measure | ASVAB-Only Model | | | NEO-Only Model | | | ASVAB + NEO | | |
|---|---|---|---|---|---|---|---|---|---|
| | $\hat{\beta}$ | SE | $R^2$ (% change) | $\hat{\beta}$ | SE | $R^2$ (% change) | $\hat{\beta}$ | SE | $R^2$ (% change) |
| General Sciences | -0.001 | 0.007 | -0.05 | | | | 0.002 | 0.007 | -0.10 |
| Arithmetic Reasoning | -0.016 | 0.008 | -9.90 | | | | -0.013 | 0.008 | -2.22 |
| Word Knowledge | 0.001 | 0.007 | -0.06 | | | | 0.004 | 0.008 | -0.24 |
| Paragraph Comp | -0.017 | 0.007 | -12.03 | | | | -0.011 | 0.007 | -1.82 |
| Math Knowledge | -0.010 | 0.008 | -3.86 | | | | -0.015 | 0.008 | -2.75 |
| Electronics Info | 0.017 | 0.006 | -15.29 | | | | 0.013 | 0.006 | -3.65 |
| Auto Information | -0.016 | 0.006 | -17.37 | | | | -0.013 | 0.006 | -4.51 |
| Mechanical Comp | -0.003 | 0.007 | -0.33 | | | | -0.006 | 0.007 | -0.56 |
| Anxiety | | | | 0.006 | 0.005 | -1.70 | 0.004 | 0.005 | -0.48 |
| Anger/Hostility | | | | 0.009 | 0.005 | -3.50 | 0.005 | 0.005 | -0.80 |
| Depression | | | | -0.003 | 0.006 | -0.33 | -0.002 | 0.006 | -0.09 |
| Self-Consciousness | | | | 0.004 | 0.005 | -0.83 | 0.004 | 0.005 | -0.60 |
| Impulsiveness | | | | -0.005 | 0.005 | -1.64 | -0.003 | 0.004 | -0.35 |
| Vulnerability | | | | 0.008 | 0.007 | -1.57 | 0.007 | 0.007 | -0.85 |
| Warmth | | | | 0.014 | 0.006 | -7.09 | 0.011 | 0.006 | -3.34 |
| Gregariousness | | | | -0.010 | 0.004 | -6.23 | -0.011 | 0.004 | -5.21 |
| Assertiveness | | | | 0.002 | 0.005 | -0.24 | 0.003 | 0.005 | -0.27 |
| Activity | | | | 0.005 | 0.005 | -1.29 | 0.005 | 0.005 | -0.97 |
| Excitement-Seeking | | | | 0.000 | 0.005 | -0.01 | -0.001 | 0.005 | -0.03 |
| Positive Emotions | | | | -0.010 | 0.005 | -5.92 | -0.010 | 0.005 | -4.31 |
| Fantasy | | | | -0.002 | 0.004 | -0.21 | -0.002 | 0.004 | -0.32 |
| Aesthetics | | | | 0.000 | 0.004 | -0.01 | -0.002 | 0.004 | -0.14 |
| Feelings | | | | 0.000 | 0.004 | -0.02 | 0.001 | 0.004 | -0.12 |
| Actions | | | | -0.007 | 0.003 | -5.14 | -0.007 | 0.004 | -3.14 |
| Ideas | | | | 0.002 | 0.005 | -0.24 | 0.005 | 0.005 | -0.69 |
| Values | | | | 0.001 | 0.004 | -0.05 | 0.002 | 0.004 | -0.15 |
| Trust | | | | -0.004 | 0.004 | -1.33 | -0.002 | 0.004 | -0.19 |
| Straightforwardness | | | | 0.003 | 0.004 | -0.80 | 0.003 | 0.004 | -0.58 |
| Altruism | | | | 0.011 | 0.005 | -4.44 | 0.010 | 0.006 | -2.97 |
| Compliance | | | | 0.010 | 0.004 | -6.61 | 0.009 | 0.004 | -3.96 |
| Modesty | | | | -0.012 | 0.004 | -13.26 | -0.012 | 0.004 | -9.37 |
| Tendermindedness | | | | -0.004 | 0.004 | -1.59 | -0.005 | 0.004 | -1.71 |
| Competence | | | | 0.003 | 0.006 | -0.39 | 0.004 | 0.006 | -0.46 |
| Order | | | | -0.002 | 0.004 | -0.18 | -0.001 | 0.005 | -0.06 |
| Dutifulness | | | | 0.011 | 0.007 | -3.36 | 0.010 | 0.007 | -1.96 |
| Achievement-Striving | | | | -0.020 | 0.007 | -9.95 | -0.018 | 0.007 | -5.98 |
| Self-Discipline | | | | 0.002 | 0.007 | -0.13 | -0.001 | 0.007 | -0.02 |
| Deliberation | | | | 0.001 | 0.004 | -0.02 | 0.001 | 0.004 | -0.02 |

Note: $R^2$ represents the generalized $R^2$.

