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Prediction of Air Traffic Controller Trainee Selection and Training Success Using Cognitive Ability and Biodata

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This is to certify that the doctoral dissertation by

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Walden University
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Abstract

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MBA, University of Southern California, 1995

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Organizational Psychology

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Abstract

The Federal Aviation Administration (FAA) has experienced decreased return on investment caused by hiring too many air traffic controller specialists (ATCSs) who performed poorly in field training, thus failing to become certified professional controllers (CPCs). Based on Schmidt and Hunter's theory of job performance and biodata theory, this quantitative, archival study examined whether factors of cognitive ability and biodata could predict job performance status of 2 generations of ATCSs, poststrike (PS) and next generation (NG) controllers. For each generation of controllers, binary logistic regression analysis was conducted to determine if any of the independent variables—transmuted composite (TMC) score for PS controllers, Air Traffic and Selection and Training (AT-SAT) test score for NG controllers, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status—are significant predictors of job performance status for controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training). The regression results for the PS and NG controllers were found to be statistically significant (χ^2 (23) = 68.377, $p < .001$) and (χ^2 (17) = 99.496, $p < .001$), respectively. Findings that overall high school grade point average and socioeconomic status significantly predicted ATCS job performance for both PS and NG controllers could influence the FAA's use of revised biodata to better predict ATCS job performance. Further research should include studies of socioeconomic status, gender, and race to address new evidence that the AT-SAT has adverse impact.

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Dedication

I dedicate this dissertation to my husband, Brian, who has been my biggest advocate with his unwavering belief in my ability to accomplish anything I chose to do. I thank my parents, Rosita and Dan, for their love and support, and for teaching me the values of perseverance and hard work. I also acknowledge my steadfast canine companions, Wolfgang and Star, who were by my side every day as I worked to obtain this degree.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Introduction

The Federal Aviation Administration (FAA) has experienced higher than expected attrition rates because Air Traffic Control Specialist (ATCS) candidates fail to become certified professional controllers (CPCs) because they are unable to pass the job training (OJT) programs in the field (Broach, 1992; Brown & Ghiselli, 1952; Della Rocco, Manning, & Wing, 1990; U.S. Department of Transportation Assistant Inspector General, 2011). As a United States federal agency, the FAA is responsible for ATCS candidate selection, hiring, and training. The FAA has continually faced this problem of matching and developing human capabilities to meet job requirements over the years (Ackerman & Kanfer, 1993; Barrick & Zimmerman, 2009; Broach, 1992, 2005a; Cannon & Broach, 2011; Della Rocco, 1998; Mertler & Vannatta, 2010; Schmidt & Hunter, 2004; Schmidt & Hunter, 1998).

Because the requirements for the FAA ATCS selection and training process are so competitive, the stakes are high for the FAA to hire ATCS candidates who will eventually pass the program and become CPCs (Broach, 1992, 2012; Taylor, Van Deventer, Collins, & Boone, 1983). Applicants can invest thousands of dollars in tuition for training without any guarantees of employment, and the average time to complete all field training is 2 to 3 years (D. Broach, personal communication, March 4, 2013). Using a multiple-hurdle, or two-stage, sequential selection approach, the FAA believes that measuring cognitive ability early in its selection process can help screen out potentially poor performers, thereby reducing the expenses associated with lost training and rehiring

(EiBfeldt, 2002). Trainees who fail OJT have invested 2 to 3 years in a career without any guaranteed certification to show for it (EiBfeldt, 2002). Investment costs are not only high but also depict lost opportunity, because training losses represent unfilled positions in ATC facilities (Ackerman & Kanfer, 1993).

Research that can help the FAA determine which candidates are most likely to pass all the requirements of the job is crucial for the long-term success of both the agency and the job candidates (Broach, 2012). As presented in the literature reviews of Schmidt and Hunter (1983) and Hunter, Schmidt, and Judiesch (1990), the organizational practice of hiring and selecting the controllers who can perform the job is based on the idea that large individual differences in job performance and productivity exist in all lines of work. These reviews show that the overall work efficiency of an organization is critically dependent on the extent to which the organization selects the most productive workers possible (Schmidt, Hunter, McKenzie, & Muldrow, 1979; Schmidt, Hunter, & Outerbridge, 1986).

In industrial-organizational (IO) psychology, job performance is conceivably the most influential dependent variable, which tasks researchers with developing theories of job performance (Ones & Viswesvaran, 2011; Schmidt, Ones, & Hunter, 1992; Schmidt, Shaffer, & Oh, 2008). General mental ability (GMA) is the most valid determinant of future performance and learning in jobs (Hunter & Hunter, 1984; Schmidt & Hunter, 1998). GMA test scores are more highly correlated to overall job performance than are narrower abilities, such as social ability, psychomotor ability, and physical ability (Ones & Viswesvaran, 2011).

FAA's Civil Aerospace Medical Institute (CAMI) researchers explored other assessments based on collecting biographic information, referred to as biodata, from ATCS trainees (Dean & Broach, 2012). CAMI researchers collected biodata, which included prior experience, self-reported grades in high school math, and self-reported expectations on future performance. Research has shown that self-reported grades in high school mathematics were predictive of training outcomes at the field OJT (Broach, 1992, 1998; Collins, Nye, & Manning, 1992; Devlin, Abrahams, & Edwards, 1992).

Researchers have indicated that a gap exists in the literature on empirical studies of cognitive ability on job performance (Durso & Manning, 2008; Postlethwaite, Giluk, & Schmidt, 2012). They suggested that future studies should continue to leverage the extant research on cognitive ability on job performance and focus on the construct, nature, and measure of intelligence that are relevant to the critical issues in business applications. Moreover, Scherbaum, Goldstein, Yusko, Ryan, and Hanges (2012) indicated the need for further studies on the construct of GMA in workplace job tasks.

General FAA ATCS Background

The FAA has three primary categories of hiring sources for ATCS candidates: (a) individuals with previous experience (e.g., military), (b) Air Traffic Collegiate Training Initiative (AT-CTI) students, and (c) the general public, who do not require previous experience (Aul, 1991; Broach et al., 2013; U.S. Department of Transportation Assistant Inspector General, 2012).

Types of ATCS

ATCSs work as tower controllers, radar approach/departure controllers, and en route controllers. Tower controllers work primarily from traffic control towers, facilitate the movement of planes on the runway, and provide the pilots with clearance for takeoff or landing (Durso & Manning, 2008). Radar approach/departure controllers ensure that planes traveling within an airport's airspace, which normally covers a 40-mile radius, keep a safe and minimum distance apart. Radar approach/departure controllers ensure the safe and efficient flow of airplanes arriving and departing the airport, sequence the flow of airplanes arriving and departing the airport, guide pilots during takeoff and landing, and update pilots with information on weather conditions using radar equipment to control flight paths (Bureau of Labor Statistics, 2012). While both tower controllers and radar approach/departure controllers work primarily from traffic control towers, en route controllers monitor airplanes after the planes depart the airport's airspace, and they work at any of the 21 ATC centers located throughout the United States.

Overview of FAA ATCS Selection and Training Process

ATCS training is lengthy and extensive because candidates have to meet several qualification requirements AT-CTI ATC candidates must be U.S. citizens, obtain air traffic management (ATM) degrees from an FAA certified school, achieve passing scores on the FAA pre-employment test, and be no older than age 30 (Aul, 1991). ATCSs are civil servants who follow the United States federal civil service laws and regulations. In this case, Public Law 92-297, which passed in 1971, warrants that ATCSs hired after May 16, 1972 must retire at age 56 (Broach & Schroeder, 2005).

The FAA does not extend offers of provisional positions to all ATCS candidates who pass the pre-employment tests and qualify for employment (Aul, 1991). Instead, the FAA extends tentative offers of employment based on the highest scoring individuals on down. The FAA makes final offers of employment to individuals upon completion of a medical exam, security clearance, and drug test. After individuals have accepted their offers, the FAA officially appoints and swears into the civil service those ATC candidates as temporary employees at the FAA Academy screening program in Oklahoma City, Oklahoma (Della Rocco, 1998). Although sworn into the ATCS job, ATC trainees work on a provisional basis and do not become CPCs until they successfully complete their field OJT (EiBfelt, Heil, & Broach, 2002; U.S. Department of Transportation Assistant Inspector General, 2011).

Two Generations of ATC Controllers

The FAA has had the opportunity to conduct research on the job performance of members of two generational cohorts, the Post-Strike (PS) and the Next Generation (NG), due to the illegal Professional Air Controllers Organization (PATCO) strike in 1981 (Cannon & Broach, 2011). On August 3, 1981, 10,438 ATCS who were union members went on an illegal strike against the United States federal government (Aul, 1991). Ronald Reagan, the President of the United States at the time, declared that any controllers who failed to return to work immediately would be fired; more than 11,000 of approximately 15,000 ATCS were fired after they failed to comply with the president's declaration (Broach, 2005a). The significant loss of nearly 71% of the ATCS workforce influenced how the FAA recruited, tested, screened, and trained individuals for the occupation of ATCS between 1981 and 1992 (Broach, 1998).

PS Controllers. The FAA rebuilt the workforce after the PATCO strike by hiring approximately 15,000 PS controllers who were between the ages of 18 and 30 due to the mandate that the maximum age at entry for the job of ATCS is 30-years-old (Broach, 2005a; Cannon & Broach, 2011). Hired between the years 1981 and 1992, PS controllers are predominantly members of the Baby Boomer generation, defined as individuals born during the years 1946 and 1964.

NG Controllers. According to Boys (2010), in the mid-2000s, the FAA conducted a massive effort to fill future open positions vacated by retiring PS controllers, who were mandated by law to retire by the age of 56 years (Public Law 92-2979; Broach & Schroeder, 2005). In 2005, as many PS controllers neared retirement, the FAA has been hiring NG controllers between the ages of 18 and 30. Whereas the PS controllers comprise the majority of the Baby Boomer cohort, the NG controllers are the predominant cohort of Generation Y (aka "Millennials"), which is defined as individuals born between 1982 and 2002 (Broach, 1998; Levenson, 2010). In the past 5 years, the FAA has hired more than 7,800 NG controllers, with plans to hire more than 10,000 controllers by 2020 (Cannon & Broach, 2011). Because the FAA has been collecting self-reported Biographical Questionnaire (BQ) data from both the PS and NG generations of controllers, the FAA has had the opportunity to conduct research on generational differences without the potential confounds of career and age progression (Cannon & Broach, 2011).

Stages of FAA ATCS Selection and Training

The FAA ATCS selection and training process consists of two stages of assessment and OJT (see Figure 1). The first stage of selection for PS controllers involves the pre-screening of applicants with the U.S. Office of Personnel Management (OPM) test battery (Della Rocco et al., 1990). In contrast, the NG controllers took the updated computer-administered aptitude test battery called the Air Traffic Selection and Training (AT-SAT) test. Applicants from the ATCS-CTI programs and the general public who did not possess previous controller were required to take AT-SAT as part of the application process.

The second stage of selection involves training at the FAA Academy at Oklahoma City, Oklahoma. The FAA Academy provided technical and managerial training for the aviation community including (a) developing and training of the aviation workforce; (b) planning, maintaining, and managing FAA's distance learning systems; and (c) providing a training program management and consultation services (Federal Aviation Administration, 2010). While both generations of controllers attended the FAA Academy training, they had to pass different performance programs. PS controllers had to pass the *FAA Academy Screen*, and the NG controllers had to pass a *Performance Verification* test. CAMI collected biodata from generations of new hires for research purposes at the beginning of the FAA Academy training (D. Broach, personal communication, August 27, 2012). As indicated by CAMI's past research findings, biodata display incremental validity over GMA (Taylor et al., 1983). Biodata are useful for predicting ATCS success in the following areas (Taylor et al., 1983): (a) Prior ATCS experience, (b) High school grades in math and science, (c) Self-assessment of performance potential, (d) Prior military ATC experience, and (e) Tendency to assists friends with problems.

After passing the FAA Academy training in the second stage, the controllers achieved the status of *developmental* controllers who subsequently started OJT or *field training* in a classroom at a facility. In this study, I use both the terms of OJT training and field training synonymously. Field training at a facility typically consists of a mix of classroom-based instruction, simulation-based skills building, and on-the-job training with live traffic under the extremely close supervision of a qualified ATCS instructor. Field training builds on the knowledge and skills demonstrated in the Performance Verification. Students demonstrate their command of an en route sector or terminal position before entering OJT. (D. Broach, personal communication, June 14, 2012)

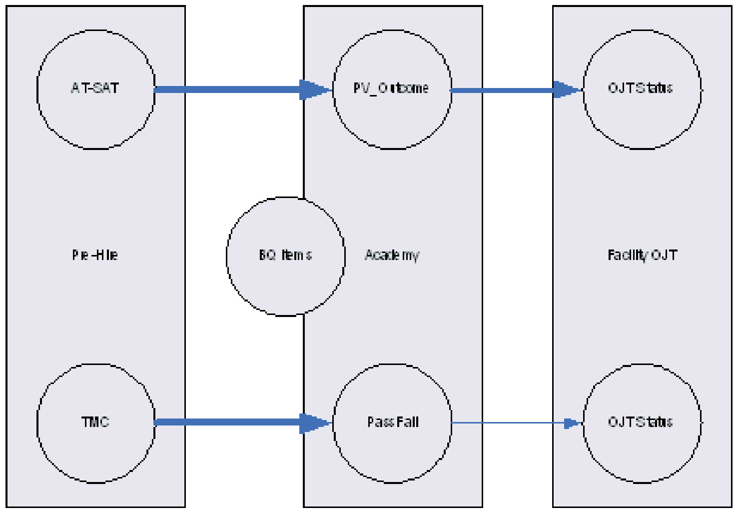

Figure 1. ATCO hiring & training for PS & NG ATC trainees. From D. Broach, personal communication, December 12, 2012.

Problem Statement

To reduce the sunk investment costs associated with the hiring and training of ATCS students who fail training, the FAA needs more useful selection and hiring criteria to increase the probability of determining which applicants will most likely pass all phases of training and become CPCs. Concurrently, researchers have attested that further studies should be conducted to keep the emphasis on empirical studies that support the application of intelligence in the workplace, instead of first delving into the development of unsubstantiated theories linking GMA to performance (Lievens & Reeve, 2012). Industrial organizational (IO) researchers identified an existing gap in the GMA literature, calling for additional studies on job performance using predictor variables related to the GMA constructs in workplace job tasks (Durso & Manning, 2008;

Postlethwaite et al., 2012). Specifically, extant research should be leveraged on the construct, nature, and measure of intelligence that are relevant to the critical issues in business applications.

Purpose of the Study

The purpose of this research was to help the FAA improve their ATCS selection and training process by identifying which factors of GMA and biodata could determine job performance status as measured by whether ATCSs would tend to pass the training requirements and become CPCs. The FAA also benefitted from the study findings that compared both generations of PS and NG controllers. Conducting this study offered not only the opportunity to enhance the extant research of the FAA (Scherbaum et al., 2012; D. Broach, personal communication, August 16, 2012), but also addressed the gap identified from IO researchers who called for additional research on job performance using predictor variables associated with GMA constructs.

Research Questions and Hypotheses

The following research questions and associated hypotheses attempted to address the research gaps that surfaced after a thorough review of the literature. The research questions and hypotheses were the same for both archival sample populations of PS and NG controllers. One key distinction was that the predictor for cognitive ability for PS controllers was the OPM transmuted composite (TMC) score, whereas the AT-SAT composite test score was the cognitive ability predictor for NG controllers. Chapters 2 and 3 discuss these tests in additional detail.

Research Question 1: PS Controllers

Can job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status? If job performance status of PS controllers as CPC can be predicted correctly, which variables are central in the prediction of that status? Does the inclusion of a particular variable increase or decrease the probability of a specific outcome? How good is the model at classifying cases for which the outcome is unknown? In other words, how many job performance statuses of PS controllers are classified correctly?

Hypothesis 1: PS Controllers

$H_0$1: Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status while growing up.

$H_1$1: Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status while growing up.

Research Question 2: NG Controllers

Can job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) be correctly predicted from AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status? If job performance status of NG controllers as CPC can be predicted correctly, which variables are central in the prediction of that status? Does the inclusion of a particular variable increase or decrease the probability of a specific outcome? How good is the model at classifying cases for which the outcome is unknown? In other words, how many job performance statuses of NG controllers are classified correctly?