**Table 6. Hazard Ratios for Cox-PH Models**

| Test Measure | ASVAB Only | | NEO Only | | ASVAB & NEO | |
|---|---|---|---|---|---|---|
| | HR | p-value | HR | p-value | HR | p-value |
| General Sciences | 0.9901 | 0.8811 | -- | -- | 1.0238 | 0.7359 |
| Arithmetic Reasoning | 0.8482 | 0.0337 | -- | -- | 0.8799 | 0.1043 |
| Word Knowledge | 1.0122 | 0.8701 | -- | -- | 1.0411 | 0.5944 |
| Paragraph Comp | 0.8459 | 0.0193 | -- | -- | 0.8982 | 0.1409 |
| Math Knowledge | 0.9010 | 0.1845 | -- | -- | 0.8647 | 0.0706 |
| Electronics Info | 1.1804 | 0.0082 | -- | -- | 1.1437 | 0.0368 |
| Auto Information | 0.8534 | 0.0051 | -- | -- | 0.8739 | 0.0210 |
| Mechanical Comp | 0.9739 | 0.6971 | -- | -- | 0.9437 | 0.4147 |
| Anxiety | -- | -- | 1.0589 | 0.2211 | 1.0371 | 0.4494 |
| Anger/Hostility | -- | -- | 1.0893 | 0.0790 | 1.0493 | 0.3274 |
| Depression | -- | -- | 0.9688 | 0.5892 | 0.9806 | 0.7424 |
| Self-Consciousness | -- | -- | 1.0449 | 0.3948 | 1.0453 | 0.3982 |
| Impulsiveness | -- | -- | 0.9476 | 0.2324 | 0.9714 | 0.5177 |
| Vulnerability | -- | -- | 1.0822 | 0.2420 | 1.0707 | 0.3158 |
| Warmth | -- | -- | 1.1492 | 0.0132 | 1.1191 | 0.0468 |
| Gregariousness | -- | -- | 0.9051 | 0.0194 | 0.8982 | 0.0126 |
| Assertiveness | -- | -- | 1.0239 | 0.6445 | 1.0297 | 0.5687 |
| Activity | -- | -- | 1.0495 | 0.2894 | 1.0505 | 0.2833 |
| Excitement-Seeking | -- | -- | 0.9958 | 0.9263 | 0.9916 | 0.8543 |
| Positive Emotions | -- | -- | 0.9007 | 0.0228 | 0.9005 | 0.0234 |
| Fantasy | -- | -- | 0.9845 | 0.6664 | 0.9780 | 0.5381 |
| Aesthetics | -- | -- | 0.9958 | 0.9140 | 0.9843 | 0.6855 |
| Feelings | -- | -- | 1.0042 | 0.9063 | 1.0138 | 0.7064 |
| Actions | -- | -- | 0.9289 | 0.0340 | 0.9336 | 0.0529 |
| Ideas | -- | -- | 1.0221 | 0.6498 | 1.0469 | 0.3646 |
| Values | -- | -- | 1.0082 | 0.8294 | 1.0164 | 0.6694 |
| Trust | -- | -- | 0.9574 | 0.2803 | 0.9808 | 0.6350 |
| Straightforwardness | -- | -- | 1.0349 | 0.4048 | 1.0348 | 0.4059 |
| Altruism | -- | -- | 1.1137 | 0.0497 | 1.1095 | 0.0605 |
| Compliance | -- | -- | 1.1099 | 0.0164 | 1.0993 | 0.0300 |
| Modesty | -- | -- | 0.8830 | 0.0007 | 0.8838 | 0.0009 |
| Tendermindedness | -- | -- | 0.9573 | 0.2378 | 0.9483 | 0.1526 |
| Competence | -- | -- | 1.0351 | 0.5620 | 1.0458 | 0.4582 |
| Order | -- | -- | 0.9829 | 0.6947 | 0.9876 | 0.7824 |
| Dutifulness | -- | -- | 1.1210 | 0.0874 | 1.1063 | 0.1275 |
| Achievement-Striving | -- | -- | 0.8205 | 0.0032 | 0.8354 | 0.0076 |
| Self-Discipline | -- | -- | 1.0243 | 0.7408 | 0.9895 | 0.8863 |
| Deliberation | -- | -- | 1.0062 | 0.8872 | 1.0060 | 0.8924 |

Among the three Cox PH models, the full model containing both ASVAB subscales and NEO facets provided better model fit and predictive power compared to the ASVAB-subscale-only and NEO-facet-only models. The various fit indices are presented in Table 7. The full model produced larger concordance and generalized $R^2$ and lower AIC compared to the two reduced models. Additionally, the LRT statistics comparing the full model to each of the reduced models were both statistically significant with p-values < 0.001.

**Table 7. Model Fit Indices Compare the Three Cox PH Models**

| Model | Concordance (SE) | AIC | Generalized $R^2$ | LRT ($\chi^2$(df); p-value) |
|---|---|---|---|---|
| ASVAB subscales only | 0.568 (0.014) | 12437.64 | 0.038 | 68.7(30); p<0.0001 |
| NEO facets only | 0.598 (0.014) | 12442.07 | 0.071 | 29.1(8); p=0.0003 |
| ASVAB + NEO | 0.614 (0.013) | 12428.98 | 0.095 | |

Note: LRT is comparing each reduced model to the full model (ASVAB subscale + NEO facet).

The classification of PJ candidates as graduates or failures on DOT 10 estimated survival probabilities and the AUC are presented in Table 8. Specifically, DOT 10 probabilities were chosen as the basis for the readiness ratings. When the goodness-of-fit and discrimination of a model are evaluated using the data on which the model was developed, they will tend to be overestimated. Therefore, DOT 10 survival probabilities were estimated using LOOCV. For each model, the LOOCV-derived probabilities were searched to identify the optimal cutpoint that best predicted training completion while ensuring that the false negative rate was less than 20% (i.e., sensitivity > 80%). Both parsimonious models produced specificity of approximately 30% while holding sensitivity at 80%. In contrast, there was a significant increase in specificity (36%) for the full Cox PH model, which included both the ASVAB subscales and NEO facets. Finally, we present the classification results for the NEO-facets-only model in terms of deciles in Table 9.