Hypothesis 2: NG Controllers

$H_0 2$: Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

$H_1 2$: Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from their AT-SAT scores, average of high school arithmetic/math letter grade, overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

Research Objectives

The study sought to improve the understanding of cognitive ability and biodata factors that influenced the performance of PS and NG controllers. Although the predictor variables of cognitive ability were different for the two groups, with the OPM battery test scores used for PS controllers and AT-SAT scores used for NG controllers, the measurement between these two types of tests scores are functionally equivalent (D. Broach, personal communication, June 1, 2012). Conducting statistical analysis to understand the generational differences between PS and NG controllers has been relevant to the FAA in its ongoing quest to maximize the prediction of job performance (D. Broach, personal communication, June 1, 2012). In brief, this study helped to fill a gap in the FAA literature. Although the majority of the FAA's interest in the generational differences has been described in the human resource management trade press and corporate training, the prevailing descriptions of generational differences are anecdotal since few empirical studies are available (Cannon & Broach, 2011).

Theoretical Framework

Schmidt and Hunter's (1998) causal model GMA on job performance, hereafter known as the theory of job performance (TJP), and biodata theory (Broach, 2012; Hunter & Schmidt, 1996; Schmidt, 2002) were the two primary frameworks used in this study. Both frameworks supported the notion that GMA and biodata are predictors of job performance. Based on the application of meta-analysis in research literatures, Schmidt and Hunter's TJP has provided generalizable validity for the estimates of various constructs that predict job performance. With scant attention given to the development of a TJP, Schmidt and Hunter (1992) explained that researchers have focused almost exclusively on using weighted groups of disparate predictors to maximize job performance. Not until recently have researchers shifted their focus toward generating empirical research that underscores the understanding of how psychological processes influence job performance (Schmidt & Hunter, 1992). Furthermore, the research has provided more precise estimates than did previously available predictors such as job knowledge, personality, and GMA.

In the context of personnel selection inventories, biodata has been shown to have predictive validity across the workplace (Dean & Russell, 2005; Hunter & Hunter, 1984; Russell, 1994). Schmidt et al. (1992) intimated the need to research additional constructs that underlie biodata items for the advancement of biodata theory and practice. Fleishman (1988) proposed that the most valuable opportunities for comprehending human performance in organizations would come from investigating relationships between life experiences and job performance. Although the FAA did not use biodata as a condition for the selection and hiring of ATCSs, I included biodata because the BQ is the source of several cognitive predictor variables used in this study.

Significance of the Study

The results of this study contributed to positive social change through the enhancement of extant ATCS selection and training literature. Moreover, the study findings filled a gap in the IO psychology literature by furthering empirical research on job performance using predictors of GMA constructs. For example, the study findings could positively impact future personnel assessments and further ATCS knowledge management literature should CAMI integrate the new findings with baseline data from job analyses (Nickels, Bobko, Blair, Sands, & Tartak, 1995). Should the FAA use the study findings to help them increase their understanding of which ATCS controllers have a greater likelihood of becoming CPCs, then the FAA could ameliorate the systemic problem of incurring excessive costs caused by hiring too many controllers who fail to become CPCs. Moreover, this research design of comparing the binary logistic regression results of PS and NG controllers contributed to the FAA's understanding of ATCS generational differences.

This study furthered the IO psychology literature by addressing a gap identified by IO researchers to conduct additional empirical research on job performance using predictor variables related to GMA constructs. The principle of Hunter and Schmidt (1996) suggested that all other things being equal, higher intelligence is a better predictor of job performance for all jobs than it is for lower intelligence. In my study, I examined the archival records of ATCSs that consisted of predictors of GMA constructs and biodata. My review of biodata that included items such as self-perception of job performance ability as compared to the training class, environment raised, and socioeconomic status while growing up, could enable the FAA to predict more accurately which *developmentals* become CPCs. By improving the success of the FAA's ability to select which ATC candidates succeed in ATCS training, an increased likelihood exists for increasing the return on investment for both the organization and for candidates.

Nature of the Study

This study employed a quantitative nonexperimental design using ATCS archival data obtained from the FAA. The FAA archival data encompassed (a) PS and NG candidates' qualifying test battery scores, (b) biodata obtained from the candidates during their first week of training at the FAA Academy, and (c) field training outcomes (Broach, 2005b). Job candidates must obtain a minimum test battery score of 70 to qualify for employment. Biodata is not currently used as criteria for ATCS selection, and it is used solely for research purposes (D. Broach, personal communication, July 30, 2011). I conducted independent binary logistic regression analyses and interpretations on PS controllers and NG controllers prior to examining the results of both independent sample populations for similarities and differences. Chapter 3 details the research question and methodology.

Definitions

Air Traffic Collegiate Training Initiative (AT-CTI): As one of three ways for individuals to become ATCSs, ATCS-CTI is an FAA program in which the FAA collaborates with certified schools to provide air traffic management (ATM) degrees (Western Michigan University College of Aviation, 2011). In 2008, the ATCS-CTI comprised of 31 schools (Bureau of Labor Statistics, 2012) .

Air Traffic Control (ATC): The ATC staff serves to coordinate the movement or air traffic to ensure that planes stay a safe distance apart (Ree, Earles, & Teachout, 1994). Their primary concern is safety, but ATCO also must minimize delays by directing planes efficiently. Some controllers regulate airport traffic through designated airspaces while others regulate airport arrivals and departures.

Air Traffic Controller (ATCO) vs. *Air traffic control specialist* (ATCS): Both ATCO and ATCS refer to individuals who are in the air traffic controller occupation (Cannon & Broach, 2011). Most parts of the world, including Europe, use ATCO as the normal abbreviation; the United States uses the term ATCS to describe the controller occupation and most FAA technical reports and orders also reference ATCS (EiBfeldt, 2002). In this study, ATC controllers attain different statuses depending on which stage of training they are at (a) *hires*, *candidates,* or *students*, upon acceptance of the conditional job offer; (b) trainees or developmentals, until they complete their field OJT at their facilities first assigned; and (c) CPCs, after they have successfully passed the OJT.

Collegiate Training Initiative (ATCS-CTI): As one of three ways for individuals to become ATCS, ATCS-CTI is an aviation-related program of study. In 2008, the ATCS-CTI comprised of 31 schools (Bureau of Labor Statistics, 2012) .

Certified Professional Controller (CPC): A CPC is a controller who has completed all required training with the FAA Academy and facility. The CPC has also been certified to work independently. ATC trainees became CPC status after they pass the OJT training at their first assigned facility. Prior to this, ATC trainees are called developmentals (Federal Aviation Administration, 2005).

Civil Aerospace Medical Institute (CAMI): CAMI is an FAA organization whose mission includes applied psychological research in areas such as the selection of air traffic controllers.

Developmentals: An ATCS in any option who has not achieved certified professional controller (CPC) status in any facility/area (Federal Aviation Administration, 2005).

Human Factors: The Aerospace Human Factors Research Division at the Civil Aerospace Medical Institute, which is located at the Mike Monroney Aeronautical Center in Oklahoma City, conducts research specific to improving individual system efficiency, effectiveness, and safety. The primary focus is to improve human performance through enhanced equipment design. Other factors examined at the facility include interface design, organizational effectiveness, and validation of selection procedures (Federal Aviation Administration, 2011).

Performance Verification (PV): An explicit, formal, performance-based assessment that ensures trainees meet a uniform performance level before proceeding on to facility OJT. (D. Broach, personal communication, June 14, 2012).

Professional Air Traffic Controllers Organization (PATCO): The first national labor union for controllers created in 1966 (Shostak, 2009).

Assumptions

Assumptions for this study were the reliability and validity of the archival ATCS data for each of the PS generation and the NG generation because the FAA collected this information over a span of several decades. Dana Broach was the single point of contact to provide me with the archival data of both generations. Another assumption was that controllers answered the biodata survey truthfully and accurately.

Scope and Delimitations

Because the history of the FAA ATCS selection and training process is so massive, I covered only the relevant aspects, tasks, and procedures of the ATCS selection process in Chapter 2. The emphasis of the study focused more on the similarities than on the differences of the PS and NG controller selection processes.

Limitations

Limitations of this study consisted of the risks inherent in using archival data, biodata, restriction of range, and comparing logistic results across two generations of sample data. For example, the predictor variables and criterion variables I chose for my logistic regression analyses were limited to the data available from the BQ survey. Since my study consisted of conducting intergenerational comparisons between PS and NG sample populations, I used TMC scores for PS controllers and AT-SAT score for NG controllers. Although the test batteries were different, they were functionally similar aptitude tests. The measurement for the criterion variable of ATCS job performance had to be established based not only on how the variables were operationalized, but whether I could access similar items for both PS and NG controller sample populations.

Used for purposes of research only, biodata was not part of the selection criteria for hiring ATCSs because ATC trainees did not respond to the BQ survey until after they had been hired as controllers. Although an assumption of the study was that the ATC trainees were truthful in their responses on the BQ survey, limitations to this study included risks of using biodata such as self-report biases, self-recall biases, and incorrect responses. Another limitation of the study was restriction of range on the TMC score for PS controllers and the AT-SAT score for the NG controllers because these scores were from incumbent ATCSs and are not representative of the entire population of ATCS.

Summary

This chapter described the ATCS selection and training challenges faced by the FAA and the need to design a study that assessed the criterion of job performance with predictor variables associated with cognitive ability and biodata. Chapter 2 examines the extant literature that characterizes the role of GMA and biodata on job performance. It also discusses the fundamental supporting theories that are TJP and biodata. The literature review focuses on empirical studies leading up to the development of the TJP, as well as a review on biodata selection frameworks. Chapter 2 describes the multiple-hurdle selection and training approach used by the FAA. Furthermore, Chapter 2 justifies the predictor and criterion variables for this study. The conclusion of Chapter 2 focuses on the implication of past research on this current study.

Chapter 3 explains the research design and rationale of this study. It also characterizes the methodology including the population, sampling procedures applicable to the use of archival data, and instrumentation. Next, Chapter 3 defines the data analysis plan, states the data assumptions, formulates threats to validity, and concludes with ethical procedures. Chapter 4 describes the data collection process and reports descriptive statistics that appropriately characterize the PS and NG controller data sets. Finally, Chapter 5 interprets the findings, describes the limitations to the generalizability that arose from the execution of the study, describes recommendations for further research that are grounded in the strengths and limitations of the current study, and ensures that recommendations do not exceed the boundaries of this study.

Chapter 2: Literature Review

This study examined whether factors of cognitive ability and biodata can predict the job performance of ATC controllers as determined by passing FAA field training. Because the FAA has experienced high attrition and investment costs in the ATCS selection and training process, IO practitioners asserted that further research should be conducted on the role of GMA in job tasks for hiring and training the most promising ATC candidates (U.S. Department of Transportation Inspector General, 2011).

Because possessing a basic knowledge of the FAA ATCS process and nomenclature is essential for appreciating this research study, I describe the ATCS selection and training process at a high level. Moreover, because training ATC students to become CPCs is costly and complex, this review explains the multiple-hurdle approach used by the FAA to aid in their selection and hiring decisions (Cascio & Aguinis, 2011). Other topics addressed in this chapter include an examination of the theoretical frameworks of TJP and biodata theory, the rationale for choosing TJP, and the reasons that GMA and biodata have predictive value in determining job performance. I also characterize the relationship between the criteria of training success and degree of subsequent performance on the job. Finally, I depict how the TJP has been applied in previous research and how the current study benefits this framework.

Literature Search Strategy

The search strategy for this study consisted of using seminal, public and private government documents, scholarly peer-reviewed articles, personal communication, and books. In the initial search, I focused on the extant literature of organizational theories on GMA, biodata, and job performance between the years 2000 and the present. Over the process of reviewing in excess of 360 journal articles, I streamlined the research to include only the seminal works of researchers that related to my study. For example, when searching for information on the development of a causal model of job performance (e.g., TPJ), I delved into peer-reviewed articles from Schmidt and Hunter (1998), whose seminal work with meta-analyses led to this undeniable conclusion about this theory. I obtained the scholarly articles from the following databases: Walden University (EBSCOhost), Academic Search Premiere, ScienceDirect, Business Source Complete/Premier, ABI/INFORM Complete, PsycARTICLES, SAGEPub, ProQuest Dissertations, and Google Scholar.

The primary government data used on the ATCS selection process and training at the FAA Academy resides on the government website (http://www.faa.gov). I conducted initial keyword searches that included, but were not limited to, *air traffic controller, FAA Academy, performance, personality, cognitive ability, aptitudes, training, training performance, biodata, traits, job performance, noncognitive, training, trainee, theory, generation, g factor, intelligence, general mental ability, post-strike*, *Next Generation*, *Millennials*, and *Baby Boomers*. Then, via personal communication, I engaged with an FAA I/O psychologist who guided me to research internal government process documents, flow charts, scholarly peer-reviewed documents, technical reports, workforce planning updates, and annual strategic plans about the FAA ATCS selection and training process. The website of the Department of Transportation Inspector General (http://www.oig.dot.gov/library-item/) provided valuable information on critical status work plan updates. Finally, I obtained scholarly peer-reviewed journal articles from applied journals such as the International Journal of Applied Aviation Studies, Journal of Applied Psychology, International Journal of Aviation Studies, and Journal of Vocational Behavior.

Multiple-Hurdle Approach

The FAA ATCS hiring and training process uses a multiple-hurdle, or two-stage, sequential selection approach. Multiple-hurdle approaches are often employed in occupations when job training is arduous, complicated, expensive, or have large applicant pools that need to be filtered to a manageable pool for further assessment and evaluation (Cascio & Aguinis, 2011; Hanisch & Hulin, 1994; Mendoza, Bard, Mumford, & Ang, 2004; Reilly & Manese, 1979). Hired on a temporary basis, ATC applicants are further evaluated through additional stages until employers determine whether applicants should be given permanent placement in their jobs (Cronbach & Gleser, 1965). Ability assessments usually occur in the first stage because the acquisition cost of information obtained in the second stage is more expensive than information acquired in the first stage (Cascio & Aguinis, 2011). The ATC applicants only advance to the second stage if they attain the requisite cut-off score on the ability measures. Even though the second stage is expensive to execute, employers still benefit from reduced overall costs because the second stage consists of a smaller group of prescreened applicants than if employers had to obtain information from all of the applicants (Cascio & Aguinis, 2011).

Stages of FAA ATCS Selection System

In this section, I compared the ATCS selection and training procedures between the PS and the NG controllers at each of the three stages that comprised the process of becoming CPCs (see Figure 1).

First Stage: Pre-Screening Testing With Aptitude Test Battery

The first stage of assessment consists of pre-screening ATC applicants via the administration of a qualifying aptitude test battery (Della Rocco et al., 1990). After the PATCO strike of 1981 resulted in a dramatic decrease of the ATCS workforce, the FAA reassessed its procedures for recruiting, testing, screening, and training of individuals for the ATCS job (Broach, 1998).

During 1981 through 1992, the FAA rebuilt its critical workforce by applying human factors research findings to assess the cognitive capabilities of over 400,000 applicants in a massive testing, screening, and training program (Broach, 2005a). From this pool, the FAA hired approximately 27,925 of the highest-scoring applicants (Della Rocco, 1998). The FAA administered different but comparable test batteries in regard to the validity and reliability to PS and NG controllers. Following the PATCO strike from 1981 to 1992, the FAA used the OPM battery that consisted of three tests: the Multiplex Controller Aptitude Test (MCAT), the Abstract Reasoning Test (ABSR), and the Occupational Knowledge Test (OKT; Broach, 1998). Whereas the PS applicants took the written OPM test battery from 1981 through 1992, the NG applicants took the improved computerized AT-SAT battery from 2004 through the present (D. Broach, personal communication, August 27, 2012). In use since 1981 without any revisions, the efficacy of the OPM test became comprised after applicants started hiring private coaches for tutoring them on test-taking strategies (Ramos, 2001). The reason was that although the candidates' test scores increased, the candidates' abilities required to perform the job did not increase to a comparable level. As a result, inflated test scores rendered the OPM battery ineffective in identifying the highest qualified candidates for hire (Ramos, 2001). Since 2004, the FAA has administered the computerized AT-SAT battery to assess the AT-CI applicants and the general public (Broach et al., 2013). Chapter 3 operationalizes the OPM and AT-SAT test batteries.

Second Stage: FAA Academy Initial Qualification

Between 1981 and 1992, over 25,645 PS controllers underwent the second-stage FAA Academy screening program and successfully completed the program (Broach, 2005a; Manning, 1998). Students obtain ATC foundational knowledge at the FAA Academy, where training techniques include the use of lecture, computer-based instruction, and simulations (U.S. Department of Transportation Assistant Inspector General, 2012). Whereas the FAA administered separate qualifying test batteries in the first stage of the ATCS selection process to PS and NG controllers, the FAA used different scoring methods for determining whether PS and NG controllers passed the FAA academy initial qualification course. The PS controllers passed the FAA training if their FAA Academy Screen Score exceeded 70; the NG controllers passed if their PV verification test score exceeded 70. Chapter 3 operationalizes the scoring system for each test.

PS FAA Academy Screen. In 1976, the FAA implemented pass/fail initial qualifications for the PS controllers who underwent the FAA Academy training, and the foundation for these courses was Nonradar ATC procedures (Della Rocco, 1998). The FAA screening program previously assigned individuals to either the en route or terminal options depending on staffing requirements. Designed to evaluate the aptitude of individuals who had no prior knowledge of the ATCS occupation, these courses were comparable to a duplicate training and testing model of selection (Manning, Kegg, & Collins, 1989). Between 1981 and 1992, approximately 40% of new controllers failed or withdrew from initial training at the FAA Academy. Moreover, 20% to 40% of the candidates who passed Phase 2 failed to complete the required OJT at the first assigned field facility in Phase 3 (Della Rocco, 1998; Manning, 1998).

NG Performance Verification Screen. From 1981 through 1992, the FAA did not provide PS controllers with the option to train as either terminal controllers or en route controllers until they passed the Academy (D. Broach, personal communication, August 27, 2012). In the previous process, the FAA did not inform the controllers about whether they would become terminal controllers or en route controllers prior to their passing the FAA Academy. After 2004, however, the FAA informed the NG controllers in advance of passing the FAA Academy which path they would take. In the previous process, PS controllers passed the FAA Academy training based on their pass/fail training outcome of the FAA Academy Screen. In the revised process, NG controllers passed based on the outcome of a more cost efficient training process called the PV

Screen. In October 1996, the FAA replaced the OPM test and the Screen with a new selection instrument called the AT-SAT project (EiBfeldt, 2002).

During the second stage, the FAA administered the BQ to members of both cohorts as part of the FAA's ongoing research on the ATCS selection process (Cannon & Broach, 2011). The BQ consists of items including aspects of controllers' backgrounds such as previous aviation experience, education, life experiences, coping styles, military service, and factors influencing their choice of occupation and employer. The U.S. federal government has long been involved with the development and validation of biodata. After conducting approximately 30 years of aviation research and training, CAMI established numerous ATCS databases that store these data of the ATCSs who trained with the FAA Academy in Oklahoma City since 1981.

Field on the Job Training

After successfully completing the required curriculum at the FAA Academy in the second stage, students achieved the status of developmentals, and they reported to their assigned facility to begin facility-specific field qualification training (Barr, Brady, Koleszar, New, & Pounds, 2011). Only controllers who are CPCs have the qualifications to direct traffic at all positions of their assigned area. Furthermore, CPCs must be certified for a minimum of 6 months at their assigned site before they are qualified to become OJT instructors who teach other new controllers (U.S. Department of Transportation Assistant Inspector General, 2011). Approximately 11,000 PS controllers completed their OJT field training and became (CPCs; Broach, 2005a). More recently, the FAA officials planned to replace approximately 66% of the total ATCS workforce that was present in 2010 by hiring 10,554 ATCSs by 2020 (Jaska, Hogan, & Ziegler, n.d.).

Fundamental Theories of Job Performance

In this study, job performance is defined as the employees' initiation of scalable actions, behavior, and outcomes that contribute to organizational goals (Viswesvaran & Ones, 2000). The FAA must guarantee that new hires possess the required aptitudes to perform the ATCS job since it is critical for ensuring the safe separation of aircraft under changeable conditions. The function of job performance should be maximized because it is the most significant criterion variable used for achieving the intended goals of this study (Borman et al., 2001).

The organizational practice of hiring and selecting the best performers for the job is based on the notion that large individual differences in job performance and productivity exist in all lines of work as demonstrated by the literature reviews in Schmidt and Hunter (1983) and Hunter, Schmidt, and Judiesch (1990). A fundamental management function is to make accurate predictions about job performance in the context of personnel selection systems. Thus, theories that provide an insight into why and when applicants have the ability to perform on the job have become a primary goal within human resource management research (Dean et al., 1999).

The literature on performance prediction indicated that three selection techniques tend to rank the highest in criterion validity and predictive power across personnel selection settings: cognitive ability tests, work sample tests, and biodata (Dean, Russell, & Muchinsky, 1999). Although considerable literature exists on the development of cognitive ability (Ruth, 1990), definitive theories are absent for work sample tests and biodata (Dean et al., 1999). Nevertheless, researchers postulated that the most meaningful opportunities for furthering the understanding of human performance in organizations remain in analyzing the relationships between life experiences and job performance (Fleishman, 1988). Two prominent theoretical frameworks that are consistent with the scope of this study are (a) Schmidt and Hunter's (1998) causal model of job performance, also known as TJP, that supports the correlation between GMA and job performance, and (b) biodata theory, which has shown a positive relationship between life experiences and job performance.

Theory of Job Performance

In 1977, higher intelligence was the principal determinant of job performance, and it tended to lead to better work performance on all jobs (Schmidt & Hunter, 2009). Based on meta-analytic findings, Schmidt and Hunter (1998) presented the validity of 19 hiring procedures for predicting future job performance and training performance. Schmidt and Hunter introduced the validity of paired combinations of GMA and the 18 other selection procedures. The most salient conclusion resulting from the authors' research was that organizational managers who hired employees without previous job experience should consider GMA, CMA, or *g* as the most valid predictor of future learning and performance (Hunter & Hunter, 1984; Hunter & Schmidt, 1994; Ree & Earles, 1992; Schmidt & Hunter, 1998).

Biodata Framework

One possible way to improve on retention and identify employees who tend to stay longer is with biodata (Dickinson & Ineson, 1993). Biodata comes from two basic information sources: (a) people's past interests and experiences, and (b) people's attitudes and opinions that stem from those experiences (Dickinson & Ineson, 1993). The concept of biodata theory follows the *consistency principle*, which assumes that the best predictor of future behavior is past behavior (Owens, 1976; Wernimont & Campbell, 1968).

A compelling force for using biodata was the desire to delve into the causes of effective job performance (Mumford & Owens, 1987). Appraisals of biographical information on the training and experience of job applicants have been a foundation of civil service examinations for several decades (Gandy, Dye, & MacLane, 1994). In the history of using biodata in U.S. civil service selection programs, empirically keyed questionnaires defined biodata. The FAA first investigated the use of biodata as a selection technique for ATCSs in the 1950s (Brokaw, 1957). The perception of biodata prediction was that not only was it a plausible measurement beyond written ability tests, but it also decreased the probability of adverse impact typically observed with ability tests (Mumford & Owens, 1987).

Job Performance

This research study uses ATC trainees' ability to achieve CPCs status as the variable for measuring job performance. According to Manning and Hanson (2002), a correlation exists between performance in ATC training and performance on the job. This notion supports the traditional psychological theory of human learning (THL;

Hunter & Schmidt, 1996; Schmidt & Hunter, 2009) that suggests performance is bounded by learning (Brolyer, Thorndike, & Woodyard, 1927). Workers who have not learned how to handle different work scenarios are less likely to have the competency to respond appropriately (Brolyer et al., 1927).

Job performance is a complicated idea that can be measured by a variety of techniques (Bruskiewicz, Manning, & Mogilka, 2000). In particular, because work sample tests are effective and commensurate measures of job proficiency, Sollenberger, Stein, and Gromelski (1997) championed their use to measure job performance. Work sample tests measure an individual's skill level by obtaining samples of trainee behavior under realistic job conditions (Bruskiewicz et al., 2000). With the intent of capturing the performance of trainees, researchers developed full-scale dynamic simulations that permit trainees to manage the activities of a sample of simulated air traffic (Bruskiewicz et al., 2000). In the FAA Academy training, measuring the job performance of ATC trainees using work sample methodology is especially applicable since computer simulations enable trainees to demonstrate how they would behave realistically in practical settings.

Schmidt and Hunter (1992) indicated that knowledge and skill acquired in training consistently reproduced high correlations with job performance across a wide variety of job types. For this reason, trainees who achieve the highest scores in their qualification tests tend to be the most likely ones who achieve CPC status. In my study, I measured job performance of ATC trainees based on whether they completed field OJT because it is the qualification required for becoming CPCs.

Study findings on trainees by Oakes, Ferris, Martocchio, Buckley, and Broach (2001) found a positive correlation between some personality factors and skill acquisition, and this notion is a predictor of the level of subsequent job performance. Oakes et al. (2001) indicated that skill acquisition should be presumably correlated with the subsequent job performance of ATCSs. This concept is based on the rigorous classroom learning standards trainees must achieve to become *full performance level* (FPL) status controllers (Oakes et al., 2001). Although the certification as an FPL or CPC is functionally equivalent, certification in one facility does not transfer to another facility (D. Broach, personal communication, March 7, 2013). Oakes et al.'s (2001) findings that skill acquisition should be correlated with subsequent ATCS job performance is strengthened in that their measurement for job performance was based on whether graduates of the FAA Academy achieved full performance level (FPL) status by 1995.

Predictors of Job Performance

Considerable evidence now suggests that the two most valid predictors of job performance are cognitive ability tests and biodata instruments (Hunter & Hunter, 1984; Rothstein, Schmidt, Erwin, Owens, & Sparks, 1990). Cognitive predictors have historically been the primary means for selecting ATCSs in the United States (Dean, Russell, & Farmer, n.d.). Likewise, researchers have asserted the utility of conducting additional research on biodata**.** The use of biodata for examining the relationships between life experiences and job performance can help to foster an understanding of human performance in the organizational context (Fleishman, 1988).

General Mental Ability

GMA is linked to job-related knowledge, skill acquisition, reasoning, and judgment when performing job tasks (Changingminds.org, 2013). Because study findings have suggested that GMA has high and nearly equal predictive validity for performance in all levels of jobs in job training programs, GMA is a first-rate predictor of job-related learning (Schmidt & Hunter, 1998). Organizations that hire people based on their intelligence experience noticeable improvements in job performance that are valuable to the firm (Schmidt & Hunter, 2009). GMA is the basis of workplace competencies such as precise and effective decision-making. Aptitude tests that assess the potential of job candidates in focused areas attempt to determine possible future capability; whereas, ability tests attempt to determine current capability (Changingminds.org, 2013). Examples of aptitudes include verbal ability, numerical ability, and mechanical, and spatial ability.

Because the operationalization of GMA is dependent on the content and requirements of the job, no one operationalization of GMA as a predictor variable is universal (Ones & Viswesvaran, 2011). Nonpsychologists consider GMA as intelligence that is related to genetic potential. Psychologists consider GMA as more than that; rather, they consider individuals' GMA to be developed at the time they take an ability test (Hunter & Schmidt, 1996). IO psychologists use the term intelligence to refer to individuals' level of ability that is developed after they are into their adult years (Hunter & Schmidt, 1996). According to Scherbaum et al. (2012), an existing gap in IO research is a lack of focus on the role of GMA and its application on everyday tasks. Scherbaum et al. indicated that additional research focusing on job tasks would lead to a better understanding of how GMA manifests in the workplace.

The finding that GMA is such a critical determinant of job performance does not seem plausible because people cannot imagine a believable reason that such a strong relationship could exist (Hunter & Schmidt, 1996). It may be problematic for people to accept empirical findings if they are unable to understand why the findings are true (Hunter & Schmidt, 1994). What is more, the differences between an adequate and inadequate selection system are large enough to considerably affect the efficiency and productivity of an organization (Hunter & Schmidt, 1996). Nevertheless, GMA is not a sole predictor of job performance because narrower abilities are also relevant to other jobs. Because the predictive validity of these narrower abilities consists of more variability across jobs and has a lower average validity across jobs, the review of narrower abilities is limited in this research study (Hunter & Schmidt, 1996).

Research findings of Hunter and Hunter (1984) suggested that a compelling factor in the maintenance of high productivity in both government and private industry is the selection of individuals with high ability for their jobs. Within the hierarchy of selection methods with the highest validity and lowest application cost, GMA was shown to be the most valid predictor of job-related learning, acquisition of job-related knowledge, and performance (Schmidt & Hunter, 1998). Furthermore, causal analysis of the predictors of job performance indicates that the main effect of GMA is on the acquisition of job knowledge (Hunter & Schmidt, 1996). The TJP indicates that GMA is the most significant cause of job performance and that the relationship between GMA and performance is stable over time (Schmidt et al., 1986).

This study is based on a theory positing that GMA predicts both the occupational level attained by individuals and their subsequent performance within their elected occupation (Schmidt & Hunter, 2004). Furthermore, GMA predicts performance in training programs and job performance (Hunter, 1986; Hunter & Schmidt, 1996). The FAA benefitted from this study's results by being able to use additional analyses with which to improve their decision-making in the selection of ATC controllers.

Biodata

Biodata is a paper and pencil selection technique that makes causal inferences about an individual's personal development by associating the individual's responses to questions about typical behavior and life experiences from an earlier time (Dean & Russell, 2005 ; Mumford & Owens, 1987). Biodata techniques are a personnel selection technique because each biodata instrument is unique and does not necessarily contain the same items, use the same constructs, or score in similar ways (Dean, 2004). The items are questions typically presented in a multiple-choice format, and the biodata inventories usually underscore the magnitude or frequency of past behavior. The items are weighted to predict the criteria of interest (Dean et al., n.d.; Mumford & Owens, 1987). Past research indicated that younger individuals with higher grades in high school mathematics, prior ATC experience, self-assessments of performance in the top 90th percentile of all ATCSs, and haven taken the OPM test once rather than multiple times, were associated with an increased probability of them passing the FAA Academy Screen (Collins, Manning, & Taylor, 1984; Collins, Nye, & Manning, 1990; Taylor et al., 1983).

Biodata items may deviate in terms of controllability that refers to the degree with which individuals have or do not have control over behaviors or actions (Dean et al., n.d.). Biodata items with higher controllability include examples such as what courses a person chooses to take or which sports to play, while those that exhibit lower controllability may consist of birth order or socioeconomic status (Dean et al., n.d.). Mael (1991) theorized that all life events have the potential to influence individuals' future behavior; therefore, socioeconomic status should be an item on the biodata instrument.

Biodata is a selection method that is not only inexpensive compared to other methods of success, but also has a record of good predictive validity for the job (Hunter, 1986; Hunter & Schmidt, 1994). A selection procedure that the FAA has used historically captures biodata from controller candidates during a two-phase selection process. Numerous studies have shown that biodata measures can be highly valid predictors of criteria such as training success and performance ratings (Hough & Paullin, 1994; Hunter & Hunter, 1984; Ramsay, 2002; Stokes, Mumford, & Owens, 1994). According to Collins et al. (1990), research results of regression analyses found that that although ATC qualification tests had higher predictive validity than biodata scores, biodata yielded incremental validity, the augmentation of biodata to the GMA-related test scores significantly enhanced the predictability of passing the FAA Academy.

However, despite the tradition of using cognitive ability measures in ATCS selection and performance prediction, the use of personality measures in personnel selection is not as widespread because of the controversy about whether personality characteristics shared by high-performing ATCSs are a function of the people doing the job, a function of job characteristics, or both (EiBfelt et al., 2002). Because biodata are a method rather than a construct such as GMA, critics have questioned the materiality of comparing the incremental validities of different methods (Schmidt & Hunter, 1998). Schmidt and Hunter predicated that given the context of real world employment, such comparisons of incremental validities would still be meaningful. For instance, the FAA conducted a study and found that contrary to previous research results, the factors of average high school mathematics grades and overall high school GPA were not found to be positive predictors of ATCS training success with the training performance of ATCSs (Pierce, Broach, Bleckley, & Byrne, 2013).

Relationship Between Training Outcomes and Job Performance

GMA and biodata are valid predictors of job performance and training outcomes (Hunter & Schmidt, 1996), but in many cases it is problematic to discern clearly between the criteria of success in training and subsequent degree of job proficiency (Brown & Ghiselli, 1952). Examples of training criteria might include course grades or supervisor ratings derived from training while job proficiency might be measured by speed, amount of product produced, achievement tests, or supervisor ratings (Brown & Ghiselli, 1952). As an illustration, the training success of welders might be based on their improved performance in work sample tests; however, on the job, welders' job performance might be gauged by the ratings of supervisors (Brown & Ghiselli, 1952).