**Table 8. Classification Table for PJ Candidates Based on Cox PH Model**

| Model | Correct | | Incorrect | | Percentages | | | | | AUC |
|---|---|---|---|---|---|---|---|---|---|---|
| | Graduate | Fail | Graduate | Fail | Correct | Sensitivity | Specificity | PPV | NPV | |
| ASVAB only | 128 | 319 | 661 | 32 | 39.21 | 80 | 32.6 | 16.2 | 90.9 | 0.61 |
| NEO facet only | 128 | 298 | 682 | 32 | 37.37 | 80 | 30.4 | 15.8 | 90.3 | 0.60 |
| ASVAB + NEO | 128 | 353 | 627 | 32 | 42.19 | 80 | 36.0 | 17.0 | 91.7 | 0.63 |

NPV = negative predictive value; PPV = positive predictive value.

Assessment of Table 8 suggests that the ASVAB-only model compares well with both the NEO-only and full model relative to classification of graduates, but it does not predict as strongly in classifying failures as both the NEO-only and ASVAB + NEO models. In addition, the NEO-only model, while performing better classifying failures than the ASVAB-only model, is 10% lower than the ASVAB + NEO model in classification accuracy. Finally, the ASVAB + NEO model best classifies failures in the cross-validation assessment while losing classification accuracy for graduates by 10%.

**Table 9. Deciles for Scaled Readiness Ratings (NEO Facets Only Model)**

| Readiness Rating | Failures | | Graduates | | Total | Corresponding Unscaled Interval |
|---|---|---|---|---|---|---|
| | n | % | n | % | | |
| [0, 0.1] | 0 | -- | 0 | -- | 0 | [0, 0.083] |
| (0.1, 0.2] | 5 | 83.3 | 1 | 16.7 | 6 | (0.083, 0.17] |
| (0.2, 0.3] | 20 | 95.2 | 1 | 4.8 | 21 | (0.17, 0.25] |
| (0.3, 0.4] | 87 | 94.6 | 5 | 5.4 | 92 | (0.25, 0.33] |
| (0.4, 0.5] | 186 | 88.2 | 25 | 11.8 | 211 | (0.33, 0.42] |
| **(0.5, 0.6]** | **320** | **87.0** | **48** | **13.0** | **368** | **(0.42, 0.50]** |
| (0.6, 0.7] | 239 | 85.1 | 42 | 14.9 | 281 | (0.50, 0.58] |
| (0.7, 0.8] | 106 | 77.9 | 30 | 22.1 | 136 | (0.58, 0.67] |
| (0.8, 0.9] | 15 | 65.2 | 8 | 34.8 | 23 | (0.67, 0.75] |
| > 0.9 | 2 | 100.0 | 0 | 0.0 | 2 | > 0.75 |
| **Total** | **980** | **86.0** | **160** | **14.0** | **1140** | |

In any predictive model, the attempt is always centered on decreasing classification error, but there is a trade-off. In classification models, when efficiency increases in classifying one category, there is a proportional decrease in its complementary category. Therefore, an increase in the number of graduates who are accurately classified as graduates will result in a concomitant reduction in classification accuracy of those who failed. This demands that a threshold for loss be established whereby a given model does not exceed the accepted loss of classification accuracy deemed acceptable.

An additional analysis was performed on the regression probabilities for passing the training based on the NEO-only statistical model. Candidates in both groups (graduates/failures) were categorized according to their regression probabilities according to the following: 0.1; 0.11-0.20; 0.21-0.30; 0.31-0.40; 0.41-0.50; 0.51-0.60; 0.61-0.70; 0.71-0.80; 0.81-0.90, 0.91-1.0 (see Table 9). However, regression probabilities for candidates were also scaled in which a 0.50 regression probability and below represented no more than 32% of the graduates (false negatives). Scaled and unscaled decile ratings are reported in Table 9. The bolded values in Table 9 represent the hypothetical predictive 0.50 cutoff, such that only 32 (20%) of 160 actual graduates in this cohort would have been falsely eliminated. Elimination at 0.50 yields the greatest classification accuracy in terms of retaining candidates who have a high probability of success, with the most saving in terms of USAF training dollars, a modest manpower loss from false eliminations, while also eliminating 298 (30%) true overall failures. (A regression probability of 0.40 and below cutoff point would have resulted in 7 false eliminations (4.4%) out of 160 graduates of the current cohort, while a cutoff probability of 0.60 would have falsely eliminated 80 (50%) of the 160 graduates.)

Once the theory of the model was established, implemented, and validated, the next step was the development of a tool to aid psychologists in interpreting the results of the NEO assessments. We utilized a visual topography as a graphic display of the NEO facets demonstrating the trainee's probability of success/failure (Figure 2). The topography provides a snapshot for psychologists who must assess how each trainee compares to the civilian, non-military population as well as the cohort of successful PJ candidates. This is useful in assessing the likelihood of successful adaptation to the rigors of training and facilitates a more focused interview to assess strengths and weaknesses. Additionally, the topography can be used across a person's military career in conjunction with ongoing assessments for comparison, especially following physical injury or psychological illness. Current test results can be overlaid for comparison with post injury or illness testing to assist in diagnosis and treatment. A visual topography can be utilized as an additional tool for psychologists to add to their repertoire of instruments to provide precision-based evaluation, performance improvement strategies, and mental healthcare.

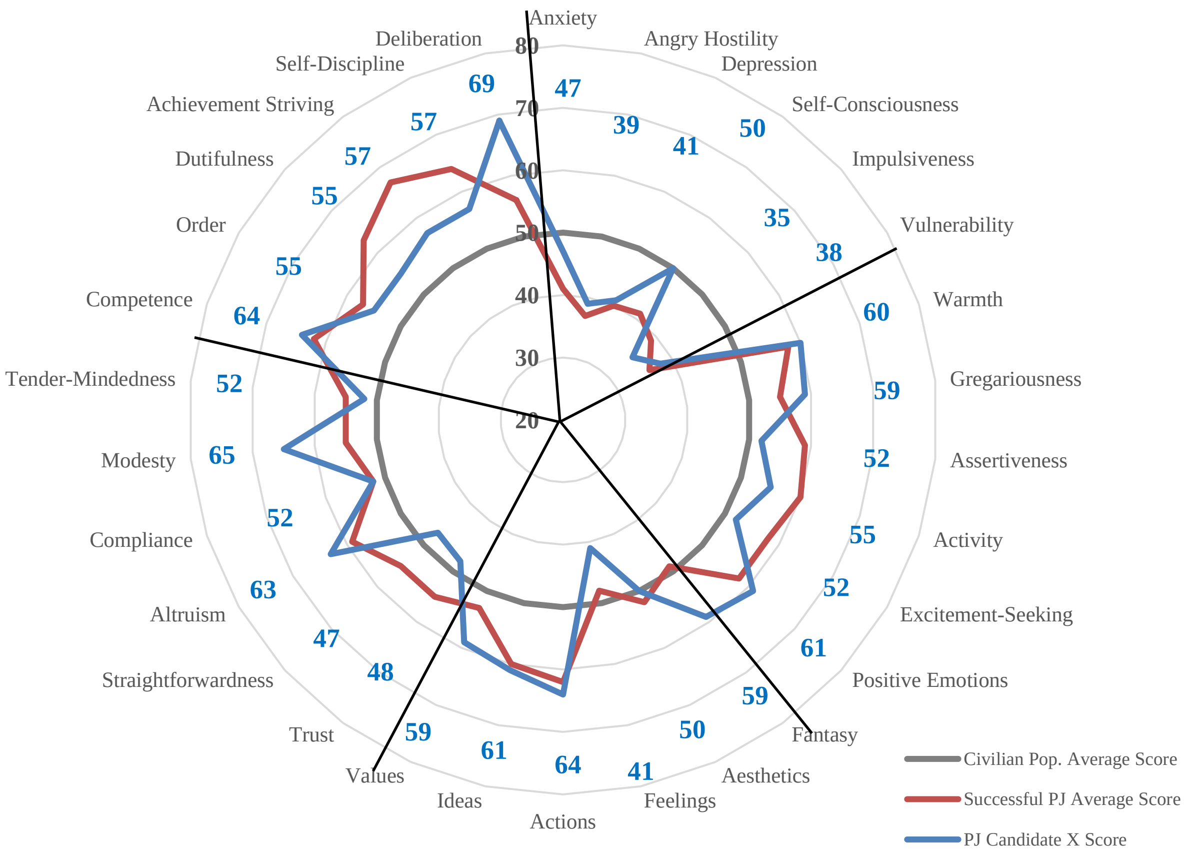


**Figure 2. PJ psychological topography tool for aeromedical operational psychology.**

# 5.0 DISCUSSION

## 5.1 Distribution of Training Failures

The results of the study confirmed that attrition does not occur in a linear fashion over the courses of initial entry. Rather, the majority of training attrition between FY14-17 (86%) occurred during the first 55 days, with most attrition by the 10$^{th}$ day of training. Based on description of the training courses provided earlier, Indoctrination and Development Courses do not represent the most rigorous aspects of training. These courses are used to progressively assist training candidates with achieving the required skills and abilities to successfully pass subsequent courses where physical and psychological rigors are more taxing.

The results of attrition occurring at such early stages reveal that most candidates are not ready (either due to physical and psychological aptitudes, motivation, or combination thereof) for training. This finding provides supportive evidence for improving post-accession evaluation of training candidates prior to entry into PJ training (i.e., BMT, courses of initial entry). In 2014, USAF Air Education and Training Command (AETC) developed a battlefield airmen training squadron during BMT to better prepare and improve the readiness of training candidates prior to entering formal PJ training. The results of Figures 1 and 2 suggest that this strategy has not fully made the desired impact. The attrition rates continue to remain high well after implementation. Overall, the finding that relatively high levels of attrition occurring at very early and less rigorous stages of training suggests that current alignment and selection processes lack the sensitivity and specificity with recognizing physically healthy and high-functioning candidates who are at high risk for failure. However, the current program now includes both pre-entry into active duty (i.e., before embarking into training program) and the post-BMT pre-entry into courses of initial training (BA Prep). There is not enough data yet to determine if these initiatives are working to enhance training and overall training success.

Overall, the results of the skewed distribution of attrition at the very beginning during the less rigorous phases provide empirical support for making improvements to pre-accession recruiting procedures, as well as post-accession training processes and aeromedical evaluations determining psychological fitness, suitability, and readiness for special duty training. The results also suggest that methods for improving evaluation procedures via statistical analyses of training outcomes should consider the skewed distribution of attrition.

## 5.2 General Incremental Validity of Non-Cognitive Aptitude Testing

A relatively modest increase in incremental validity is worthy of consideration given the general costs associated with each non-prior-service candidate (i.e., recruiting, housing/feeding, evaluating, and providing basic military training) prior to DOT 1 of PJ training. Although it is difficult to obtain an accurate accounting of actual costs, for a single candidate the general estimated cost to recruit, transport, educate, and train through BMT prior to the first day of PJ training was estimated to be approximately $30,000 (Adelson K. Personal communication; 2014 Sep). Based on this estimate from the Battlefield Airmen Training Squadron from within AETC, between 2014 and 2017 (candidates included in this study), the USAF spent approximately $34,200,000 to bring 1140 candidates to the first day of PJ training. The results reveal that only 160 candidates successfully passed training (i.e., an 86% attrition rate). This reveals a loss of approximately $29,400,000.