Another problem with discerning between success in training and subsequent degree of job proficiency is the scant attention paid to whether the abilities valuable in learning the requisite knowledge, abilities, and skills for the job are comparable to those that are valuable for subsequent job performance. Brown and Ghiselli's (1952) study findings suggested a low correlation between the validity of tests both in the prediction of training ability and job proficiency. In other words, a test that indicated the existence of high validity in the prediction of workers' capability to learn job skills may have little validity in the prediction of subsequent job performance. The abilities that are meaningful for learning a job may be decidedly different from those that are required to perform well on the job (Brown & Ghiselli, 1952). In short, researchers cannot be assured that using a test validated against the criteria of job proficiency can be used reliably to forecast for successful training outcomes.

Implications of Past Research on Current Study

CAMI uses the BQ as an instrument for studies other than for determining the predictive factors of cognitive ability on job performance of ATCS. In the mid-2000s when Millennials entered the workforce, anecdotes appeared in the human resources management (HRM) trade press about differences in work values and attitudes between Millennials and Baby Boomers. The HRM literature implied that factors such as job security, benefits, and pay would be less meaningful to Millennials than they would be to Baby Boomers (Cannon & Broach, 2011).

Concerned about how these anecdotal differences would affect the bifurcated FAA ATCS workforce of the PS and NG controllers, Cannon and Broach (2011) conducted a study hypothesizing that factors of job security and benefits would be less relevant to the NG controllers than to the PS controllers. The sample population for this study consisted of 13,227 PS and 955 NG controllers. Cannon and Broach used items from the BQ focusing on factors that potentially influenced the ATCS trainees' decisions in choosing the ATCS occupation. The proportions of PS and NG respondents choosing an occupational choice factor as having had considerable or very great influence were correlated with Z-tests for independent proportions (Kanji, 1999). The factors were then rank-ordered, and Spearman's rho was computed. Cannon and Broach focused on whether any considerable differences existed between the two cohorts in their occupational choice of ATCSs. While the findings did not support the hypothesis for this study, the salient finding was that newly hired NG trainees valued material factors similarly to PS trainees.

In another FAA study, researchers conducted regression analysis to determine the impact of biodemographic attributes on the success in ATCS training on 3,578 ATC trainees who entered the FAA Academy between October 1985 and September 1987 (Collins et al., 1990). Then the researchers compared the results with two previous groups of FAA Academy trainees. Study results indicated that a combination of interrelated constructs, such as the OPM test battery, age, prior academic success, self-assessment of future efficacy as an ATCS, prior ATC experience, and ATC knowledge prior to attending the FAA training, were the best predictors of performance at the FAA Academy (Collins et al., 1990).

Summary

This chapter detailed the stages of the FAA ATCS selection and training process for PS and NG controllers. I discussed the criterion variable of job performance along with predictors of job performance that included GMA and biodata. I also described the frameworks of Schmidt and Hunter's (1998) TJP and of biodata theory within the context of predicting ATCS job performance. Also explained was how both of these theoretical frameworks support the use of the predictor and criterion variables chosen for this study. Chapter 3 presents the research design, population and sample, and data analysis plan. Chapter 4 describes baseline descriptives, demographic characteristics of the sample populations, and study findings. Chapter 5 provides discussion of the findings, study implications, and recommendations for further study.

Chapter 3: Research Method

Introduction

This study filled a literature gap regarding job performance using predictor variables associated with GMA constructs. I evaluated the relationships between job performance, cognitive ability constructs, and biodata for two generations of controllers. My intent for this study was that the findings would help the FAA to reduce attrition costs. Furthermore, I hope the FAA will use the study findings to augment their ATCS selection and training process of identifying which candidates have the highest likelihood of becoming CPCs. In this chapter, I examine this study's research design and rationale, sample populations, sampling procedures, instrumentation, procedures, data analysis, and ethical considerations.

Research Design and Rationale

In this study, I employed a nonexperimental quantitative design that used a secondary cross-sectional survey. The Walden Institutional Review Board's (IRB) approval number for this study is #06-20-13-0154632 with an expiration date of June 19, 2014. Although a longitudinal study would have been preferable to a cross-sectional study, this was not possible given that the only time that ATC students responded to the BQ survey was when they entered into the FAA Academy training. A quantitative analysis was the appropriate method for this study because the sample populations for both PS and NG controllers were sizable. The rationale for using a quantitative design was to fill an existing gap in the IO literature that lacked empirical studies on job performance using constructs of cognitive ability (Durso & Manning, 2008; Postlethwaite et al., 2012).

Although logistic regression is comparable to both multiple regression and discriminant analysis, in my study, I used logistic regression because it requires fewer assumptions for testing hypotheses about relationships between a categorical dependent variable and categorical or continuous independent variables (Peng, Lee, & Ingersoll, 2002; Tabachnick & Fidell, 2007). In logistic regression, predictor variables do not have to be linearly related, normally distributed, or have equal variances within each group (Mertler & Vanatta, 2010). Job performance was the dichotomous categorical dependent variable for each generation and was denoted as OJT_PS_Group for PS controllers and OJT_NG_Group for NG controllers. Each PS and NG data set used a dichotomous dependent variable consisting of two categories: (a) *certified or still in training*, or (b) *failed certification or left training*.

This study examined seven predictor variables each for the PS and NG data sets, of which three were associated with cognitive ability and four with biodata. Cognitive ability constructs used were OPM TMC scores for PS controllers, AT-SAT scores for NG controllers, average of high school arithmetic/math letter grade, and overall high school average letter grade. Biodata constructs used were controllers' self-perception of estimated time needed to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of the neighborhood raised, and socioeconomic status while growing up.

This study merited the use of archival data due to the comprehensiveness of the FAA database and extremely large sample sizes. Moreover, the FAA database maintained and stored the records of each ATC controller who trained with the FAA Academy in the second stage of the selection process. Another key reason that I used the archival data from the FAA database was that there was no other viable way to obtain the data needed for my study (Rudestam & Newton, 2007).

Population and Sampling

Participants

The participants for this study were 11,400 PS controllers and 3,242 NG controllers. The 11,400 PS controllers who took and passed the written OPM test battery were hired between 1981 and 1992. In contrast, 3,242 NG controllers took and passed the PV were hired by the FAA between 2007 and 2009 (D. Broach, personal communication, August 27, 2012). Both generations of ATC controllers were the average age of 27 upon entry into the FAA Academy.

I obtained the controllers' archival records that were stored in the FAA's National Training Database (NTD) in Oklahoma City, Oklahoma. Then, for both PS and NG data sets, I excluded any participants with missing records for dependent and independent variables as specified by the hypotheses of this study. Although only 49% of the cases were eventually included in the binary logistic regression for each generation, the resulting sample sizes more than exceeded the size requirement for conducting this analysis. For example, Russell, Dean, and Broach (2000) indicated this point in a similar study when they applied bootstrap analyses on the archival controller data and recommended that sample sizes should be at least 175 to establish sufficient data for accurately estimating a population validity coefficient.

Procedures

As this research study encompassed the use of de-identified archival data, I did not have access to any confidential participant information. D. Broach, FAA IO psychologist, culled these data, and sent the deidentified data files to me in SPSS format via email (see Appendix A for the research agreement that I signed prior to release of the data files to me). Even though the NG controller sample population contained fewer participants than did the PS controller sample, I used all eligible PS records because having more data points for logistic regression would improve the accuracy of the model (Mertler & Vannatta, 2010).

Instrumentation

This study was conducted using archival data that consisted of self-reported BQ data of PS and NG controllers, qualification test scores, and training data. Researchers have long studied the development, psychometric characteristics, and validity of the *g*-loaded aptitude tests (Della Rocco et al., 1990; Manning, Della Rocco, & Bryant, 1989; Rock, Dailey, Ozur, Boone, & Pickrel, 1981). Research revealed that both the BQ and cognitive-based aptitude tests, which are the OPM test battery and the AT-SAT test battery, are reliable and valid instruments for predicting job performance of ATCSs (Ramos, Heil, & Manning, 2001).

Biographical Questionnaire

CAMI developed their 145-item BQ based on items from Owens' biographical questionnaire (Owens & Schoenfeldt, 1979). The datasets included selection and training scores, measures, ratings, personality traits, biographic information, and other evidence of career progression (Manning & Heil, 2001). Specifically, CAMI's BQ (Collins et al., 1990) examined the following eight content areas (see Appendix B for BQ questions):

- Educational background
- Prior experience in the job
- Importance placed on several factors such as benefits, salary, and job security
- Time expected to become an effective ATCS
- Commitment level to the job of ATCS
- Job-related attitudes
- Expected satisfaction with aspects of ATCS careers
- General personal information such as socioeconomic status growing up

Numerous meta-analyses have shown the favorable aspects of using a biodata technique, such as its predictive validity value of r = .30 - .40 or above (EiBfeldt, 2004; Hunter & Hunter, 1984; Schmitt, Gooding, Noe, & Kirsch, 1984). Consequently, I conducted this study with biodata and constructs of cognitive ability with the intent to fill the gap in the IO literature.

OPM Test Battery

The development of the OPM test battery, which was used from 1981 through 1992, enabled the FAA to make sound predictions for a sizeable number of applicants about their expected job performance (Broach, 1998). The FAA achieved its organizational goal of using this test battery to help screen and funnel a large pool of applicants down to a manageable number of candidates suitable for intensive evaluation. The OPM test battery produced reliable scores, and a composite of those scores was valid as a predictor of short-term training outcomes (Broach, 1998).

As previously discussed in Chapter 1, the OPM test battery consisted of three subtests: (a) multiple-choice aptitude test (MCAT), (b) abstract reasoning (ABSR), and (c) occupational knowledge test (OKT; see Table 1 for the scoring of the OPM test battery including the three subtests). The MCAT tested for aptitude and required candidates to identify potential conflicts between aircraft (Broach, 1998). In addition to testing candidates on how to interpret the tabular and graphical information, the MCAT tested candidates on their knowledge of solving time, speed, and distance problems. The ABSR tested candidates on their abstract reasoning skills, and the OKT was a job knowledge test that consisted of items related to aviation-related knowledge domains, ATC phraseology, and procedures (Broach, 1998).

Table 1

ATCS Aptitude Test Battery Scoring

Test	OPM #	Scoring	Weight	N Items
MCAT	510	N Right	2	110
ABSR	157	N Right - (0.25*N Wrong)	1	50
OKT	512	N Right	*	80

Note. Extra points awarded as follows for OKT raw scores: 0-51 = O extra points; From "Air Traffic Control Specialist Aptitude Testing, 1981-1992," In D. Broach (Ed.), *Recovery of the FAA Air Traffic Control Specialist Workforce, 1981-1992. (DOT/FAA/AM-98/23),* (p. 14.), by D. Broach, 1998, Washington, DC: Federal Aviation Administration. Reprinted with permission.

In regard to the OPM test battery, the computation of the TMC score was the sum of the weighted averages of the MCAT and ABSR scores. The TMC score ranged from 19.5 to 100 and determined the eligibility for selection. The FAA selected the ATC applicants who achieved a minimum rating of 90 for employment as controllers. Applicants who did not possess prior specialized ATC experience, education, or excellent academic records needed to achieve a minimum TMC of 75.1. Applicants who achieved the qualifying TMC score to pass were then awarded extra points on the basis of OKT scores as described in Table 2 (Broach, 1998). The computation of the *OPM rating* (RAT), also known as *final civil service rating*, was the sum of the TMC, extra points, and arbitrated veteran's preference points, if any. The sum of TMC, OKTPTS, and VET comprised the RAT.

Table 2

AT-SAT Battery and Eight Subtypes

Subtest	Description
Dials (DI)	Scan and interpret readings from a cluster of analog instruments
Applied Math (AM)	Solve basic math problems as applied to distance, rate, and time
Scan (SC)	Scan dynamic digital displays to detect targets that regularly change
Angles (AN)	Determine the angle of intersecting lines
Letter Factory (LF)	Participate in an interactive dynamic exercise that requires categorization skills, decision making, prioritization, working memory (incidental learning), and situation awareness
Air Traffic Scenarios (ATST)	Control traffic in interactive, dynamic low-fidelity simulations of air traffic situations requiring prioritization
Analogies (AY)	Solve verbal and nonverbal analogies that require working memory and the ability to conceptualize relationships
Experience Questionnaire (EQ)	Respond to Likert scale questionnaire about life experiences

Note. From "Operational Use of the Air Traffic Selection and Training Battery," by R. E. King, C. A. Manning, & G. K. Drechsler, *(DOT/FAA/AM-07/14)*, p. 2. Copyright 2007 by the FAA. Reprinted with permission.

Test-retest reliability calculates the variation to which individuals obtain nearly the same test score when they retake the same test at another time. The test-retest correlation for the MCAT was assessed at .60 in a sample of 617 new ATC hires (Broach, 1998; Rock et al., 1981). Parallel forms method appraises the variation to which individuals with obtain nearly the same score on alternate tests that are equivalent in content, response processes, and characteristics. The parallel forms reliability calculated on the same sample ranged from .42 to .89 for assorted combinations of items (Rock et al., 1981). According to Ghiselli, Campbell, and Zedeck (1981) internal consistency calculates the degree to which test items are equivalent. Lilienthal and Pettyjohn (1981) evaluated internal consistency and item difficulties for 10 versions of the MCAT (Broach, 1998). Cronbach's alpha for the 10 accounts ranged from .63 to .93, and the alphas for 70% of the accounts were greater than .80 (Broach, 1998). The extant data for the MCAT have shown satisfactory reliability; however, research has shown that the MCAT was vulnerable to the effects of practice.

In contrast, the FAA has not reported any test-retest, parallel forms, or internal consistency calculations of the ABSR test (Broach, 1998). As a result, the measurement properties of the ABSR do not indicate any conclusions. Published data exist for the OKT (Broach, 1998): (a) parallel forms reliability ranged from .88 to .91 (Rock et al., 1981), (b) internal consistency estimate of reliability was .95 (Kuder & Richardson, 1937), and (c) Lilienthal and Pettyjohn (1981) chronicled Cronbach alphas for 10 accounts ranging from .85 to .94 on a sample of nearly 2,000 FAA Academy ATC students. Although no estimates of reliability for test-retest estimates of reliability were published, the extant data indicated that the OKT has satisfactory reliability.

AT-SAT

The intent of the AT-SAT is to predict the likelihood of success in ATC training and on the job (King, Parker, Mouzakis, Fletcher, & Fitzgerald, 2007). The AT-SAT battery test is a computerized test battery that consists of eight subtests based on 22 individual scores that are weighted, combined, and then totaled for a single overall score. As exhibited in Table 2, the AT-SAT is composed of the following eight subtests: Dials

(DI), Applied Math (AM), Scan (SC), Angles (AN), Letter Factory (LF), Air Traffic Scenarios Test (ATST), Analogies (AY), and Experience Questionnaire (EQ; King, Manning, & Drechsler, 2007). All but seven of the eight AT-SAT subtests assess cognitive ability; the EQ test assesses personal history and personality issues (King, Manning, et al., 2007).

The AT-SAT score is computed by summing the weighted average of each subtest to yield the maximum validity as indicated by job tasks (King, Manning, et al., 2007). Next, the absolute value of the resulting score is truncated to yield a maximum score of 100 (King, Manning, et al., 2007). Applicants are then sorted into one of three categories based on their AT-SAT score. Those with scores of less than 70 are categorized as *not qualified* and removed from consideration. Applicants with scores of 70 to 84.99 are categorized as *qualified,* and those with scores of 85 to 100 are categorized as *well qualified*. Veteran's preference is applied within the category in accordance with civil service rules. FAA considers Well Qualified candidates for employment first. Wise, Tsacoumis, Waugh, Puktka, and Hom (2001) addressed the potential issue of adverse impact by reweighting the subtests and adjusting the overall constant to mitigate potential group differences. In a later study, Dattel and King (2010) found that this effort achieved its goal of mitigating group differences that could affect adverse impact.

In sum, the FAA developed the initial AT-SAT test battery after review of trial tests, studies, and careful consideration of the professional judgment and experiences of a team of testing experts (Quartetti, Kiechaefer, & Houston, 2001). The evolution and validation of the AT-SAT played a significant function in reducing the costs of attrition from ATC training (King, Manning, et al., 2007). Multiple linear regression analysis conducted by the FAA found that the AT-SAT battery has equivalent, if not better, predictive validity than did the OPM test selection procedure (Waugh, 2001). As a valid selection test, the AT-SAT ensures that hired individuals have the GMA to develop the appropriate knowledge and skills of ATC controllers; the AT-SAT is not a test of ATC knowledge.

Data Analysis Plan

This study employed binary logistical regression analysis to find a parsimonious and best fitting model that described the relationship between a dichotomous categorical variable and a set of predictor variables (Hosmer, Lemeshow, & Sturdivant, 2013). Although the goal of conducting logistic regression analysis is similar to that of other regression models, I chose to use logistic regression because the criterion variable was dichotomous as well as categorical. A logistic regression model was the most appropriate tool for me to use because predictor variables can be either categorical, continuous, or a mix of both in one model (Pallant, 2013), and the majority of my independent variables was categorical.

PS controllers' TMC test scores, NG controllers' AT-SAT test scores, average high school grades, and average high school math grades were predictors of cognitive ability. The grouping variable of job performance was measured by a dichotomous generic outcome variable that was coded into (a) those controllers who passed the FAA field training or are still in training, and (b) those who failed the FAA field training or who left training (D. Broach, personal communication, August 23, 2012). The biodata factors encompassed the controllers' self-report responses to survey questions about the (a) projected time it takes to become fully effective in the ATCS role, (b) percentile ranking in the FAA program relative to the class, (c) relative size of the neighborhood in which they were raised, and (d) socioeconomic status while growing up.

Binary logistic regression was conducted for each independent sample population: PS controllers and NG controllers. I compared the results of both logistic regression models to assess whether patterns existed in determining whether ATCS trainees pass the FAA field training and become CPCs or fail out of the program. In the analysis with PS controllers, the dependent variable of OJT_PS_Group was coded as a dichotomous variable with two groups: Group 1 = *certified or still in training*; Group 2 = *did not certify or left training* at the first assigned field facility. Similarly, with NG controllers, the dependent variable of OJT_NG_Group was coded as a dichotomous variable with two groups: Group 1 = *certified or still in training*; Group 2 = *did not certify or left training* at the first assigned field facility (See Table 3 for the descriptive statistics associated with each hypothesis).

Table 3

Descriptive Statistics Associated With Each Hypothesis

Hypothesis /Generation	DV Name	IV Name	Equation	Variable Type
H1: PS Controllers				
	TMC score		TMC = weighted average (MCAT + ABSR)	Quantitative
	OJT_PS_Group*		OJT_PS_Group = □(TMC, BQ)	Categorical
H2: NG Controllers				
	AT-SAT score		OJT_NG_Group = □(AT-SAT score, BQ)	Quantitative
	OJT_NG_Group**			Categorical
H1 and H2: PS and NG Controllers				
		BQ6***		Categorical
		BQ9***		Categorical
		BQ111***		Categorical
		BQ112***		Categorical
		BQ130***		Categorical
		BQ131***		Categorical

Note.*Refer to Appendix B to cross-reference the variable name with BQ items.
**Refer to Appendix C to cross-reference the variable name with BQ items.
***Refer to both Appendix B and Appendix C to cross-reference the variable name with BQ items.

Hypotheses

Hypothesis 1: PS Controllers

$H_0$1: Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

$H_1$1: Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

Hypothesis 2: NG Controllers

$H_0$2: Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

$H_1 2$: Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from their AT-SAT scores, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

Data Assumptions

In this study, data assumptions were are follows:

1. The ratio of the number of cases to independent variables was reviewed because problems can occur when too few cases relative to the number of independent variables comprise the data (Tabachnick & Fidell, 2007).
2. Logistic regression relies on a goodness-of-fit test for assessing the fit of the model to the data (Tabachnick & Fidell, 2007). I checked for any cells with expected frequencies that are too small that could yield an analysis with too little power.
3. Logistic regression is sensitive to multicollinearity, so I checked for high intercorrelations among independent variables (Pallant, 2013).
4. I reviewed the outliers on predictor variables because subsequent logistic regression models are especially sensitive to extreme values. Because it is

possible for a case in one outcome category to show a high probability for belonging in another category, several cases like this produce a very poor fitting model (Tabachnick & Fidell, 2007).

5. Although similar to discriminant analysis, logistic regression does not make any assumptions of linearity, normality, or requirements of equal variances within each group (Tabachnick & Fidell, 2007).

Threats to Validity

Threats to the validity for this study include restriction of range, difficulty in measurement of the criterion variable, and inability to confirm the biodata items. Prior to becoming CPCs, ATCSs were screened on test scores based either on the OPM test battery for PS controllers or the AT-SAT for NG controllers (Bayless, 2001). As a result, the PS and NG sample populations in this study contain only the records of those ATC controllers who were the highest performers. Due to range restriction, the results of the binary logistic regression underestimated what would have been the actual validity had the sample populations consisted of all ATC candidates and not just incumbents.

Although the ATCS job is complex and potentially problematic to capture in a criterion development effort, the FAA intended to establish criteria measures that would provide an overall representation of ATCS job performance (Borman et al., 2001). Job performance success was measured by the ATC trainees' successful completion of both the FAA Academy training and at the first facility (Pierce et al., 2013) . However, a threat to the validity of job performance success or failure could include the level of complexity specific to a facility at the field OJT, which could ultimately influence the rates of success (Pierce et al., 2013).

Another threat to validity was the inability to confirm the veracity of biodata factors, especially for high school arithmetic/math average letter grade or overall high school average grade. Although these variables are g-related, they could have been vulnerable to recall bias resulting from self-report bias and school-related variation in grading methods (D. Broach, personal communication, August 27, 2012).

Ethical Procedures

In exchange for obtaining the archival data from the FAA, I agreed to a set of conditions. I would protect the data from inadvertent disclosure; include a standard disclaimer that opinions of the researcher are not the opinions of CAMI, the FAA, or the U.S. government; allow CAMI contacts to review the finished dissertation for factual errors, and provide CAMI with a library copy of the completed dissertation. Furthermore, I agreed to provide a copy of the IRB compliance to CAMI as required by Walden University with a signed copy of the research agreement (See Appendix B for a copy of the research agreement).

Summary

A nonexperimental quantitative survey design using archival data was chosen to fill the gap in the IO literature and to determine predictors of the job performance of ATCSs using constructs of cognitive ability and biodata. I provided a high-level, historical review of the FAA ATCS selection processes for two generations of controllers. I also covered the research design, research questions, and restated the hypotheses. Then, I discussed the participants, instrumentation, and data collection method. Finally, I delineated the statistical software, data analysis plan, and threats to validity. Chapter 4 reports the baseline descriptive statistics and demographic characteristics of the sample populations, states the statistical assumptions for binary logistic regression, and presents the results of the analyses. Chapter 5 provides a discussion of the findings, study limitations, and offers recommendations for further study.

Chapter 4: Results

Introduction

The purpose of this study was to answer the research questions for both PS and NG controllers by determining if any of the independent variables (OPM TMC score for PS controllers, AT-SAT score for NG controllers, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status) are significant predictors of job performance status for controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training). In addition, I attempted to determine if job performance status of PS and NG controllers as CPC can be predicted correctly, and if so, which variables are central in the prediction of that status? Does the inclusion of a particular variable increase or decrease the probability of a specific outcome? How good are the models at classifying cases for which the outcome is unknown? In other words, how many job performance statuses of PS and NG controllers are classified correctly?

In this chapter, I report the demographic characteristics and descriptive statistics of the samples. Then, I address the statistical assumptions associated with conducting binary logistic regression such as checking for multivariate normality, reviewing homogeneity of dispersion, addressing missing data, and examining outliers. Finally, I present the results before concluding the chapter with a summary of the findings.

Data Collection

As described in Chapter 3, I received archival data files in SPSS format containing records for 11,400 PS controllers and 3,242 NG controllers via email from Dana Broach an external FAA research partner. These deidentified data files consisted of the qualifying test scores, BQ survey response, and training outcomes of the PS and NG controllers who entered the FAA Academy in Oklahoma City, Oklahoma. Both PS and NG data survey samples highly represented their referent populations. For example, the PS controller sample of 11,400 cases represented 100% of the larger population of interest defined as those controllers who attended the FAA academy Nonradar Screen between October 1984 and January 1992. Similarly, the NG controller sample of 3,424 cases represented approximately 94% of the total referent population of 3,465 controllers who had a requirement to take the AT-SAT battery during their hiring process (D. Broach, personal communication, August 27, 2013).

Demographic Characteristics of Samples

Although not evaluated in the hypotheses of this study, I compared the demographic variables of sex and race between PS and NG controller sample populations. The ratio of males to females was the same for both PS and NG controller sample populations. The PS controller sample population (see Table 4) consisted of 9,384 males (82.3%) and 2,016 females (17.7%); the NG controller sample population consisted of 1,191 males (82.8%) and 248 females (17.2%).

See Table 4 for the racial composition of the PS controller sample population in which 10,156 White controllers (91.4%) overwhelmingly dominated all other ethnic groups: 72 American Indian/Alaskan Natives (.6%), 160 Asians (1.4%), 383 Blacks (3.4%), and 343 Hispanics (3.1%). Note that the racial composition of NG controllers represented more diverse ethnic groups than did the PS controller sample population, with five ethnic groups representing PS controllers compared to the six ethnic groups representing NG controllers. The racial composition of the NG controller sample population consisted of 13 Native American/ Alaskan Natives (.9%), 38 Asians (2.8%), 135 Blacks (9.8%), 60 Hispanics (4.4%) and 1039 Whites (75.6%), and 89 Multi-racials (6.5%).

Table 4

Representative Sample of Sex and Race of PS and NG Controllers

Generation	Sex/Race		*n*	%
PS Controllers	Sex			
		Male	9384	82.3
		Female	2016	17.7
	Race			
		American Indian/Alaskan Native	72	.6
		Asian	160	1.4
		Black	383	3.4
		Hispanic	343	3.1
		White	10156	91.4
	Sex			
NG Controllers		Male	1191	82.8
		Female	248	17.2
	Race			
		Native American/Alaskan Native	13	.9
		Asian	38	2.8
		Black	135	9.8
		Hispanic	60	4.4
		White	1039	75.6
		Multi-racial	89	6.5

Note. The race variable is labeled differently for PS and NG controllers because it was defined this way in the BQ survey raw data. PS controllers = American Indian/Alaskan. Native and NG controllers = Native American/Alaskan Native.

Classified by sex and race, the PS controller sample population (see Figure 2) consisted of 8,374 White males (75%) and 1,782 White females (16%). The remaining participants of the sample population comprised 61 American Indian males (1%), 127 Asian males (1%), 287 Black males (3%), 293 Hispanic White males (3%), 11 American

Indian females (0%), 33 Asian females (0%), 96 Black females (1%), and 50 Hispanic White females (0%).

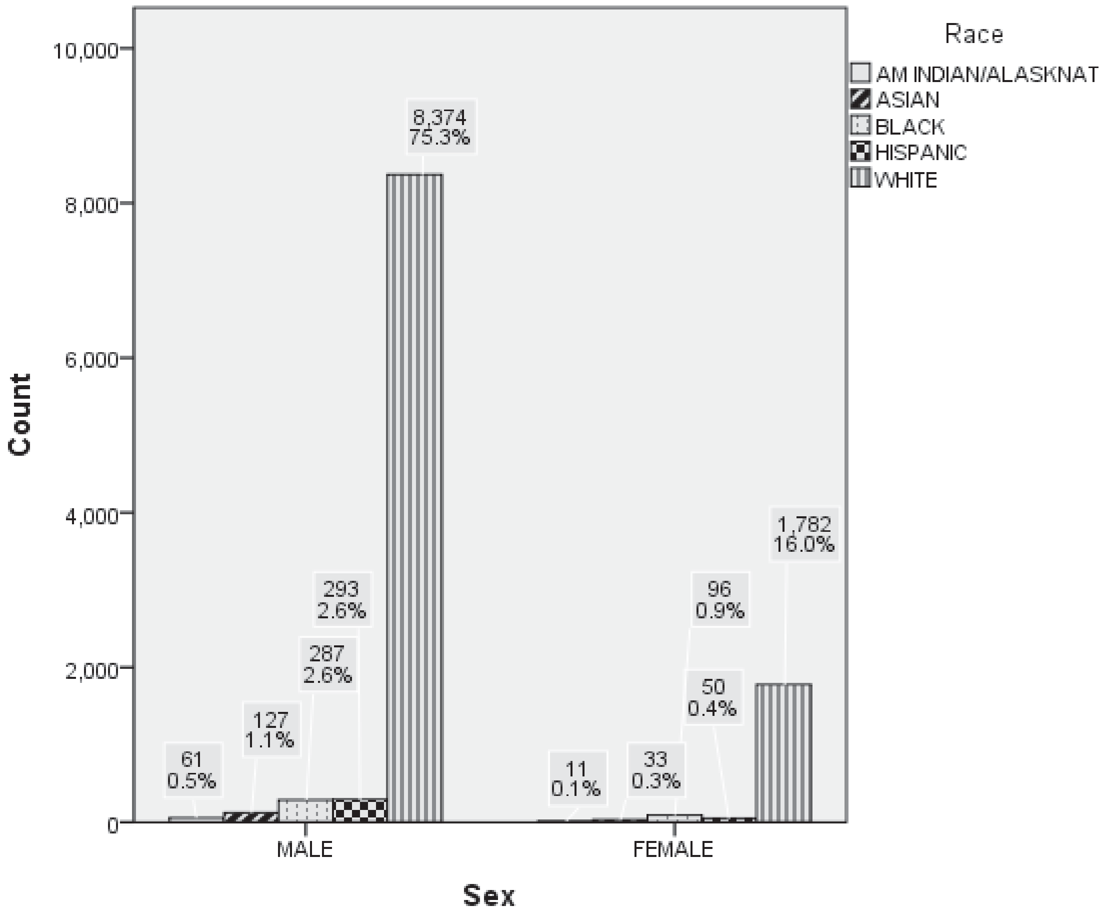

Figure 2. Percentage and count of PS controllers by sex and race

When classified by sex and race, the distributions of the NG and PS controller sample populations were similar in that White males and White females comprised the majority of each sample population. For example, the NG controller sample population (see Figure 3) consisted of 856 White males (63%) and 164 White females (12%). The remaining participants in the NG sample population comprised nine American Indian males (1%), 29 Asian males (2%), 98 Black males (7%), 52 Hispanic White males (4%), 75 Multi-racial males (6%), four Native American-Alaskan Native females (0%), seven Asian females (1%), 37 Black females (2.7%), and eight Hispanic White females (1%), and 12 Multi-racial females (1%).

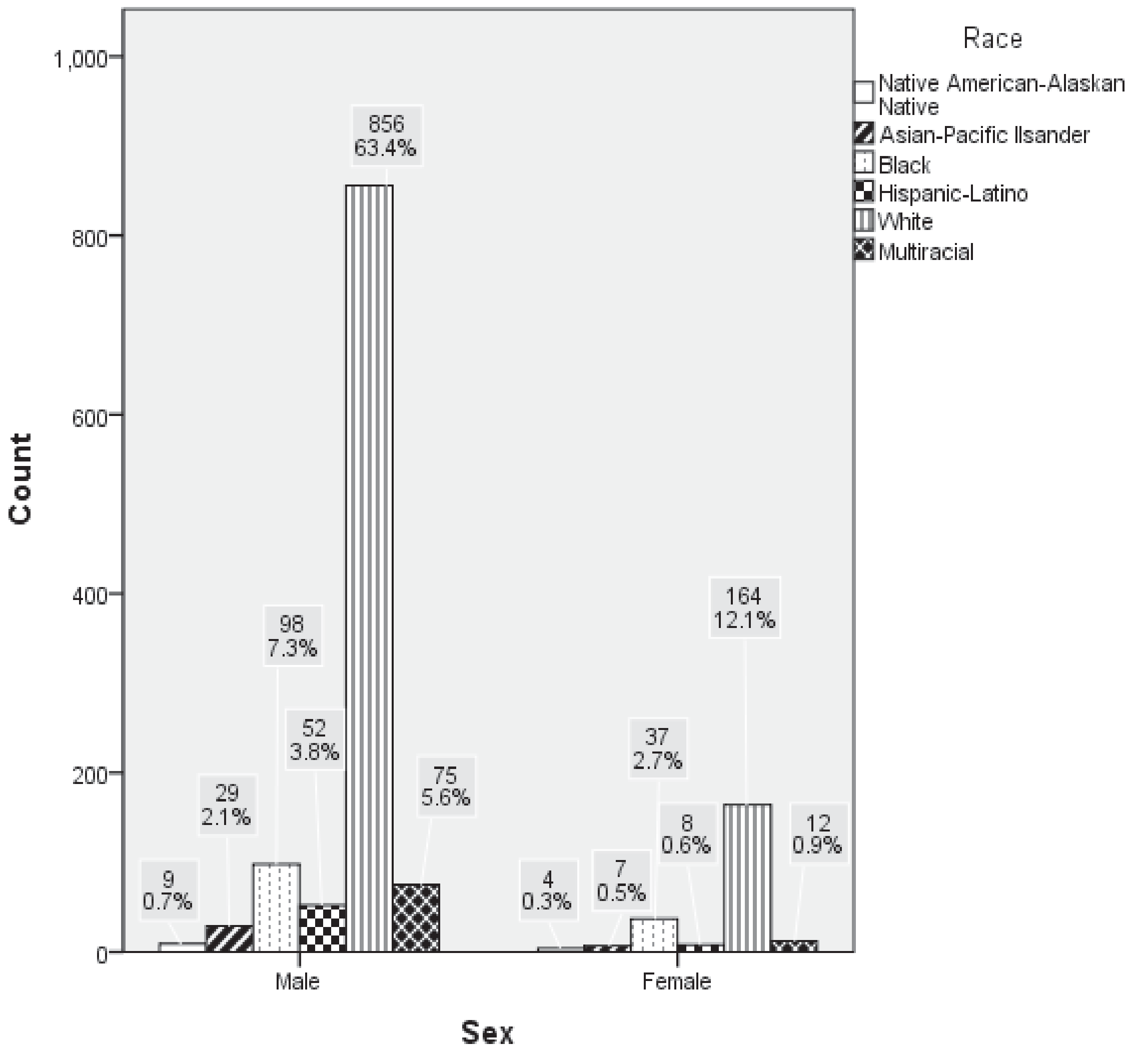

Figure 3. Percentage and count of NG controllers by sex and race

Descriptive Statistics of Logistic Regression Variables

The dichotomous outcome variables of OJT_PS_Group for the PS data set and OJT_NG_Group for the NG data set measured job performance of ATCSs based on whether individuals failed certification or left training, or are certified or still in training. The PS controller sample population consisted of 955 individuals (16.4%) who failed certification or left training and 4,855 individuals (83.6%) who are certified or still in training. In contrast, the NG controller sample population consisted of 307 individuals (10.5%) who failed certification or left training and 2,618 individuals (89.5%) who are certified or are still in training.