Due to the finding that attrition occurs during early stages of training, Cox regression survival analysis was used to develop and evaluate the efficacy of statistical models based on ASVAB cognitive aptitude test scores, NEO PI-3 personality test scores, and a combination of both measures. Statistical models focused on the probability of “survival” past DOT10. As mentioned previously, this point of training is where 52% of attrition has occurred. Combinations of ASVAB and NEO PI statistical models were evaluated regarding how well various statistical models combining cognitive and non-cognitive functioning could improve capabilities for correctly classifying training outcomes of PJ training candidates between 2014 and 2017.

The results of the study reveal the inclusion of pre-training non-cognitive testing significantly improves capabilities to accurately classify the probability of success or failure of each candidate. Multiple statistical models were evaluated (ASVAB only, NEO PI only, and combined ASVAB + NEO PI models) and the results of this study reveal the NEO PI as a sensitive measure for accurately identifying candidates who are (or are not) ready for PJ training above and beyond the singular utilization of a cognitive aptitude measure. The findings also reveal the NEO PI model utilizing all 30 facets was better at predicting classification outcomes than a general measure of cognitive aptitude. However, the best model for predicting outcomes involved the combination of cognitive and personality-based measures. This finding provides empirical support for selection programs of high-risk, high-demand career fields to consider a holistic approach with the inclusion of such testing and the importance of evaluating emotional, social, and behavioral functioning with respect to adapting to unique and adverse conditions.

## 5.3 Impact of Non-Cognitive Traits Predicting Training Outcomes

The results of analyses reveal that each area of non-cognitive functioning that was assessed can have an impact on training outcomes. Although an exhaustive analysis of all the possible interactions between the variables assessed was beyond the scope of this study, the results of survival analysis revealed salient areas of functioning impacting outcomes that warrant discussion.

First, higher levels of *modesty*, *achievement-striving*, *gregariousness*, and *assertiveness* were identified as some of the most impactful predictors. The results reveal that possessing a higher than average level of humility, diligence, persistence, and purposeful motivation with high aspirations and a strong desire to interact in group settings, speak without hesitation and, if needed, engage in a dominant fashion were key traits to success. The results also revealed those who succeed, as a group, were more aggressive and competitive, while at the same time cognizant of subordinating self-interest to work cooperatively with others to accomplish specific tasks. The higher levels of humility also revealed those who succeeded were more willing to take corrective action from training cadre without becoming emotionally overwhelmed or "defeated" by strong criticism. Although such traits are critical to successfully responding to a wide range of challenges, they appear to be particularly relevant to overcoming the physical as well as psychological hardships faced in training and future operations. Training cadre and operators collectively report that candidates who are "self-starters," who are described by others as "humble," "confident," "tenacious," "assertive," and "responsible," possess traits that are critical to adapting to the rigors of training (Howk K. Personal communication; 2015 Oct).

Second, higher levels of *tendermindedness*, but lower levels of *warmth*, *compliance*, *altruism*, and *dutifulness*, were also impactful predictors for training outcomes. Although those who succeeded had high levels of each of these traits, the results also suggest that having an active concern and willingness to help others in need without being overly affectionate and consumed in the problems and concerns of others is also important. The results also reveal that those who succeed are more likely to have well-defined ethical principles and code of conduct, as well as a strong desire to act in accordance with moral obligations. Such traits likely facilitate positive relationships and strong ties/bonds with others and are likely traits that facilitate constructive interpersonal exchanges that are necessary for effectively solving and working through complex situations that require a group effort. These findings are consistent with remarks by training cadre and operators who reported having "a strong ethical code of conduct" and "genuine willingness to help others and sacrifice self-interests" while "maintaining healthy relationship boundaries" and "not get overly consumed with the problems of others" as critical areas of functioning (Carpenter T. Personal communication; 2015 Oct). Third, the results of the study reveal higher levels of *positive emotions* and lower levels of *anger, anxiety,* and *vulnerability* as significant predictors of success. Maintaining an optimistic demeanor, as well as sustaining emotional and behavioral composure and being resistant to worry and feelings of helplessness under taxing conditions and states of adversity, is critical to adaptation. This includes maintaining high levels of tolerance to frustration and hostility and confidence and independence when facing highly stressful and emergent conditions. The collective interaction of these variables is reasonably perceived as representing an unusually high degree of emotional stability and control under pressure, as well as in constantly changing and increasingly stressful demands. Such traits coincide with being self-confident and not reacting in an overly inhibited or emotionally defensive fashion in group settings and during negative feedback from training cadre. This finding appears to be particularly relevant to effectively responding to criticism, failure, and frustration that candidates routinely experience throughout the course of training. This finding also supports the requirement for training candidates and operators to effectively adapt and function within a wide range of diverse groups and changing conditions.

Fourth, higher levels of *action* and *impulsiveness* were also identified as influencing likelihood of success. These findings suggest successful candidates are more likely to possess an elevated interest and willingness to engage in novel activities and events. Such traits can assist with adapting to the various and constantly changing conditions. The training and operational demands of the PJ career field are marked by constantly changing and diverse sets of missions, tasks, and environments. Those who have interest in novelty and change may be more likely to adapt than those who harbor strong preferences for routine and predictable conditions. Although those who succeeded, as a group, had low impulsiveness (ability to resist urges and temptations), they are more likely to "give in" to specific urges, such as overindulging in activities of high interest.