Table 5

Representative Samples of PS Controllers (N = 5,810) and NG Controllers (N = 2,925) by Failed Certification or Left Training vs. Certified or Still in Training

ATCS Generation	*N*	*%*
OJT_PS_Group Failed vs. Passed		
Failed certification or left training	955	16.4
Passed certification or still in training	4855	83.6
OJT_NG_Group Failed vs. Passed		
Failed certification or left training	307	10.5
Passed certification or still in training	2618	89.5

BQ Survey Categorical Predictor Variables

Average high school arithmetic/math letter grades average is one of the six categorical predictor items on the BQ survey. See Table 6 for the PS controller sample population that consisted of 135 individuals (1.2%) who obtained average high school arithmetic/math letter grades lower than C-, 1,827 individuals (16.7%) who obtained grades between C- and C+, 5,068 individuals (46.3%) who obtained grades between B- and B+, and 3,927 individuals (35.8%) who obtained grades between A- and A+. The NG controller sample population consisted of 88 individuals (9.7%) who obtained average high school arithmetic/math letter grades between C- and C+, 273 individuals (30.0%) who obtained grades between B- and B+, 273 individuals (30.0%) who obtained grades between B- and B+, and 549 individuals (60.3%) who obtained grades between A- and A+.

Table 6

Representative Samples of PS Controllers (N = 10,957) and NG Controllers (N = 910) by Average High School Math Letter Grade

ATCS Generation	*N*	%
PS average high school math letter grade		
Lower than C-	135	1.2
C- to C+	1827	16.7
B- to B+	5068	46.3
A- to A+	3927	35.8
NG average high school math letter grade		
About C- to C+	88	9.7
About B- to B+	273	30.0
About A- to A+	549	60.3

Overall high school average letter grade is another categorical predictor on the BQ survey. See Table 7 for the PS controller sample population that consisted of 109 individuals (1.0%) who obtained average high school arithmetic/math letter grades lower than C-, 2,103 individuals (19.2%) who obtained grades between C- and C+, 6400 individuals (58.4%) who obtained grades between B- and B+, and 2,341 individuals (21.4%) who obtained grades between A- and A+. The NG controller sample population consisted of 76 individuals (8.2%) who obtained average high school arithmetic/math letter grades between C- and C+, 393 individuals (42.3%) who obtained grades between B- and B+, and 461 individuals (49.6%) who obtained grades between A- and A+. Interestingly, NG controllers received a higher percentage of high school average letter grades between A- and A+ (49.6%) than did PS controllers (21.4%).

Table 7

Representative Samples of PS controllers (N = 10,953) and NG Controllers (N = 930) by High School Average Letter Grade

ATCS Generation	*N*	%
PS high school average letter grade		
Lower than C-	109	1.0
C- to C+	2103	19.2
B- to B+	6400	58.4
A- to A+	2341	21.4
NG high school average letter grade		
About C- to C+	76	8.2
About B- to B+	393	42.3
About A- to A+	461	49.6

See Table 8 for the variable of self-estimation of time to become fully effective in the ATCS role for the PS controller sample population that consisted of 163 individuals (1.5%) who responded that they would take much longer than most others, 384 individuals (3.5%) would take somewhat longer than most others, 4,179 individuals

(38.1%) would take the average amount of time as most others, 5,168 individuals (47.1%) would take a little less time than most others, and 1,076 individuals (9.8%) would take much less time than most others. In contrast, self-estimation of time to become fully effective in the ATCS role for the NG controller sample population consisted of 24 individuals (2.4%) who responded that they would take somewhat longer than most others, 315 individuals (32.1%) would take about as long as most others as others, 498 individuals (50.8%) would take a little less time than most others, and 144 individuals (14.7%) would take much less time than most others.

Table 8

Representative Samples of PS Controllers (N = 10,970) and NG Controllers (N = 981) by Self-estimation of Time to Become Fully Effective in the ATCS Role

ATCS Generation	*N*	%
PS estimated time to become fully effective		
Much longer	163	1.5
Somewhat longer	384	3.5
Average	4179	38.1
Little Less	5168	47.1
Much less	1076	9.8
NG estimated time to become fully effective		
Somewhat longer than most others	24	2.4
About as long as most others	315	32.1
A little less time than most others	498	50.8
Much less time than most others	144	14.7

See Table 9 for the variable of self-estimation of percentile ranking in the FAA program relative to the class for the PS controller sample population that consisted of 10 individuals (.1%) who responded that would rank in the lowest 10%, 22 individuals (.2%) would rank at the lower half, 734 individuals (6.7%) would rank at about the average level; 5,991 individuals (54.6%) would rank in the upper half, and 4,213 individuals (38.4%) would rank in the top percent. In contrast, self-estimation of percentile ranking in the FAA program relative to the class for the NG controller sample population consisted of 47 individuals (4.8%) who responded that would rank at about the 50% or average level, 501 individuals (51.1%) would rank at the upper half, and 432 individuals (44.1%) would rank in the top 10%.

Table 9

Representative Samples of PS Controllers (N = 10, 975) and NG Controllers (N = 980) by Self-estimation of Percentile Ranking in the FAA Program Relative to the Class

ATCS Generation	*N*	%
PS self-estimation of percentile ranking		
Lowest 10%	10	.1
Lower half	22	.2
Average	734	6.7
Upper half	5991	54.6
Top 10%	4218	38.4
NG self-estimation of percentile ranking		
At about the 50% or average level	47	4.8
In the upper half	501	51.1
In the top 10%	432	44.1

Another BQ survey item stem asked controllers in what size neighborhood they were raised when growing up (see Table 10). The PS controller sample population consisted of 1,455 individuals (13.3%) who responded that they were raised in a rural area, 2,408 individuals (22%) were raised in a small town, 3,825 individuals (34.9%) were raised a suburb, 1,687 individuals (15.4%) were raised in a city of less than 500,000 inhabitants, and 1,576 individuals (14.4%) were raised in a city of greater than 500,000 inhabitants. In contrast, the NG controller sample population consisted of 85 individuals (8.7%) who responded that they were raised in a rural area, 214 individuals (22%) were raised in a small town; 415 individuals (42.6%) were raised in a suburb of a large city; 98 individuals (10.1%) were raised in a city of less than 500,000 inhabitants, and 162 individuals (16.6%) were raised in a city of greater than 500,000 inhabitants.

Table 10

Representative Samples of PS Controllers (10,951) and NG Controllers (N = 974) by Size of Neighborhood Raised

ATCS Generation	*N*	%
PS size of neighborhood raised		
Rural	1455	13.3
Small town	2408	22.0
Suburb	3825	34.9
City of <500K	1687	15.4
City of >500K	1576	14.4
NG size of neighborhood raised		
In a rural area	85	8.7
In a small town	214	22.0
In a suburb of a large city	415	42.6
In a city of < 500K inhabitants	98	10.1
In a city of > 500K inhabitants	162	16.6

Socioeconomic status while growing up was the final categorical predictor on the BQ survey for this study (see Table 11). The PS controller sample population consisted of 378 individuals (3.5%) who responded that they were lower class, 1,953 individuals (17.8%) were lower middle class, 5,691 individuals (51.9%) were middle class, 2,799 individuals (25.5%) were upper middle class, and 134 individuals (1.2%) were upper class. On the other hand, the NG controller sample population consisted of 44 individuals (4.5%) who responded that they were lower class, 143 individuals (14.7%) were lower middle class, 449 individuals (46.1%) were middle class, and 339 individuals (34.8%) were upper middle class.

Table 11

Representative Samples of PS Controllers (N = 10,955) and NG Controllers (N = 975) by Socioeconomic Status

ATCS Generation	*N*	%
PS socioeconomic status		
Lower	378	3.5
Lower middle	1953	17.8
Middle	5691	51.9
Upper middle	2799	25.5
Upper	134	1.2
NG socioeconomic status		
Lower	44	4.5
Lower middle	143	14.7
Middle	449	46.1
Upper middle	339	34.8

Cognitive-based Quantitative Predictor Variables

In addition to the six categorical predictor variables for each hypothesis for the PS and NG controller sample populations, each sample population had a seventh quantitative predictor variable for each hypothesis that was based on cognitive ability, which was TMC score for PS controllers and AT-SAT score for NG controllers (see Table 12). Although the OPM test battery and AT-SAT tests were different but functionally equivalent, the test results of PS and NG controllers had similar means and standard deviations as evidenced by the 10,864 PS controllers who attained TMC scores (M = 91.46, SD = 5.02) and those 1,935 NG controllers who attained AT-SAT scores (M = 90.78, SD = 6.72).

Table 12

Representative Samples of PS Controllers and NG Controllers by Cognitive-based Predictor Variable

Generation	Cognitive-based IV	*N*	*M*	*SD*
PS Controllers	TMC score	10,864	91.463	5.0163
NG Controllers	AT-SAT score	1,935	90.784	6.7200

Evidence of Quality

According to Mertler and Vannatta (2010), logistic regression assumptions consist of ensuring the adequacy of sample size, reviewing data for multicollinearity, and reviewing the presence of extreme outliers. Prior to running the binary logistic regression analyses for both PS and NG data sets, I performed any necessary transformations, screened for acceptable sample sizes, checked for missing data, deleted outliers, and resolved issues of multicollinearity.

Transformations

As part of the prescreening process, I made two types of transformations in both PS and NG controller data sets. First, I recoded the categories of any predictor variable with the values of *Other*, *Skip this item (routing)*, *Skip this item (user)*, and *Missing system* into the *Missing system* category. Second, to create a dichotomous dependent variable for each data set, I recoded the variable of OJT_Status for PS controllers and OJT_Status for NG controllers into OJT_PS_Group and OJT_NG_Group, respectively. The categories within OJT_PS_Group and OJT_NG_Group were (0 = Certified or stayed in training; 1 = Failed certification or left training).

Sample Size and Missing Data

Of the archival data sets for the PS (*N* = 11,400) and NG (*N* = 3,242) sample populations, the valid numbers of selected cases included in the logistic regression analyses were 5,243 PS controllers (46%) and 789 NG controllers (24%). I chose to use the *exclude casewise* procedure that resulted in the deletion of any cases with even one missing value in any variables used in the analysis. Even though the number of missing cases was large for both PS and NG sample populations, the remaining sample sizes more than met the preferred case-to-variable ratios of 20 to 1 for simultaneous logistic regression as indicated by Hosmer et al. (2013). According to Peng et al. (2002), based on the logistic regression literature, the general rule suggested a minimum ratio of 10 observations to one predictor variables with a minimum sample size of 100. Consequently, I considered the study findings for both PS and NG data sets to be stable because the number of valid cases exceeded this recommendation. As for missing data, I dealt with values of less than 20 in the independent variable categories by combining categories; otherwise, the logistic regression output contained numerical errors in the form of large standard errors.

Outliers and Multicollinearity

For the PS and NG data sets, I determined the outliers using Mahalanobis's distances calculated on each data set's continuous independent variable, which was *TMC Score* for PS controllers and *AT-SAT Score* for NG controllers. Because extreme values are sensitive to the fit of a logistic regression model (Tabachnick & Fidell, 2007), cases that exceeded the critical χ^{2} of 10.828 ($p < .001$, $df = 1$) were deleted from the analyses. After reviewing the findings of both data sets, I determined that the multicollinearity was not violated because the collinearity statistics of tolerance exceeded the 0.1 cutoff and the variance inflation factor (VIF) value was less than 10 (Mertler & Vannatta, 2010). After performing binary logistic regression in SPSS for both PS and NG data sets, I also deleted any outlier cases with a standardized residual larger than 3.0 or smaller than -3.0.

Binary Logistic Regression Results

To determine whether the findings for this study supported the hypotheses of the PS and NG controllers, I evaluated the results based on multiple indicators: (a) significance tests between the alternative model and the null model, (b) statistical tests of the individual predictors to the outcome variable, (c) Goodness-of-fit tests, and (d) predictive power of the model (Peng et al., 2002). In this section, I restate the PS null and alternative hypothesis prior to presenting the findings. Similarly, I then restate the NG null and alternative hypothesis before describing the results.

PS Controllers Restatement of Hypothesis

Null hypothesis. Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

Alternative hypothesis. Job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

PS Controller Findings

A direct binary logistic regression analysis using SPSS was performed on job performance status as the dichotomous criterion variable and seven predictors: OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of the neighborhood raised, and socioeconomic status. A test of the full model chi-square was statistically significant, (χ^2 (23) = 68.377, p < .001) that indicated the combination of predictors reliably distinguished between PS controllers who failed certification or left training and those who were certified or stayed in training (see Table 13 for the statistics of overall model fit). The model as a whole explained between 1.3% (Cox and Snell R square) and 2.2% (Nagelkerke R squared) of the variance in ATCS job performance.

Table 13

Statistics for Overall Model Fit of the PS Controller Data

Tests	χ^2	*df*	*p*
Omnibus Tests of Model Coefficients	68.377	23	.000
Likelihood Ratio test	4448.426		
Hosmer-Lemeshow Goodness-of-fit test	40.296	8	.000

Note. Cox & Snell R^2 = 1.3%. Nagelkerke R^2 = 2.2%. Regression results indicated that the overall fit of the model was good (-2 Log Likelihood = 4448.426). The model displayed improvement as evidenced by a reduction in the -2 Log Likelihood of 68.38 from the initial -2 Log Likelihood of 4516.802.

Goodness-of-fit statistics evaluate the fit of a logistic model against actual outcomes. The Hosmer-Lemeshow Goodness of Fit Test indicated a poor fit (χ^2 (8) = 40.296, p < .001) because a poor-fitting model will have a significance value that is less than .05 (Peng et al., 2002). The model correctly classified 84.5% of the cases (see Table 14).

Table 14

Observed and Predicted Frequencies for OJT_PS_Group by Logistic Regression with the Cutoff of 0.50

		Predicted		
		OJT_PS_Group Fail vs. Pass		% Correct
Observed		0 Failed certification or left training	1 Certified or still in training	
OJT_PS_Group Fail vs. Pass	0 Failed certification or left training	0	811	0
	1 Certified or still in training	0	4432	100.0
Overall % Correct				84.5

Note. Sensitivity = 4432/ (0+4432) = 100%. Specificity = 0/ (0+811) = 0. False Positive = 811/ (811+4432) = 15.5%. False Negative = 0/ (0+0) = 0.

Statistically significant PS predictor variables. As depicted in Table 15, four of the seven independent variables contained categories that made a unique statistically significant contribution to the model (average high school math letter grade, overall high school average letter grade, size of neighborhood raised mostly growing up, and socioeconomic status when growing up).

Table 15

Logistic Regression Predicting Likelihood of Becoming Certified or Staying in Training

Predictor	β	SE	Wald	*p*	Odds ratio
Constant	2.353	1.647	2.041	.153	10.517
TMC	-.006	.008	.486	.486	.994
Average high school math letter grade					
C- to C+	-1.606	.748	4.608	.032	.201
B- to B+	-1.633	.747	4.782	.029	.195
A- to A+	-1.818	.750	5.875	.015	.162
Overall high school average letter grade					
C- to C+	.629	.417	2.278	.131	1.875
B- to B+	.995	.416	5.715	.017	2.704
A- to A+	.956	.426	5.040	.025	2.600
Time you need to become fully effective					
Somewhat longer	-.088	.354	.062	.804	.916
Average	.268	.298	.809	.368	1.308
Little Less	.297	.295	1.012	.314	1.346
Much less	.334	.314	1.126	.289	1.396
Percentage you will be able to perform					
Lower half	.079	1.468	.003	.957	1.082
Average	.110	1.247	.008	.930	1.116
Upper half	.123	1.236	.010	.921	1.131
Top 10%	.272	1.236	.049	.826	1.313
Live most while you were growing up (Size of neighborhood raised)?					
Small town	-.538	.143	14.147	.000	.584
Suburb	-.363	.138	6.910	.009	.696
City of < 500K	-.409	.154	7.033	.008	.664
City of > 500K	-.371	.160	5.391	.020	.690
Economic status while you were growing up?					
Lower middle	.740	.201	13.586	.000	2.096
Middle	.500	.184	7.427	.006	1.649
Upper middle	.788	.195	16.239	.000	2.198
Upper	.590	.408	2.092	.148	1.804

$^{*}p < .05$.

Average high school math letter grade. For the variable of average high school math letter grade, the odds of passing certification or staying in training were only .162 times as likely for respondents who received *A- to A+* than for those who received *Lower than C-,* .195 times as likely for respondents who received *B- to B+* than for those who received *Lower than C-*, and .201 times as likely for respondents who received *A- to A+* than for those who received *Lower than C-*.

Overall high school average letter grade. In regard to the variable of overall high school math letter grade, the odds of passing certification or staying in training were 2.600 times more likely for respondents who received *A- to A+* than for those who received *Lower than C-* and 2.704 times more likely for respondents who received *B- to B+* than for those who received *Lower than C-*.

Neighborhood raised mostly while growing up. For the variable of neighborhood raised mostly while growing up, the odds of passing certification or staying in training were only .584 times as likely for respondents who grew up mostly in small towns than for those who grew up mostly in a rural area, .696 times as likely for respondents who grew up mostly in the suburbs than for those who grew up mostly in a rural area, .664 times as likely for respondents who grew up mostly in cities with less than 500,000 inhabitants than for those who grew up mostly in a rural area, and .690 times as likely for respondents who grew up mostly in cities with more than 500,000 inhabitants than for those who grew up mostly in a rural area.

Socioeconomic status while growing up. For the variable of socioeconomic status, the odds of passing certification or staying in training were 2.096 times more likely for respondents who grew up with a lower middle class socioeconomic status than for those who grew up with a lower class socioeconomic status, 1.649 times more likely for respondents who grew up with a middle class socioeconomic status than for those who grew up with a lower class socioeconomic status, 2.198 times more likely for respondents who grew up with an upper middle class socioeconomic status than for those who grew up with a lower class socioeconomic status, and 1.804 times more likely for respondents who grew up with an upper class socioeconomic status than for those who grew up with a lower class socioeconomic status.

Evaluations of the PS controller logistic regression model. I found a statistically significant overall relationship between the combination of independent variables and the dependent variable (χ^2 (23) = 68.377, $p < .001$), so there is evidence to reject the null hypothesis. However, the model was limited in its usefulness because the null model had already correctly classifed 84.5% of the cases.

NG Controllers Restatement of the Hypothesis

Null hypothesis. Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) cannot be correctly predicted from AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

Alternate hypothesis. Job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) can be correctly predicted from their AT-SAT scores, average of high school arithmetic/math letter grade, overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status when growing up.

NG Controller Findings

A direct binary logistic regression analysis using SPSS was performed on job performance status as the dichotomous criterion variable and seven predictors: AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, and socioeconomic status. A test of the full model chi-square was statistically significant (χ^2 (17) = 99.496, $p < .001$), which suggested that the combination of predictors reliably distinguished between the job performance status of NG controllers (see Table 16 for the statistics of overall model fit). The model as a whole explained between 12.5% (Cox and Snell R square) and 55.2% (Nagelkerke R squared) of the variance in ATCS job performance.

Table 16

Statistics for Overall Model Fit of the NG Controller Data

Tests	χ^2	*df*	*p*
Omnibus Tests of Model Coefficients	99.496	17	.000
Likelihood Ratio test	91.970		
Hosmer-Lemeshow Goodness-of-fit test	1.988	8	.981

Note. Cox & Snell R^2 = 12.5%. Nagelkerke R^2 = 55.2%. Regression results indicated that the overall fit of the model was good (-2 Log Likelihood = 91.970). The model displayed improvement as evidenced by a reduction in the -2 Log Likelihood of 99.50 from the initial -2 Log Likelihood of 191.466.

The Hosmer-Lemeshow Goodness of Fit Test had a nonsignificant value of (χ^2 (8) = 1.988, p = .981), indicating that the model was a good fit against the data. The model correctly classified 97.6% of the cases (see Table 17).

Table 17

Observed and Predicted Frequencies for OJT_NG_Group by Logistic Regression with the Cutoff of 0.50

Observed		Predicted		
		OJT_NG_Group Fail vs. Pass		% Correct
		0 Failed certification or left training	1 Certified or still in training	
OJT_NG_Group Fail vs. Pass	0 Failed certification or left training	6	15	28.6
	1 Certified or still in training	3	724	99.6
Overall % Correct				97.6

Note. Sensitivity = 724/ (3+724) =99.9%. Specificity = 6/ (6+15) = 28.6%. False Positive = 15/ (15+724) = 2%. False Negative = 3/ (3+6) = 33%.

After running the first logistic regression analysis with the NG controller data set, I detected standard errors of coefficients for the Wald statistic that exceeded the value of 2, which suggested the presence of numerical problems (University of Texas, n.d.). I identified the numerical problems for the variables of overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, and socioeconomic status when growing up. To resolve this issue, I combined and recoded in SPSS the category values for any predictor variables with categories containing values less than 20, removed any outliers that exceeded the absolute value of two, and reran the logistic regression analysis.

Statistically significant NG predictor variables. As depicted in Table 18, six of the seven independent variables contained categories that made a unique statistically significant contribution to the model (AT-SAT score, overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, and socioeconomic status when growing up).

AT-SAT score. The probability of the Wald statistic for the variable of AT-SAT score, which was the sole independent variable pertaining to GMA constructs, was .013. Thus, the null hypothesis that the b coefficient for AT-SAT score was equal to zero was rejected. The odds ratio was 1.142, which indicated that a one unit increase in AT-SAT score increased the odds that the NG controllers would become certified or stay in training.

Overall high school average letter grade. In regard to the variable of overall high school average letter grade, the odds of passing certification or staying in training were 317.344 times greater for respondents who received *A- to A+* than for those who received *C- to C+* and 14.094 times greater for respondents who received *B-to B+* than for those who received *C- to C+*.

Time to become fully effective in the ATCS role. For the variable of time to become fully effective in the ATCS role, the odds of passing certification or staying in training were 26.582 times greater for respondents with much less time than most others than for those who responded with somewhat longer than most others, 27.300 times greater for those who responded with a little less time than most others than for those who responded with somewhat longer than most others, and 6.934 times greater for those individuals who responded with about as much time as most others than for those who responded with somewhat longer than most others.

Table 18

Logistic Regression Predicting Likelihood of Becoming Certified or Staying in Training

Predictor	β	SE	Wald	*p*	Odds ratio
Constant	-19.049	5.232	13.257	.000	.000
ATSAT Score	.133	.053	6.196	.013	1.142
Average high school math letter grade					
B- to B+	.642	.849	.571	.450	1.900
A- to A+	-.146	.955	.023	.878	.864
Overall high school average letter grade					
B- to B+	2.646	.835	10.033	.002	14.094
A- to A+	5.760	1.574	13.385	.000	317.344
Time you need to become fully effective					
Average	1.936	.917	4.456	.035	6.934
Little Less	3.307	1.085	9.287	.002	27.300
Much less	3.280	1.458	5.062	.024	26.582
Percentage you will be able to perform					
Upper half	2.336	.920	6.447	.011	10.341
Top 10%	.964	.929	1.077	.299	2.622
Live most while you were growing up (Size of neighborhood raised)?					
Small town	2.506	1.239	4.088	.043	12.252
Suburb	.393	.979	.161	.688	1.481
City of < 500K	2.245	1.747	1.651	.199	9.436
City of > 500K	1.347	1.104	1.490	.222	3.848
Economic status while you were growing up?					
Lower middle	4.038	1.311	9.485	.002	56.733
Middle	3.393	.864	15.428	.000	29.765
Upper middle	5.673	1.259	20.291	.000	290.817

*$p < .05$.

Percentile ranking in the FAA program relative to the class. For the variable of percentile ranking in the FAA program relative to the class, the odds of passing certification or staying in training were 10.341 times more likely for respondents who thought they would rank in the upper half of the class than for those who responded they would rank at about the 50% or average level.

Neighborhood raised mostly while growing up. For the variable of neighborhood raised mostly while growing up, the odds of passing certification or staying in training were 12.252 times more likely for respondents who they grew up mostly in small towns than for those who grew up mostly in rural areas.

Socioeconomic status while growing up. For the variable of socioeconomic status, the odds of passing certification or staying in training were 290.817 times more likely for respondents who grew up in an upper middle class socioeconomic status than for those who grew up in a lower class socioeconomic status, 29.765 times more likely for those who grew up with a middle class socioeconomic status than those who grew up in a lower class socioeconomic status, and 56.733 times more likely for respondents who grew up with a lower middle class socioeconomic status than for those who grew up with a lower class socioeconomic status.

Evaluations of the NG controller logistic regression model. I found a statistically significant overall relationship between the combination of independent variables and the dependent variable (χ^2 (17) = 99.496, $p < .001$), so there is evidence to reject the null hypothesis. However, the model was limited in its usefulness because the null model had already correctly classifed 97.2% of the cases.

Summary

The findings of this study for PS controllers support my decision to reject the null hypothesis that was indicated by observing that the logistic regression model was statistically significant (χ^2 (23) = 68.377, $p < .001$). Moreover, individual independent variables of average high school math letter grade, overall high school average letter grade, size of neighborhood raised mostly growing up, and socioeconomic status were statistically significant predictors of job performance. Despite this, the usefulness of the model was limited and and the Hosmer-Lemeshow goodness-of-fit test indicated a poor fit (χ^2 (8) = 40.296, $p < .001$).

The findings of this study for NG controllers support my decision to reject the null hypothesis that was indicated by observing that the logistic regression model was statistically significant (χ^2 (17) = 99.496, $p < .001$). The independent variables of AT-SAT score, overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, and socioeconomic status made significant contributions to the model. Despite this, the usefulness of the model was limited and the Hosmer-Lemeshow goodness-of-fit test revealed a poor fit (χ^2 (8) = 1.988, $p = .981$).

Chapter 5 summarizes the key findings for both PS and NG controllers. Then, I explain the findings and conclusions that materialized from the study by comparing them to the peer-reviewed literature described in Chapter 2. I also describe the limitations of the study and suggest recommendations for action and further study.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this research study was to extend the knowledge base of the FAA ATCS selection and training process by determining whether factors of GMA and biodata could predict job performance success or failure. Success referred to those ATC controllers who became certified or stayed in training; failure referred to those ATC controllers who failed certification or left training. With the intent of augmenting the FAA's knowledge based on generational differences, I conducted independent binary logistic regressions using FAA CAMI archival data from the BQ survey that comprised aptitude test scores and training data for each PS and NG sample population. The opinions expressed in this section are those of mine alone and do not necessarily reflect the official policies of the FAA, the U.S. Department of Transportation, or United States government. Furthermore, this study filled a gap in the IO literature that had a dearth of empirical studies on job performance using constructs based on GMA (Durso & Manning, 2008; Outtz & Hanges, 2013; Postlethwaite et al., 2012).

Chapter 5 restates the PS and NG research questions, summarizes the key findings, and discusses the findings within the context of theoretical frameworks and extant research as described in Chapter 2. Then, I describe the limitations and implications of this study within the context of recent FAA research. I conclude the chapter with suggested recommendations for action and further study.

Discussion and Interpretation of the Findings

As mentioned in Chapter 2, the theoretical frameworks of Schmidt and Hunter's (1988) TJP and biodata theory that associated GMA and biodata as predictors of job performance (Hunter & Schmidt, 1996) informed the research questions for this study.

PS Controllers

The first research question pertained to PS controllers: Can job performance status of PS controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) be correctly predicted from OPM TMC score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status?

For PS controllers, I rejected the null hypothesis for Hypothesis 1 based on the regression result indicating that the overall model fit of four predictor variables (average high school math letter grade, overall high school average letter grade, size of neighborhood raised, and socioeconomic status) was statistically reliable in distinguishing between job performance status ($\chi 2$ (23) = 68.377, $p < .001$). Three predictors (TMC score, self-assessment of estimated time to become fully effective in ATCS role, and self-assessment of percentage ranking relative to the class) did not add value to the model. However, the model was limited in its usefulness because the null model had already correctly classifed 97.2% of the cases.

Based on cognitive ability, TMC score was not found to be a significant predictor of job performance status. A possible reason is that OPM test became impractical after it continued to be used without any necessary revisions (Ramos, 2001). ATC candidates began taking courses in test-taking strategies, and while these courses may have improved the ATC candidates' OPM test scores, it also lead to decreased construct validity of the OPM test. Consequently, the FAA was unable to feasibly identify which candidates were the most qualified to hire because higher test scores did not compensate for the candidates' lack of competencies that were required to complete the training (Ramos, 2001).

A review of Chapter 2 indicated that, for the most part, preliminary research based on the BQ survey found that the biodata items of previous ATC experience, average high school grades in mathematics, overall high school grade point average, age, previous military experience, and self-assessment of ATCS performance potential were the most useful for predicting air traffic controller success (Collins et al., 1984; Collins et al., 1990). Moreover, Collins et al. (1990) found that the most consistent predictor of success was average high school math grades. A recent study by Pierce et al. (2013), however, found that previous ATC experience, average high school grades in mathematics, overall high school grade point average, age, previous military experience, and self-assessment of ATCS performance potential indicated that average high school math grades did not predict training success. Pierce et al.'s findings were unexpected, but at least their results were not the only ones contrary to those found in the literature.

The findings in my study for average high school math letter grade were a surprise not only because this variable did not predict job performance success, but also average high school math letter grade was a significant predictor of job performance failure for PS controllers. Still, overall high school average letter grade was found to be a significant predictor of job performance success, which is compatible with the conclusions found in the peer-reviewed literature described in Chapter 2 (Hough & Paullin, 1994; Hunter & Hunter, 1984; Ramsay, 2002; Stokes et al., 1994).

Self-assessment of estimated time to become fully effective in ATCS role and self-assessment of percentage ranking relative to the class were not significant predictors of job performance status. These results were not consistent with those found in previous research suggesting that overall average personal performance expectations predicted job performance (Collins et al., 1990).

Size of neighborhood raised was found to be a significant predictor of job performance status in another unexpected finding. This finding was surprising because ATC trainees who lived in rural areas were more likely to become certified or stay in training than were those ATC trainees who lived in towns and cities with a larger population of inhabitants. Moreover, socioeconomic status was found to be such a significant predictor of job performance success for both PS and NG controllers that I expected rural areas and high socioeconomic status would be inversely correlated.

This is the first empirical research study that examined socioeconomic status within the context of BQ survey items such as training outcomes and aptitude test scores (D. Broach, personal communication, December 19, 2013). As previously mentioned and consistent with past research, socioeconomic status was positively related to job performance success for both PS and NG controllers. Gough (1946) found that socioeconomic status has a small positive relationship to academic achievement, whereas Roberts, Kuncel, Shiner, Caspi, and Goldberg (2007) concluded that personality traits predict occupational attainment better than does socioeconomic status. Furthermore, this finding lends credibility as to the generalizability of the findings because according to Roberts et al. (2007), studies of socioeconomic status and cognitive abilities usually included exceptionally large samples.