Although there were 30 different variables measured, the areas of emotional, behavioral, and social functioning above stood out as the most influential on training outcomes (see Tables 5 and 6). This study provides insight into the various areas of psychological functioning regarding adapting to the unique rigors of training. Although improving fitness standards and training may also help to reduce the high levels of attrition [84], we propose that successful adaptation to both the rigors of training and subsequent operational demands requires more of the operator himself than simply possession of high levels of physical functioning. This report demonstrates that candidates who pass training differ from those who fail in all areas of functioning including non-cognitive areas, cognitive performance, and physical abilities. This study also provides meaningful knowledge for steering improvements to the pre-training selection and screening process.

The results of this study demonstrate that successful PJ operators possess traits that are consistent with the list of "essential attributes" of military personnel across a range of high-risk, high-demand operational duty positions, and these traits are also common areas of functioning addressed in assessment and selection programs for high-risk occupations [52,59], as well as U.S. Army Special Forces, Navy SEALs, and Air Force special duty programs [81]. The limited number of publications on the essential attributes of special operations military personnel may be due in part to the reluctance of those overseeing military selection programs to expose the details of their assessment and selection process. Many details of operational selection programs are classified, and security concerns preclude their publication. Even when programs are not classified, the complexity and importance of maintaining the security of military assessment and selection programs preclude military personnel from disclosure. Despite the literature offering comparative results being limited, the findings of this study provide supportive evidence that candidates who successfully pass special operations training possess an identifiable set of unique non-cognitive attributes. Such attributes represent areas of emotional, behavioral, and social traits that must be present in sufficient degree for a candidate to have a reasonable likelihood of adapting to the unique rigors of training, as well as the unconventional, high-risk, high-demand conditions of operational missions.

The results of this study are largely consistent with an earlier study assessing the impact of non-cognitive aptitudes with completing PJ training [25]. The results of the earlier study using the EQ-i revealed that those who passed training reported higher scores in self-regard, independence, self-actualization, interpersonal relationship, stress tolerance, impulse control, reality testing, flexibility, optimism, and happiness. The results also revealed the largest differences between those who passed versus failed training were on measures of general mood and stress management. The results of this current study using the NEO PI-3 are consistent with the earlier study using the EQ-i regarding the influence of emotional, social, and behavioral functioning with adapting to the rigors of PJ training.

### 5.4 Post-Accession Classification Matrices Based on Survival Analyses Outcomes

The results of the study reveal that on average from 2014-2017, 90% of training candidates with a scaled survival rating (based on the NEO PI-3 Cox regression survival analyses) of 0.50 or less failed training. This represents approximately 26% of total training candidates and 30% of failed candidates. This result suggests that current recruiting and selection efforts can be significantly improved via utilization of this classification matrix. Training candidates who have a survival rating of 0.50 or less can be reassessed and rerouted to alternative career fields. This would reduce the overall number of candidates entering the technical training pipeline by 26% without significantly reducing the number of candidates who pass training. The overall number of candidates passing would be reduced by 20%, yet substantially fewer unsuitable candidates would enter training. Although reassignment of training candidates into an alternative career field would result in a smaller number of candidates entering the technical training pipeline, there are multiple benefits. Such benefits include a decrease in the student-instructor ratio, thereby allowing for more individualized attention to candidates who would have passed the pipeline if they had received additional instruction.

Furthermore, the survival rating may be used as an additional source of information for operational psychologists tasked with evaluating the readiness of training candidates. Additional sources of information, such as the empirically based survival rating, can greatly aid psychologists with providing precision-based assessments. Such additional sources of information can be invaluable given the brief amount of time (e.g., 45 minutes) allotted to conducting a complex and comprehensive psychological evaluation for assessing a candidate’s risk for adaptation problems. The survival rating can be an invaluable source of information when combined with other information (e.g., clinical interview, additional testing) for helping a psychologist interpret a candidate’s profile and readiness utilizing an evidence-based, empirically driven methodology. The psychologist could then more effectively help reassign those who are at high risk for failure if they continue into the PJ training pipeline to an alternative career field.

## 5.5 Visual Topographies of NEO PI Scores

The final goal of this study was to provide visual topographies to enable users to compare an individual candidate's psychological functioning with normative data from the civilian population and successful PJ trainees. The results of the normative data for the NEO PI-3 (as delineated in Figure 2) reveal that successful candidates represent a unique group of adults who differ from peers in the civilian population. This can help shape personnel alignment, aeromedical practices, and individualized performance enhancement strategies by targeting specific areas of non-cognitive functioning that are key to readiness and performance. The translational application of candidate topographies is multifaceted, providing aspects of operational relevance throughout the progression of a person's military career.

For example, at the outset of the training pipeline, the visual topography communicates, in a quantitative fashion, how an individual's personality traits compare with peers in the civilian population and those who successfully complete training. The comparison of career-field-specific non-cognitive normative data sheds light on interpreting a candidate's test scores and identifying relative strengths and weaknesses regarding training adaptation. This comparison also demonstrates that some areas of psychological functioning, which are at an exceptionally high level in comparison to general population norms, may represent only average or below average levels of functioning when compared to those who complete training. The normative data for successful PJ candidates displayed by the visual topography highlight the necessity of occupationally specific normative data when assessing prospective training candidates. Interpreting these nuances is vital to accurately determine psychological readiness and suitability for high-risk, high-demand occupations. The visual topography also reinforces the notion that verifying the absence of diagnosable psychological pathology is necessary, but on its own is insufficient in determining a person's readiness.

The visual topography may also remove subjectivity and bias when a provider is making a clinical ARMA determination for a candidate. The objective test scores, which are empirically linked to performance outcomes, provide an operational psychologist with a rich source of information for making objective data-driven decisions, especially when combined with collateral sources (e.g., behavioral observation and background data).