NG Controllers

The second research question pertained to NG controllers: Can job performance status of NG controllers as measured by whether they pass the field OJT (i.e., certified or still in training, or failed certification or left training) be correctly predicted from AT-SAT score, average of high school arithmetic/math letter grade, overall high school average letter grade, self-estimation of time to become fully effective in the ATCS role, self-estimation of percentile ranking in the FAA program relative to the class, size of neighborhood raised, or socioeconomic status?

As previously noted, I rejected the null hypothesis for Hypothesis 2 because the regression results indicated that the overall model fit of six predictors (AT-SAT score, overall high school average letter grade, self-assessment of estimated time to become fully effective in the ATCS role, self-assessment of percentile ranking in the FAA program relative to the class, size of neighborhood raised, and socioeconomic status) was statistically reliable in distinguishing between job performance status ($\chi 2$ (17) = 99.496, p

< .001). However, the model was limited in its usefulness because the null model had already correctly classifed 97.2% of the cases.

Consistent with the TPJ and biodata theories in Chapter 2, AT-SAT score for NG controllers was found to be a significant predictor of job performance success. Hunter (1986) asserted that cognitive ability is a predictor of job performance mostly because it predicts learning and mastery of jobs. Given that learning on the job is vital to job performance, and GMA predicts learning, Hunter logically assumed that GMA is the main predictor of job performance (Hunter, 1986). Pierce, Bleckley, and Crayton (2013) conducted a study to assess the utility of the AT-SAT in the CTI hiring process and found that those ATC candidates who were classified as Well-Qualified trainees performed better in training than those ATC candidates who were only classified as Qualified. Thus, finding that AT-SAT score was a predictor of successful ATCS job performance in this study confirmed the results in the FAA literature. The reason that AT-SAT score, and not TMC score for PS controllers, was a significant predictor to the successful job performance was probably because hierarchical regression analysis found that AT-SAT was a valid predictor of average job performance ratings (Dean & Broach, 2012). Moreover, the AT-SAT was found to have equal or better predictive validity than the OPM battery and Nonradar screen process as indicated in the extant literature (Manning & Heil, 2001).

Average high school math letter grade was not a significant predictor of job performance status for NG controllers. Past research described in Chapter 2 indicated that self-reported high school mathematics grades were significantly related to performance at the FAA Academy and in field OJT (Broach, 1992; Collins et al., 1992; Taylor et al., 1983). More recent research, however, found that average high school mathematics grades and overall high school GPA were not positive predictors of ATCS training success (Pierce et al., 2013). As previously discussed, the finding that no relationship existed between average high school math letter grade and job performance status for NG controllers was not so unusual given the mixed results from past research.

Despite the findings that average high school math letter grade did not contribute to job performance status as expected, overall high school average letter grade was found to be a significant predictor of job performance status for both PS and NG controllers. This finding confirmed the major themes in the literature suggesting that GMA was the most valid predictor of job-related learning, obtainment of job-related knowledge, and performance from job-related learning and knowledge (Hunter & Hunter, 1984; Schmidt & Hunter, 1998). Furthermore, this result was compatible with Schmidt and Hunter's (2009) TJP that suggested higher intelligence is not only the most influential determinant of job performance but also has a propensity to lead to increased work performance across all jobs.

Contrary to the PS findings that showed no evidence of any relationships between self-assessment of estimated time to become fully effective in the ATCS role and self-assessment of percentage ranking relative to the class, a review of the regression model for NG controllers revealed that these two BQ items significantly predicted job performance success. This finding confirmed past research indicating that self-assessment of ATCS performance potential was one of the most useful biodata items for predicting air traffic controller success (Collins et al., 1990). It is important to note that care should be taken when evaluating the usefulness of self-efficacy in selecting applications (Ackerman & Kanfer, 1993). For instance, a possible reason why these two constructs made such significant contributions to job performance status could be that respondents “faked good” on these measures in an attempt to provide answers they perceived were favorable to instructors.

Although the size of neighborhood raised was a significant predictor of job performance failure for PS controllers, the regression model results for NG controllers found that size of neighborhood raised significantly predicted job performance success. Further studies could determine the correlation between size of neighborhood raised and socioeconomic status using other methods and analysis.

As previously described, socioeconomic status was found to be a significant predictor of job performance success for PS and NG controllers. Because these findings were consistent for both generations, this confirmed the biodata research in Chapter 2 that suggested biodata as a predictor of ATCS job performance had merit (Dean & Broach, 2012). Further studies should be conducted on socioeconomic status within the context of ATCS training performance, training outcomes, aptitude scores, and gender.

Limitations of the Study

Limitations to this study included the use of archival data and biodata that may have attenuated the validity and the generalizability of the findings. The research design was bounded by the use of archival data because I could only use the predictor variables that were already available. For example, the GMA-based constructs of TMC score for

PS controllers and AT-SAT score for NG controllers were derived from different but functionally similar tests. Restriction of range on the GMA-based constructs of TMC score for PS controllers and AT-SAT score for NG controllers was an impediment to the generalizability of the findings because ATC trainees who responded to the BQ survey had already been hired by the FAA based on high test scores. Moreover, biodata items are not part of the criteria for ATCS selection and hiring process but instead are used for research purposes.

Despite assumptions to the contrary, inherent risks of using biodata in this study are that respondents did not answer the BQ survey truthfully as a result of recall bias, self-report bias, "planned faking," and incorrect responses (Dean & Broach, 2012; Stokes et al., 1994). It is possible that controllers responded to the BQ survey according to their preconceived notions of how they thought their FAA superiors wanted them to respond (Dean & Broach, 2012). The lack of operationalization of BQ items could also have resulted in incorrect responses. As an illustration, respondents may not have known how to answer which socioeconomic status they grew up in for what someone considered middle class could be perceived by someone else as upper middle class. Even *g*-related biodata items such as average high school math letter grade or overall high school average letter grade could have been vulnerable to recall bias resulting from self-report bias and school-related variation in grading methods (D. Broach, personal communication, August 27, 2012).

Implications

Besides supplementing findings in extant FAA literature, this study offers new empirical information to IO practitioners and FAA CAMI researchers by comparing the influence of constructs of GMA and biodata on ATCS job performance status of two generations of controllers. This research also identified the BQ item of socioeconomic status as a predictor of ATCS job performance along with more traditionally studied items such as aptitude scores, g-related constructs of average high school grade point averages, training performance outcomes, and self-estimate of performance potential.

The FAA has been tasked with recent initiatives that have catapulted the need for this study. Specifically, the FAA Administrator commissioned a series of Barrier Analysis Reports (BARs) completed on May 2013 that identified and analyzed potential barriers of equal employment opportunities within the ATCS Centralized Hiring Process (Outtz & Hanges, 2013). The BARs indicated that the AT-SAT has adverse impact and is consequently a barrier to the achievement of equal employment opportunity (D. Broach, personal communication, December 19, 2013). The FAA should extend the finding of this study that socioeconomic status is a significant predictor of ATCS job performance, along with gender and race, in their ongoing research efforts to address the recommendations of the BARS.

Another recent event that has spurred the FAA to conduct additional studies of biodata as a predictor of ATCS selection occurred in 2011 when the FAA Administrator established an Independent Review Panel (IRP) to advise the FAA on recommended practices for improving the selection, training, and placement of ATCSs (Barr et al., 2011). Since the IRP recommended that the FAA incorporate several biodata factors into its selection and hiring process, the findings of this study can offer important insights as to the role of socioeconomic status and overall high school average letter grade in future studies.

Although this study produced a few mixed results, the findings that overall high school average letter grade and socioeconomic status were significant predictors of ATCS job performance success for both generations of controllers lend credence to its generalizability, which is consistent with the frameworks of TJP and biodata theory. Further dissemination to the IO research community could occur via publication of this research study.

Recommendations for Action and Further Study

Because Pierce et al.'s (2013) study found that contrary to expected results, several biodata factors did not predict ATCS training success, the FAA recommended that a new biodata instrument be developed that would be able to evaluate and identify the appropriate skills for the prediction of job performance success for future groups of controllers. The findings of this study indicating that socioeconomic status and overall high school average letter grades were significant predictors of ATCS job performance for both PS and NG controllers is of particular interest to the FAA researchers. The reason is that it is consistent with past research indicating that biodata is a valid predictor of ATCS training performance.

The findings of this study could inform future FAA research studies. As past FAA research on biodata factors on ATCS job performance has not examined the relationship between socioeconomic status and other traditional measures of biodata, FAA CAMI should conduct additional studies that include socioeconomic status along with gender and race in their ongoing research efforts to address the BARs findings that the AT-SAT had evidence of adverse impact. Based on Pierce et al.'s (2013) study suggestions, I recommend that FAA CAMI extend this study while including different biodata factors and updated measures of job performance for the development of an improved selection technique to predict ATCS job performance success.

As the IRP recommended that the FAA incorporate several biodata factors into its selection and hiring process, the findings of this study can offer important insights as to the role of socioeconomic status and overall high school grade point average in future studies. To help the FAA achieve their research goals of further defining and evaluating biodata, I recommend that FAA CAMI conduct these additional studies.

Conclusion

This study revealed considerable support for the knowledge inherent in the theoretical frameworks of TJP and biodata theory as well as in the extant FAA and IO literature. More specifically, this study found that the majority of GMA and biodata factors were significant predictors of NG job performance success, whereas much fewer of the constructs significantly predicted PS job success. While average high school math letter grade did not predict ATCS job performance, both socioeconomic status and overall high school average letter grade significantly predicted ATCS job performance for both PS and NG controllers. This research provided new information on socioeconomic status and intergenerational comparisons that should help influence the future direction of FAA research on ways to determine how biodata may be revised to better predict ATCS job performance.

Cognitive ability and biodata both have a role in predicting training success and job performance. However, because of the limitations that exist for biodata, such as its undefined nature, subjective measures, or the inability to confirm its veracity, applied practitioners should ensure optimization of the face validity of their assessment before putting it into practice.

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Appendix A: Research Agreement

Preface to the Research Agreement

A key research problem in aviation safety is the selection of personnel into safety-critical occupations such as air traffic control specialist (ATCS). Analysis of the data from different perspectives helps to advance our scientific knowledge and understanding of this applied problem.

To that end and to advance scientific understanding in personnel selection, de-identified ATCS selection data are requested for analysis by Karen Fox under the supervision of Dr. John Deaton, Walden University, 1-407-782-9259, john.deaton@waldenu.edu under the terms below.

Terms of the Research Agreement

1. Karen Fox will ensure that the requested data will be used for the stated research purpose only.

2. Karen Fox and Dr. John Deaton will protect the data from inadvertent disclosure. Both agree that the data will not be re-distributed to any other party without the express written permission of the FAA technical point of contact below.

3. Karen Fox is responsible for compliance with Walden University Institutional Review Board (IRB) and research policies and will provide a copy of the IRB finding for this research project to the FAA.

4. Karen Fox and Dr. John Deaton agree to provide any presentations, publications, and briefings derived from these data to the FAA point-of-contact for review and comment prior to their submission for publication or presentation. The FAA reserves the right to require correction of factual errors only; matters of opinion, interpretation, and discussion are reserved to the student and faculty supervisor under this Research Agreement.

5. All presentations, publications, briefings, documents, and other artifacts based on the data provided by the FAA will include (a) an acknowledgment that the data were provided by the Federal Aviation Administration's Civil Aerospace Medical Institute and (b) a disclaimer that the opinions expressed are those of the author alone and do not necessarily reflect the official policies of the FAA, the U.S. Department of Transportation, or United States government.

6. Karen Fox will provide a bound copy of the completed and approved dissertation to the Civil Aerospace Medical Institute Library within 30 days of completion.

7. Upon completion of the research project, Karen Fox and Dr. John Deaton shall certify in writing to the FAA point-of-contact that the data have been destroyed unless otherwise given permission in writing by the FAA for continued use of the data provided under this Research Agreement. The FAA shall maintain the archival copy of the data provided under this Research Agreement.

Agreed

For the FAA	**Student**
Printed Name	*Printed Name*
Signature	*Signature*
Date	*Date*

Faculty Supervisor
Dr. John Deaton
Walden University
Work: 1-407-782-925,
Email: john.deaton@waldenu.edu

Printed Name

Signature

Date

Appendix B: BQ Survey for PS Controllers

Predictor Variable Name	Item Stem	Response Key	Response Label
BQ6	What was your average high school arithmetic/math letter grade		
		1	NA
		2	Lower than C-
		3	C- to C+
		4	B- to B+
		5	A- to A+
BQ9	What was your overall high school average letter grade?		
		1	NA
		2	Lower than C-
		3	C- to C+
		4	B- to B+
		5	A- to A+
BQ111	How long do you think that it will take you to become fully effective in your current job?		
		1	Much longer
		2	Somewhat longer
		3	Average
		4	Little less
		5	Much less

(appendix continues)

Predictor Variable Name	Item Stem	Response Keys	Response Label
BQ112	Of all the ATCSs in the country, at what percentile do you think you will be able to perform?		
		1	Lowest 10%
		2	Lower half
		3	Average
		4	Upper half
		5	Top 10%
BQ130	While growing up, where did you live most of the time?		
		1	Rural
		2	Small town
		3	Suburb
		4	City of < 500K
		5	City of > 500K
BQ131	While growing up, what was the economic status of your family?		
		1	Lower
		2	Lower middle
		3	Middle
		4	Upper middle
		5	Upper
OJT_PS Group	Did they become certified or stay in training/	0	Did not certify or left training at first field facility
		1	Certified or still in training

Appendix C: BQ Survey for NG Controllers

Predictor Variable Name	Item Stem	Response Key	Response Label
BQ6	What was your average high school arithmetic/math letter grade		
		0	Did not have course
		1	Lower than C-
		2	C- to C+
		3	B- to B+
		4	A- to A+
BQ9	What was your overall high school average letter grade?		
		0	Did not have course
		1	Lower than C-
		2	C- to C+
		3	B- to B+
		4	A- to A+
BQ111	How long do you think that it will take you to become fully effective in your current job?		
		1	Much longer
		2	Somewhat longer
		3	Average
		4	Little less
		5	Much less

(appendix continues)

Predictor Variable Name	Item Stem	Response Key	Response Label
BQ112	Of all the ATCSs in the country, at what percentile do you think you will be able to perform?		
		1	Lowest 10%
		2	Lower half
		3	Average
		4	Upper half
		5	Top 10%
BQ130	While growing up, where did you live most of the time?		
		1	Rural
		2	Small town
		3	Suburb
		4	City of < 500K
		5	City of > 500K
BQ131	While growing up, what was the economic status of your family?		
		1	Lower
		2	Lower middle
		3	Middle
		4	Upper middle
		5	Upper
OJT_NG_Group	Did they become certified or stay in training/	0	Did not certify or left training at first field facility
		1	Certified or still in training

Curriculum Vitae

Karen D. Fox

EDUCATION:

Ph.D. Organizational Psychology (ABD – all but dissertation)
Walden University (anticipated graduation 2014)

MBA Master of Business Administration (1995)
University of Southern California - Marshall School of Business

B.S. Finance (1989)
Santa Clara University

EXPERIENCE:

11/2000 – 5/2006 **Sun Microsystems**
Data Center Solutions Product Marketing Manager

- Managed and led global product launches of services and solutions in the Data Center Solutions divisions.
- Solutions included third party applications such as SAP Consolidations, Mainframe Rehosting, Enterprise Messaging and ERP Oracle Products.
- Collaborated with engineering and automated order and business processes as required for data solution program rollout.

09/1997 – 08/2000 **Oracle Inc.**
Senior Organizational Change Management Consultant
Senior Product Manager

- Employed in the Oracle Education Performance high-technology industry as a senior change management consultant, I lead and consulted with organizations such as Hitachi Data Systems, and

Sun Microsystems.

- Senior Product manager for the Oracle 11i Customer Relationship Management (CRM) Business Intelligence product suite.

08/1995 – 08/1996

Price Waterhouse, LLP.

Senior Management Consultant for Organizational Change Management

- As client engagement leader, I executed business process and cost/benefit analyses for ERP integration and implementation for corporate clients in the high technology, entertainment, and pharmaceutical sectors.

- High tech corporate consulting clients included, but not limited to, Applied Materials, 3Com, Hitachi Data Systems, and Sun Microsystems.

- Entertainment clients included MCA Universal and Sony Pictures. Pharmaceutical company included ValueRx.

09/1989 – 09/1993

Westinghouse Electric Company
Marine Division

Cost/Schedule Analyst

- Manufacturing cost accountant in the Operations Finance group and financial analyst in the corporate budgeting department.
- Buyer of steel commodities in the Purchasing department.