The visual topography can also inform individualized performance enhancement techniques to be implemented in the training pipeline and throughout an airman's lifecycle. Precision-based performance improvement plans would be based upon the individual's strengths and weaknesses identified by personality data empirically linked to performance outcomes. The training candidate values represented on the topography (see Figure 2) can be thought of as being analogous to lab values on a panel of blood tests: providing a measure of overall readiness and capability and serving as a means of monitoring changes in readiness status over time. While a PJ candidate may exhibit a personality profile within normal limits based on the normative data of successful candidates, that individual will have a unique profile of strengths and weaknesses based on the clustering and combination of facet deviations when compared with normative data of successful PJ candidates.

To illustrate the application of performance enhancement strategies, consider a PJ candidate with an adaptability rating of 0.61 with a confidence interval between 0.52 and 0.68. The candidate's profile (Figure 2) yielded valuable information related to how he was likely to perceive, interpret, and respond when faced with challenges under physically and psychologically taxing conditions. Specifically, the candidate's individual facet scores suggested that while he possessed strong will, resilience, and determination (high scores within the Conscientiousness domain and consistent with PJ norms), he also possessed vulnerabilities related to regulating emotional arousal in extreme situations in which tolerating duress and maintaining performance levels under emergent conditions are necessary. This formulation was based upon the psychological interpretation of several combinations and interactions among facet scores utilizing PJ normative data. For example, his overall profile reveals he is (1) predisposed to overthink/overanalyze situations (very high deliberation combined with very low impulsivity) when needed to make quick decisions; (2) uncomfortable when not able to adapt to demands and expectations placed upon him; (3) unlikely to ask for help or assert himself in pressure-oriented situations; and (4) likely to experience a heightened state of anxiety when drawing attention to himself in high-risk conditions (high on facets associated with the Conscientiousness domain combined with Self-Consciousness, Anxiety, and Modesty, both 1 SD above PJ-specific normative data, and a facet score on Excitement Seeking and Assertiveness almost 1 SD below the PJ-specific normative data). While inclined to "get stuck in his head," the candidate's facet score on Feelings (which was over 1 SD below the PJ normative data) suggests he does not have an adequate level of insight into his emotional functioning and that he may be resistant to trusting others and seeking help (Straightforwardness and Trust almost 1 SD below PJ normative data). Subsequently, his profile deviations are indicative of a potential for the candidate's emotional responses to impair cognitive processes related to judgment and decision-making, thereby interfering with performance and adaption. In progressing through the PJ training pipeline, the aforementioned concerns were identified during water confidence training exercises in which the candidate repeatedly panicked during buddy breathing training events. He struggled asking for help, recognizing he was overthinking conditions, and increasing his emotional reactivity. To address the candidate's performance difficulty, he received individual coaching that trained him to better self-regulate his autonomic arousal through altering cognition and perceptual patterns that were precipitating the experience of panic and subsequent performance dysfunction. Through repeated practice of the techniques provided in the coaching sessions, the candidate was effectively able to enhance his threshold for distress and consequently improve his acquisition of skill-based training competencies. The candidate continued to demonstrate successful adaptation to the demands of the training environment. While this scenario is based upon a case example in which performance improvement strategies were implemented after performance disruption was evident, the topography provided a conceptual basis for the identified performance difficulty. Pinpointing the psychological origin of the issue allowed for swift, targeted intervention. However, the topography, like lab values on a blood test, possesses the ability to identify a vulnerability before it manifests. It would therefore be possible to implement precision-based coaching strategies that would incorporate psychological strength building techniques into training plans, teaching the skills to facilitate adaption before maladaptation occurs.

Lastly, the benefits of baseline testing and the visual topography may also be gained on an individual level in terms of lifecycle sustainment. Establishing baseline values on an individual level provides context and necessary points of reference for the interpretation of testing that may be completed at a later point in one's career. To illustrate, valuable information can be obtained during repeat testing. For example, if a PJ was retested after 10 years of operational duty and following a significant disruptive life event or tumultuous deployment and produced a t-score of 53 on the facet of Depression and a t-score of 52 on the facet of Anxiety, this would be considered within normal limits for the general population. However, when interpreted using normative data from the general population, such facet scores are 1.5 SDs above the PJ population average, suggesting the person is not as emotionally resilient as most of his peers in the career field. However, to provide further individualized context, if the hypothetical PJ's baseline facet scores on Depression and Anxiety were 37 and 39, respectively, his current scores of 53 and 52 on Depression and Anxiety, respectively, would be interpreted as an elevation well above their baseline functioning. The visual topography provides a way for identifying how an individual's profile has changed in response to a psychological trauma or injury and whether treatment and rehabilitation are needed and also how interventions may be individually tailored to provide for precision-based healthcare and performance improvement strategies.

## 5.6 Aeromedical Operational Psychology Recommendations

Recommendations about assessing and evaluating the psychological readiness of training candidates for high-risk, high-demand operational duty positions involve two stages: selecting-in and selecting-out. The select-out phase involves the assessment of psychological functioning focused on the presence or history of psychopathology. This involves areas of emotional, social, and behavioral functioning diagnostic of a psychiatric disorder or that are maladaptive under a wide range of conventional, routine, and non-high-demand conditions. Such evaluations typically identify problems with emotional stability (e.g., depression, anxiety), difficulty adapting to life stressors (e.g., adjustment-related disorders, acute and post-traumatic stress), interpersonal-relational problems, behavioral problems (e.g., criminal activity and violence), as well as alcohol and substance misuse. Current USAF aeromedical processes focus on the selecting-out phase via reliance upon flight medicine physicians who conduct medical records reviews and interviews, subsequently removing candidates with a known and documented history of emotional, social, and behavioral problems.

However, this process does not involve aeromedical operational psychologists, who typically have a more extensive repertoire of skills and tools for conducting such evaluations, especially with soliciting self-disclosure in situations where training candidates are reluctant to share their history of psychological difficulties. As a result, it is recommended that AETC embed "seasoned" operational psychologists within flight medicine and operational units to improve USAF capabilities to effectively assess the readiness and fitness of training candidates and identifying those with a history of psychopathology. The utilization of the visual topography combined with background questionnaires, interviews, and other testing (e.g., Minnesota Multiphasic Personality Inventory-2nd Edition Revised, MMPI-II-R) will bolster an operational psychologist's ability to identify candidates with overt and subtle forms of psychopathology.

The select-in phase involves the assessment of relatively healthy candidates to determine those who are “best-suited” and “most psychologically ready” for the nature of training and adapting to operational demands. Select-in procedures are oriented to evaluate candidates with a core set of psychological attributes (i.e., areas of emotional, social, and behavioral traits) that are collectively representative of an extraordinary, unusual, and optimal state of functioning necessary for performance under demanding conditions. Findings from this study indicate that the use of embedded operational psychologists tasked to provide “select-in” recommendations could result in significant improvements for training effectiveness and efficiency, but this function is not part of the current PJ selection and aeromedical evaluation process. Utilization of the NEO PI-3 30-facet statistical model to develop probability ratings for candidates regarding their relative risk for failure (i.e., likelihood of success) during the early stages of training may be used in combination with the visual topography. The use of (a) the classification matrix for interpreting the rating and a candidate’s likelihood for success and (b) the topography for evaluating a training candidate’s test scores and interpreting individual strengths and weaknesses for adaptation provides the knowledge and tools for a precision-based select-in evaluation. The rating and topography may also be used to develop individualized training strategies for performance improvement to enhance the likelihood of success.

Although the visual topography may also help to steer future studies on the relevance of specific traits and their interactions to promote or hinder adaptation to training rigors, what remains to be determined is the degree of compensatory effects within and between traits, each trait’s relationship to training, and the interaction among traits and thus the impact on training.

## 5.7 Limitations of the Study

There are limitations of the study that bear discussion. First, caution is warranted when generalizing the results of this study to other military special operations training candidates. The selection process, type of operational missions, and requirements can differ significantly. Second, repeated studies are needed to assess for the impact of non-cognitive testing and minority status of training candidates to ensure selection processes do not have an adverse impact on certain groups. Unfortunately, the current demographic among minority populations within special operations communities is too small to allow for assessment of the model’s impact on minority populations. Third, the study did not account for differing levels of motivation that influence performance and adaptation. While motivation can be implied from observable behavior, a specific assessment of motivation was not conducted. High levels of motivation and drive to succeed may help to compensate for non-cognitive vulnerabilities or weaknesses and may be a contributing factor to those who self-eliminated or failed training. Objective measures assessing motivational level (internal and external rewards) for pursuing the PJ career field may also improve screening procedures. Fourth, it is unclear how much (a) the desire to self-report positive characteristics and (b) the setting of basic military training affected self-reporting. Although positive impression management on self-report measures of personality in the context of an occupational setting is not an uncommon or unusual occurrence in civilian and military organizations, it is unknown if such tendencies affected results. Fifth, unforeseen life events (e.g., injury, death of a loved one) that occur during training and interfere with performance may also, to some degree, cause those who would have otherwise graduated training to have performance problems, fail, or self-eliminate from training. Finally, an assessment of the relationships and interaction between variables is needed to further understand how areas of non-cognitive functioning interact to influence adaptation. Specifically, additional insight into the curvilinear relationship of specific variables may help to further identify why certain candidates fail but appear to have levels of specific traits that appear to enhance likelihood for success [48].

## 6.0 CONCLUSIONS

The selection of personnel for high-risk, high-demand occupations is not based on exact formulas. While human behavior is difficult to predict, evaluating both physical and psychological areas of functioning through standardized tests and procedures yields a profile of qualities that can be used to distinguish between those who are likely to fail and those who have a high probability of graduating. The current study represents an initial attempt to improve selection processes and appears to identify methodologies that may result in more effective personnel selection and training strategies. Findings appear to indicate that the tools implemented (the ASVAB and the NEO PI-3) retain an adequate level of sensitivity to identify personnel with a high probability of success in comparison to current USAF selection and classification procedures. While this study used the NEO PI-3 as a viable instrument to assess non-cognitive attributes, it is not the only tool available. Other instruments may be as likely or better able to assess these attributes; this study represents only an initial step toward understanding and improving predictive, non-cognitive indicators of successful training outcomes through neuropsychological testing.

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# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AETC** | Air Education and Training Command |
| **AIC** | Akaike information criterion |
| **ARMA** | Adaptability Rating for Military Aviation |
| **ASVAB** | Armed Services Vocational Aptitude Battery |
| **AUC** | area under the curve |
| **BA Prep** | Battlefield Airman Preparatory Course |
| **BMT** | basic military training |
| **DoD** | Department of Defense |
| **DOT** | day of training |
| **EQ-i** | Emotional Quotient Inventory |
| **HR** | hazard ratio |
| **LOOCV** | leave-one-out cross-validation |
| **LRT** | likelihood ratio test |
| **NEO PI-3** | NEO Personality Inventory – 3rd Edition |
| **PAST** | Physical Ability and Stamina Test |
| **PH** | proportional hazard |
| **PJ** | pararescue |
| **SD** | standard deviation |
| **USAF** | U.S. Air Force |